Effect of a fertilizer subsidy on the agricultural sector and household welfare in Kenya

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Executive summary

The agricultural sector in Kenya is significant for food security and economic development. It accounts for 27% of the country's gross domestic product (GDP) and over 80% of the rural workforce. Therefore, the productivity of this sector is important to the economy as a whole. The Government of Kenya seeks to increase fertilizer consumption to 50kg/hectare from the current 31kg/hectare, by financing infrastructure and supporting fertilizer markets through various programmes. The overall objective of this study is to analyze the impact of the current fertilizer subsidy of 54% on crop production, household welfare and other sectors of the economy. A computable general equilibrium (CGE) model is calibrated to a social accounting matrix (SAM) for Kenya and two scenarios are simulated: first, a fertiliser subsidy is applied to food crops only and second, the subsidy is applied to all crops.

We conclude that i) fertilizer is an important agricultural input accounting for 11% of total intermediate input and 2.5% of domestic production cost, ii) applying a fertiliser subsidy for all crops increases factor prices specific to agriculture (i.e., land and agricultural capital) and has a strong effect on overall agricultural production, iii) focusing fertilizer subsides on food crops results in land prices declining, while other factor prices increase, hence the outcome in terms of income is less pro-poor. But food crop production increases more than with a general fertilizer subsidy, resulting in lower food prices benefitting especially the landless rural poor and the urban poor.

Effets de la subvention des engrais sur l'agriculture et le bien-être des ménages au Kenya

Résumé

Le secteur agricole du Kenya est important pour la sécurité alimentaire et le développement économique du pays. Il représente 27 % du Produit Intérieur Brut (PIB) du pays et emploie plus de 80 % de la main-d'œuvre rurale. La productivité de ce secteur est donc importante pour l'ensemble de l'économie. Le gouvernement du Kenya cherche à augmenter la consommation d'engrais à 50 kg/hectare, contre 31 kg/hectare actuellement, en finançant l'infrastructure et en soutenant l'offre d'engrais par le biais de divers programmes. L'objectif général de cette étude est d'analyser l'impact de la subvention actuelle des engrais de 54% sur la production agricole, le bien-être des ménages et d'autres secteurs de l'économie. Un modèle d'équilibre général calculable (ECG) a été calibré sur une Matrice de Comptabilité Sociale (MCS) pour le Kenya et deux scénarii ont été simulés : premièrement, une subvention des engrais est appliquée aux cultures vivrières uniquement et deuxièmement, la subvention est appliquée à toutes les cultures.

Nous concluons que i) les engrais sont un intrant agricole important, représentant 11 % du total des intrants intermédiaires et 2,5 % des coûts de production nationaux, ii) l'application d'une subvention aux engrais pour toutes les cultures augmente les prix des facteurs spécifiques à l'agriculture (c'est-à-dire la terre et le capital agricole) et a un effet important sur la production agricole dans son ensemble, iii) le fait de concentrer les subventions des engrais sur les cultures vivrières entraîne une baisse des prix de la terre, tandis que les prix des autres facteurs augmentent. Ce qui fait que le résultat en termes de revenu est moins favorable aux pauvres. Mais la production de cultures vivrières augmente davantage qu'avec une subvention des engrais pour toutes les cultures. Ce qui entraîne une baisse des prix des denrées alimentaires dont bénéficient surtout les pauvres ruraux qui n'ont pas (ou qui ont peu de) terre et les pauvres urbains.

1. Background

The agricultural sector in Kenya is significant for food security and economic development. It contributes 27% to the country's gross domestic product (GDP) and 75% of raw industrial materials. It also contributes 65% to the country's total export earnings, employs over 80% of the rural workforce, and contributes 18% to formal employment (2020). Given the significant role of agriculture in the Kenyan economy, productivity of this sector is important. To this end, key factors influencing crop production inputs such as fertilizers, seeds, and pesticides are critical determinants of productivity.

Fertilizers are a key input to increase agricultural productivity. During the last five years (2017-2021), Kenya's consumption of fertilizer has been varying strongly (Figure 1) and DAP[1], NPK[2] and CAN[3] fertilizers have constituted approximately 74% of total fertilizer consumption.

The Abuja Declaration of 2006 acknowledges that "fertilizer is crucial for achieving an African Green Revolution in the face of a rapidly rising population and declining soil fertility". In response to this declaration, Kenya targets to increase fertilizer consumption to 50kg/hectare from the current 31kg/hectare. The Government of Kenya (GoK) has historically encouraged its farmers to use fertilizer by financing infrastructure and supporting fertilizer markets.

The Government of Kenya has also put in place initiatives that seek to increase access to quality and appropriate fertilizers, enhancing productivity, improving household and national food security and improving incomes. These programmes, which seek to increase chemical fertilizers, include the National Accelerated Agricultural Input Access Programme (NAAIAP), the Kenya Cereals Enhancement Programme - Climate Resilient Agricultural Livelihoods (KCEP-CRAL) subsidy programme and the County Government Input Programmes. However, there is still low usage of chemical fertilizers due to high prices and lack of access to fertilizer markets due to long distance. This has resulted in rising use of organic fertilizers.

