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**Original Article**

# FOOD PRICES AND ECONOMIC GROWTH IN SUB-SAHARAN AFRICA: PATTERNS, PRESSURES, AND POLICY RESPONSES

***[1]Jane Wanjiru Kamau and [2]Emmanuel Oluwaseun Adeyemi***

[1]The Rockefeller Foundation, Nairobi, Kenya
[2]CIAT-Africa,
Kawanda Agricultural Research Institute, Uganda.
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**Abstract:** Despite the global success of the Green Revolution in enhancing agricultural productivity, Africa continues to face significant challenges in this regard, particularly evident in sub-Saharan Africa (SSA), with South Africa being a notable exception. The persistent low productivity in African agriculture exacerbates food insecurity, resulting in adverse outcomes for farm families including low returns on investments, inadequate livelihoods characterized by low income and poor nutrition, heightened vulnerability to risks, and diminished life expectancy. This situation also prompts detrimental coping strategies, contributing to environmental degradation and the depletion of natural resources. The correlation between agricultural productivity, natural resources management, and food security underscores the urgent need for targeted interventions in SSA to address these interconnected challenges.

**Keywords:** Agriculture, Sub-Saharan Africa, Food insecurity, Productivity, Natural resources management

## INTRODUCTION

Green revolution and high agricultural productivity have been attained in most regions of the world except Africa where agriculture is still characterized by low productivity, leading to widespread food insecurity – a situation most clearly observed in sub-Saharan African (SSA), especially if South Africa is excluded. Among the farm families, this results to low returns on investments, poor livelihoods (low income, poor nutrition and lack of food security, vulnerability to risks, low life expectancy, etc.), and extractive and damaging coping behavior, leading to environmental and natural resources degradation (Chianu et al., 2006). This confirms that food security and availability is closely tied to agricultural productivity and improved natural resources management (Todd, 2004). While agreeing that agricultural growth is central to winning the battle against hunger and poverty in SSA, scholars have largely blamed the rampant low and highly variable agricultural productivity and widespread land degradation [affecting 65% of Africa (Scherr, 1999; European Commission, 2007)] on the abysmally low use of farm inputs, especially mineral fertilizers. About 75 – 80% of Africa's farmland is degraded with the rate of degradation standing at an annual rate of 30 – 60 kg nutrients per hectare (Roy, 2006). Nearly all of Africa's land is vulnerable to degradation (European Commission, 2007). Without adequate inputs, farmers often cannot meet the food needs of their families and those of the rapidly growing population. Yet fertilizer use in Africa is the lowest in the world. In other regions, it is the excessive use of mineral fertilizers that is causing environmental degradation. However, Africa suffers from the opposite problem where lack of or limited use of mineral fertilizers in the farming systems is the main cause of environmental degradation due to soil nutrient mining. This notwithstanding, through the emphasis on Integrated Soil Fertility Management, the harmful effect on the environment of excessive use of only mineral fertilizers as witnessed in industrialized countries must be avoided in SSA as fertilizer consumption increases following the intervention by the African Heads of State and Government. Important safeguards include participatory monitoring and evaluation, soil testing and the application of the right types of fertilizers in different places and full involvement of agricultural extension personal and relevant NGOs.

Fertilizers in Africa are expensive, so farmers use considerably less and suboptimal levels of fertilizer per hectare than what obtain in other regions. In 1993, an African farmer could purchase 41 kg of DAP fertilizer for the price of 90 kg of maize. By late 1999 the same farmer could only purchase 25 kg of DAP fertilizer for 90 kg of maize. In 2002/03, fertilizer use (kg ha-1) in various regions and countries of the world were estimated as follows: 8 (for SSA), 80 (Latin America), 95 (India), 98 (North America), 114 (USA), 175 (Western Europe), 202 (East Asia), 260 (France), and 314 (Egypt) (Roy, 2006). Average fertilizer use in SSA is about 8 – 9 kg ha-1 compared to 260 kg ha-1 in France and 114 kg ha-1 in USA (Table 1).

At about 2 million tons year-1, SSA's fertilizer consumption is less than the 3.4 million tons annually consumed by Bangladesh (Roy, 2006; Versi, 2006), a single country. A comparison of fertilizer consumption trend (1980 – 1989 and 1996 – 2000) in SSA and developing countries of Asia shows that while average annual fertilizer consumption increased by 182% in the latter, it increased by only 16% in the former (FAOSTAT, 2003). With 9% of the world's population, SSA accounts for < 2% of global fertilizer use and < 0.1% of global fertilizer production. Since the 1950s, Africa has lost about 20% of its soil fertility irreversibly due to degradation (Dregne, 1990). The continent loses the equivalent of over US$4 billion worth of soil nutrients per year, severely eroding its ability to feed itself and generate substantial farm income. Yield and production losses due to land degradation have been reported to range from 2 to 50% (Lal, 1995; Scherr, 1999). When soil nutrient inputs are lower than soil nutrient removals (following water and wind erosion, crop nutrient uptake, leaching, etc.), soil depletion and degradation occur. Nutrient balances for cropping systems in most SSA countries are negative, implying soil nutrient mining (Figure 1).

Annual nutrient loss from cultivated land is estimated (in million tons) at: 4.4 for Nitrogen (N), 0.5 for Phosphorus (P), and 3.0 for Potassium (K). These rates are several times higher than SSA's (excluding South Africa) annual fertilizer consumption (in million tons) of 0.8 for N, 0.26 for P, and 0.20 for K. Nutrient loss (kg ha-1) during the last three decades is equivalent to 1400 of Urea, 375 of Triple Super Phosphate (TSP), and 896 of Potassium Chloride (KCl).

The above anomalies exist even though Africa has the highest endowments of the principal ingredients or natural resources (Phosphates, Nitrates, etc.) used in manufacturing fertilizers. Yet, production of fertilizer on the continent is low. With fallow periods getting shorter in many African countries, the absence of fertilizer means that soil is being leached of essential minerals. While land is being degraded, soil fertility is declining to levels insufficient to sustain and support economically feasible agricultural production.

Given that several alternative options for increasing soil fertility for enhanced agricultural productivity has been tried (with little success) in the past, a debate on the way forward concluded on the urgent need to increase the average rate of use of mineral fertilizers at farm level, unfortunately coming at a time when the world fertilizer free on board (FOB) cost (US$ t-1) is trending upwards and reaching historic highs. To actualize the agreed way forward, top-level lobbying and policy dialogue are being used, based on the conviction that a move towards reducing hunger on the African continent must begin by addressing its severely depleted soils.

The declaration of the African Heads of State and Government to support increase in fertilizer use in Africa from the present average of about 8 kg ha-1 to new average of about 50 kg nutrient ha-1 by 2015 took place at the Africa Fertilizer Summit (AFS) in June 2006. Figure 2 shows how this relates to fertilizer use in other regions of the world.

Following the political declaration, the question of how best to attain this goal became critical in the minds of scientists and policy and economic analysts, especially given the high and increasing farm gate price of the generally imported mineral fertilizers in most parts of SSA [about US$ 482 t-1 for NPK in Malawi (Saudi Arabia to Blantyre via Beira) compared with the NPK fertilizer FOB of US$ 289 t-1 (Malawi delivery) or about US$ 513 t-1 for NPK in Rwanda (Black Sea-Russia- Kigali via Dar es Salaam) compared with the NPK fertilizer FOB of US$ 207 t-1 (Rwanda delivery)] of mineral fertilizers in most parts of SSA. Using the examples of Malawi and Rwanda, the rather high farm gate price is partitioned and attributed (in %) as shown in Table 2. Table 2 shows that FOB price only accounts for 40 – 60% of the farm gate price. Other key items of cost that add up to explain the high and increasing farm gate price are trucking (especially from sea port to in-country warehouse), which accounts for 15 – 34% of the farm gate price, and sea shipping that accounts for 10 – 12%.

This paper contributes to answering the question: ‘how best to attain the goal of increasing fertilizer use from the current average of about 8 kg ha-1 to a new average of about 50 kg ha-1 by 2015)’ by ex-ante analysis of the potential benefits of joint regional fertilizer procurement to reduce farm gate price and provide incentive for increased fertilizer demand and use in SSA. It compares the effect of structural changes in fertilizer market on fertilizer demand, and total and additional farm income with the base condition. This was carried out under three own (fertilizer) price elasticity of demand scenarios. It provides information on potential benefits of regional joint fertilizer procurement to reduce farm gate price of fertilizers, creating incentives for increased fertilizer use in SSA. Increase in volume of order through consortia also leads to a fall in FOB price.

Clearly, there are some structural weaknesses in the African fertilizer industry. For instance, to move one metric ton of fertilizer a distance of 1000 km costs an average of US$15 (in USA), US$30 (India), and US$100 (SSA). Within SSA, huge disparities also exist depending on the physical location of a country, with the highest cost incurred in landlocked countries. For instance, in Rwanda, it costs about US$163 to move one metric ton of fertilizer a distance of 1000 km. Also, while it costs about US$50 to move one metric ton of maize from Iowa (USA) to Mombasa (Kenya), a distance of about 13,600 km, it costs about US$100 to move the same quantity of maize from Mombasa to Kampala (Uganda), a distance of about 900 km, implying a structural problem. Improvements in structural supply issues [ordering trucks in product, ordering in bulk, sourcing from the lowest cost advance, actively negotiating, use of large ships that stop plants, selecting low cost (but 'right') fertilizers, etc.] have in few locations, ordering 'generic' mass-produced NPK been found to lead to 11–18% reduction in fertilizer farm gate price (Kelly et al., 2003; Kumar, 2007). Kumar (2007) noted that these could reduce fertilizer farm gate price in Malawi by 14.5%, from US$482 t-1 to US$412 t-1. This indicates that improving the overall procurement process could reduce the price of mineral fertilizers in SSA.

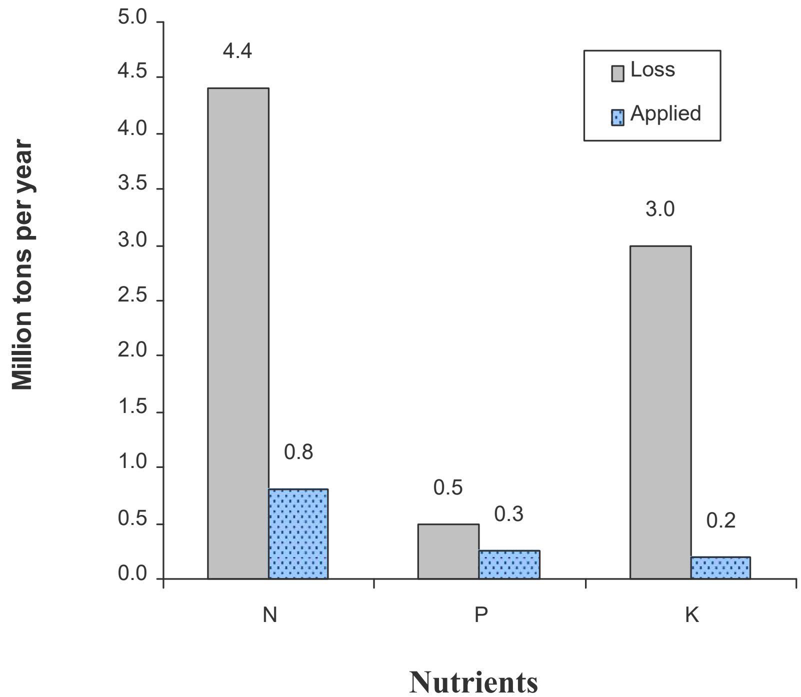

**Figure 1.** Macronutrients applications versus losses in Sub-Saharan Africa (Source: Sanchez et al., 1997).

| **Region** | **1961** | | | **1997** | | |
|---|---|---|---|---|---|---|
| | **Population (million)** | **Crop land (million ha)** | **Fertiliser Use (kg/ha)** | **Population (million)** | **Crop land (million ha)** | **Fertiliser use (kg/ha)** |
| World | 3136 | 1352 | 23.00 | 5823 | 1501 | 90.00 |
| Developing Countries | 978 | 654 | 42.00 | 1294 | 640 | 87.00 |
| **SSA** | **219** | **120** | **0.15** | **578** | **154** | **9.00** |
| DR Congo | 16 | 7.0 | 0.04 | 48 | 8 | 0.80 |
| Kenya | 9 | 28.8 | 2.80 | 28 | 5 | 29.00 |
| Nigeria | 38 | 0.6 | 0.50 | 104 | 31 | 4.50 |
| **Egypt** | **29** | **2.6** | **93.00** | **65** | **3** | **313.00** |
| **France** | **46** | **21.4** | **113.00** | **58** | **20** | **260.00** |
| India | 452 | 160.9 | 21.00 | 966 | 170 | 95.00 |
| USA | 189 | 182.5 | 41.00 | 272 | 177 | 114.00 |

**Table 1.** Population, cropped land and fertilizer use (1961 and 1997).
Source: FAOSTAT, 2003

**Table 2.** Percent attribution of the high farm gate prices of fertilizers: Malawi and Rwanda.

| **Farm gate price, Fertilizer FOB price, & Items of attribution** | **Malawi** | **Rwanda** |
|---|---|---|
| Farm gate price (US$/ton) | 482 | 513 |
| Fertilizer FOB price (US$/ton) | 289 | 207 |
| ***Item of attribution:*** | | |
| Fertilizer FOB (%) | 60 | 40 |
| Sea shipping (%) | 12 | 10 |
| Stevedoring, shore handling, *ad-valorem*[*], bagging, warehousing, customs (on value), insurance and clearing (%)[#] | 5 | 8 |
| Trucking from port to in-country warehouse (+ border fees) (%)[$] | 15 | 34 |
| In country trucking and warehousing (%) | 8 | 8 |
| Total (%) | 100 | 100 |

*Various duty charges, taxes and port fees based on FOB dollar value of shipment
#In the case of Rwanda, other items listed within this sub-group are: demurrage, bags, port storage (indirect discharge), C+F *ad valorem* wharfage, private in port security, 3 tallies, loading on truck, sundries and losses from B/L.
$This is made up of gasoline, overhead, taxes and tolls, depreciation, tire, and driver costs
Source: Adapted from Kumar (2007)

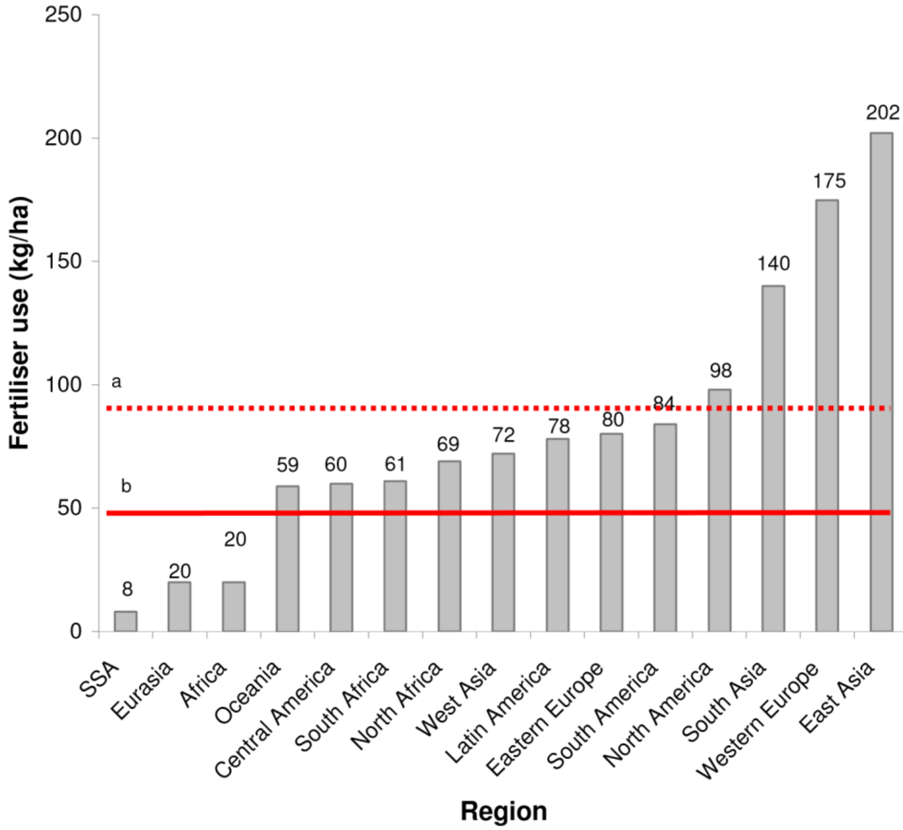


**Figure 2.** Relationship between global mean fertilizer use and African fertilizer summit recommendation. a = Global mean fertilizer use (93 kg/ha); b = African Fertilizer Summit recommendation (50 kg/ha).

**Theoretical framework and elasticity scenarios**

Elasticity (*e*) is a measurement used by economists to estimate the responsiveness of demand to changes in price. Technically, *e* refers to proportionate change in a dependent variable of a function (*Y*), divided by proportionate change in an explanatory or independent variable (*X*) at a given value of the explanatory variable and is a product of ratios (Bannock et al., 2003).

Observation of market behavior is important for the calculation of *e*, explaining why *e* is usually estimated using historical statistical data. Alternatively, *e* can be derived from econometric model expressing demand as a function of price in an equation. The formula is:

$e = \frac{\% \text{ change in } y}{}$ .

% *change x*

Where *e* is a measure of the sensitivity of one thing (demand for commodity) to another thing (the price of it). In the case of price elasticity, *Y* would be quantity demanded, and *X* would be price. If elasticity has an absolute magnitude numerically <1, quantity demanded is said to be price-inelastic (that if the price is increased (marginally) the quantity demanded will not fall proportionately as much and, therefore, the total expenditure on the good will increase). If the good is price-elastic (elasticity is numerically >1) demand will be reduced more than price, and therefore less will be spent on the good than before price was increased. We can have elasticity of anything with respect to anything else, not just in consumer demand theory. An own price *e* of say – 0.35 for fertilizer means that a 10% increase in price would result in 3.5% decrease in fertilizer demand. Using the estimated price elasticity of a commodity (and other factors sometimes), percent increase or decrease in its usage in future years can be projected.

## MATERIALS AND METHODS

FAO data for 11 African countries (Burkina-Faso, Ghana, Mali, and Nigeria in West Africa; Democratic Republic of Congo, Kenya, Rwanda, and Uganda in East and Central Africa; and Malawi, Mozambique, and Zambia in Southern Africa) were used as base data. The case study crops were maize, millet, sorghum and cassava. The areas (ha), yields (kg $ha^{-1}$), outputs (metric tons MT), prices (US$/MT), and output values (US$) of the crops were used in computations.

Literature information indicating that structural changes in fertilizer procurement can reduce the farm gate price of fertilizers by d 11 - 18% (Kelly et al., 2003) was employed. An approximate middle value (15%) of the range was used in computations. Estimations were carried out under three-fertilizer own price elasticity of demand scenarios: –0.38, –1.43, and –2.24 earlier estimated in Ethiopia, Cote d'Ivoire, and Ghana, respectively. These were further classified as low elasticity for –0.38 (representing situations in less endowed countries), medium elasticity for –1.43 (actually high in own respect), and high elasticity for –2.24 (typical of highly endowed agriculture). The elasticity figures are generally interpreted as in the example given earlier.

Data analysis combined simulation techniques with regional farm enterprise analysis based on ex-ante information to assess the impact on farm income of alternative fertilizer pricing policies. The increases in demand (even under the different elasticity scenarios) due to the reduction in farm gate prices were multiplied by the current level of use of fertilizers to arrive at new levels of demand for fertilizers. We used the estimate of the increase in yield per kg of fertilizer applied to estimate the overall increase in production from the expanded fertilizer use. Thereafter, we multiply by world market price for the test crops to obtain the additional farm incomes or value of additional food production.

For each of the elasticity estimates, we assumed an average decline in farm gate price of 15% [approximated middle value of the range given by Kelly (2006)]. The demand for fertilizer will increase depending on the own price elasticity of demand for fertilizers. Based on the 15% decline in farm gate price the percent increase in demand for fertilizer was computed under each elasticity scenario as follows:

Low own fertilizer price elasticity of demand:

________3.8*0.15 = 5.7%

0.10

(i) Medium own fertilizer price elasticity of demand:

$$\frac{14.3 * 0.15}{0.10} = 21.5\%$$

High own fertilizer price elasticity of demand:

$$\frac{22.4 * 0.15}{0.10} = 33.6\%$$

With the above, all we needed was to multiply the increase in demand by the current level of use of fertilizers to get the new level of demand for fertilizers. Then, we used the estimate of the increase in yield per kilogram of fertilizer used to estimate the overall increase in production from the expanded fertilizer use. We then multiplied by the world market price for the crops to get the additional farm incomes or value of additional food production.

**RESULTS AND DISCUSSIONS**

Some selected characteristics (total land area cultivated; land area under maize, millet, sorghum, and cassava; proportion of total land area accounted for by maize, millet, sorghum, and cassava; and the current average rate of fertilizer application) of the countries of study are presented in Table 3, which also shows that current mineral fertilizer consumption for these countries ranges from a low value of 1 kg/ha (Democratic Republic Congo and Uganda) to 39 kg/ha (Malawi) with a mean of 9.8 kg/ha across the 11 countries. Table 4 shows the current total fertilizer marketed in the 11 countries and the effect (under the three elasticity scenarios) on total fertilizer marketed of a structural change in fertilizer marketing arrangement that leads to a 15% reduction in farm gate price of fertilizer. Without the intervention of 15% farm gate price reduction due to joint fertilizer procurement, an own price elasticity of say –0.35 would mean that a 10% increase in fertilizer price would result in a 3.5% decrease in demand for and use of fertilizer. With this type of information, we can project how far down the percent usage of fertilizer can go in the future. Table 4 shows how the structural change that brings about a 15% reduction in farm gate price of fertilizer actually results in an increase in demand and use of fertilizer under the three own price elasticity scenarios.

Results in Table 5 show that compared with base situation, a structural change in fertilizer procurement arrangement that resulted to a 15% reduction in farm gate price led to: 6% additional farm income (US$125 million) under the low own price elasticity of fertilizer demand scenario, 22% (or US$472 million) additional farm income under the medium own price elasticity of fertilizer demand scenario, and 34% (or US$730 million) additional farm income under the high own price elasticity of fertilizer demand scenario. Switching from one scenario to another also indicates a potential for 20 – 32% further increase in farm income (Table 5).

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**Table 3.** Selected characteristics of study countries.

| Country | Total land cultivated (x 1000 ha) | Land area devoted to Maize, Millet, Sorghum and Cassava (x 1000 ha) | Land area devoted to the four commodities as % of total land area | Average rate of fertilizer application (kg/ha) |
|---|---|---|---|---|
| Burkina Faso | 4250 | 2998 | 71 | 3 |
| Congo, Dem R | 7800 | 3507 | 45 | 1 |
| Ghana | 6214 | 2027 | 33 | 4 |
| Kenya | 5127 | 1842 | 36 | 29 |
| Malawi | 2340 | 1706 | 73 | 39 |
| Mali | 4691 | 2274 | 48 | 9 |
| Mozambique | 4268 | 2658 | 62 | 5 |
| Nigeria | 31683 | 20387 | 64 | 6 |
| Rwanda | 1265 | 411 | 32 | 4 |
| Uganda | 7187 | 1712 | 24 | 1 |
| Zambia | 5288 | 724 | 14 | 8 |
| **Mean** | **7283** | **3659** | **46** | **9.8** |

**Table 4.** Structural change in fertilizer market (15% price fall).

| Country | Total fertilizer (x 1000 MT) | | | |
|---|---|---|---|---|
| | Current | Scenario 1 (–*0.38*) | Scenario 2 (–*1.43*) | Scenario 3 (–*2.24*) |
| Burkina-Faso | 12.4 | 13.1 | 15.1 | 16.9 |
| DRC | 4.4 | 4.7 | 5.4 | 5.9 |
| Ghana | 24.6 | 26.1 | 29.9 | 32.9 |
| Kenya | 146.1 | 154.5 | 177.5 | 195.2 |
| Malawi | 90.1 | 95.2 | 109.4 | 120.4 |
| Mali | 41.3 | 43.6 | 50.1 | 55.2 |
| Mozambique | 21.4 | 22.6 | 26.0 | 28.5 |
| Nigeria | 191.6 | 202.5 | 232.7 | 255.9 |
| Rwanda | 5.3 | 5.6 | 6.4 | 7.1 |
| Uganda | 7.2 | 7.7 | 8.8 | 9.7 |

| | | | | |
|---|---|---|---|---|
| Zambia | 44.3 | 46.8 | 53.8 | 59.2 |
| **Across countries** | **588.8** | **622.4** | **715.1** | **786.7** |

**Conclusion**

The paper notes the strong need to support structural changes in fertilizer market and any other interventions that can reduce farm gate price of fertilizers (and other inputs). Such interventions increase farm-level use of inputs, farmer productivity, and total production and farm income, thereby leading to improved livelihoods.

The fertilizer FOBs that are being reported are from the developed world where the cost of inputs (e.g., labor) is high. This presents a strong argument for fertilizer production in Africa where, apart from the existence of natural deposits of the key raw materials (over 75% of rock phosphate deposits in the world is found in Africa) for producing fertilizers, labor is also relatively cheap. This calls for the need to address the many constraints (achieving sufficient scale, obtaining cost effective credit, etc) in developing viable fertilizer manufacturing in Africa in order to solve the challenge facing African producers. Lastly, improving the overall fertilizer procurement process could reduce the price of fertilizer in sub-Saharan Africa.

**Table 5.** Farm (total and additional) income changes from 15% farm gate fertilizer price reduction

| **Current and different elasticity scenarios** | **Farm income (US$ x 1,000,000)** | | **% increase in income following switches** | | |
|---|---|---|---|---|---|
| | **Total** | **Additional** | | | |
| Current status (C) | 2198 | - | C to 1,2,3 | 1 to 2, 3 | 2 to 3 |
| Scenario 1 (1) | 2324 | 125 | 6 | - | - |
| Scenario 2 (2) | 2670 | 472 | 22 | 20 | - |
| Scenario 3 (3) | 2920 | 730 | 33 | 32 | 27 |

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