1.1 Fertilizer production and import in Kenya

Kenya does not have the capacity to produce synthetic fertilizers, given that the country does not have the necessary raw materials such as natural gas or hydrogen. In Africa, only South Africa and Morocco can manufacture fertilizers since hydrogen is available as a raw material in the country. Kenya has established a manufacturing plant that blends imported ingredients for local use.

Kenya is highly dependent on fertilizer imports and thus the country's domestic fertilizer prices are equally dependent on the prevailing world market fertilizer prices. High fertilizer cost in the last 12 months has been occasioned by global circumstances including increased cost of natural gas, trailing effects of the COVID-19 pandemic and interruptions of global supplies due to the ongoing Russian invasion in Ukraine (KBNS, 2022).

Fertilizer imports attract no tariffs in Kenya although the following fees are imposed on importers:

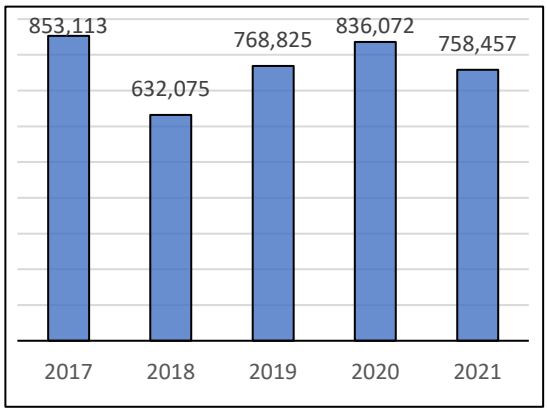
i. Import Declaration Fee (IDF) of 3.5% of the value of cost, insurance and freight (CIF).

[1] Diammonium phosphate,
[2] Nitrogen, phosphorus, and potassium
[3] Calcium Ammonium Nitrate

ii. Railway Development Levy (RDL) of 2.5% of the value of Cost, Insurance and Freight (CIF).

iii. Port handling fees of 90 USD per tonne

Figure 1 shows the quantities (in tonnes) of chemical fertilizers imported for the period 2017-2021. Kenya imports chemical fertilizers mainly from Russia and Ukraine, other sources of fertilizer imports by type are presented here.



S/No.	Fertilizer type	Alternative source
1	NPKs	China, European Union, Egypt
2	DAP	Morocco, Saudi Arabia, US
3	Urea	Saudi Arabia, China
4	CAN	European Union, China
5	MOP	Jordan, China
6	SA	Saudi Arabia, Madagascar

Figure 1: Quantities (in tonnes) of chemical fertilizers imported for the period 2017-2021 and alternative Source countries

Source: Author's compilation based on KNBS. (2022).

1.2 Fertilizer subsidy programme

Given that Kenya relies on fertilizer imports, high world fertilizer prices have affected domestic prices. In June 2020, the retail cost of a 50kg bag of DAP fertilizer was Kshs. 2,800, by September 2022, a 50kg bag was costing Kshs. 6,550. This price increase severely limited access to fertilizers for most farmers. To overcome the increasing fertilizer price challenge, in September 2022, the government implemented a fertiliser subsidy programme that would reduce high fertilizer costs and availed Kshs 3.55 billion for the 2022 short rains season fertilizer subsidy. This funding would subsidise a total of 71,000 MT (1.42 million x 50kg bags) through the National Cereals and Produce Board (NCPB) depots across the country so that farmers can easily access fertilizer. With this subsidy, a 50kg bag of DAP fertilizer would sell at a retail price of Kshs 3,500 per 50 Kgs, implying a 54% reduction in the domestic fertiliser price (GOK 2022).

A fertilizer subsidy is expected to increase the use of fertilisers. This was found to increase farmers yields by 50% compared to farmers who do not use inorganic fertilizers (Njagi and Carter, 2019). Secondly, such subsidies increase access to inputs for poor farmers who would normally not access such products (Ojalaand Bunde, 2019). Third, there is an increase of farm profits, depending also on the residual effects of previous fertilizer application, timing or use of fertilizer during the right season, and communal financial support structures such as group saving (Ochola, 2015).

This analysis aims to establish the impact of the fertilizer subsidy on domestic crop production and the resulting effects on agricultural production and other sectors of the Kenyan economy and private household welfare.

2. Methods

2.1 Database

A Social Accounting Matrix (SAM) for Kenya for the year 2019 has been designed at the International Agricultural Trade and Development Group at Humboldt-Universität zu Berlin based on Elnour et al. (2022) and extended with support from the staff of the Kenya National Bureau of Statistics.

The SAM identifies 46 activities producing 49 commodities, of which 20 are agricultural commodities. Additionally, the SAM includes eight production factors: two types of capital (agricultural and not), two land types (irrigated and not) and four labour categories. Labour is classified based on skill level (skilled and unskilled) and gender (male and female). Besides, households are categorised into four groups, depending on location (rural and urban) and income level (poor and non-poor).

2.2 Model and closure rules

We use the computable general equilibrium (CGE) model STAGE (McDonald and Thierfelder 2015). A CGE model combines economic theory and numerical models to establish the impact of shocks in an economy. Real economic data is used to fit a set of equations that replicate the structure of the economy. From this framework, it is possible to simulate the effect of exogenous shocks, such as policy changes, including economy-wide interactions. The following presents a summary of the CGE model used:

- Production is structured by a three-level nest of Constant Elasticity of Substitution (CES) and Leontief production functions. At the top level, aggregate value-added, and intermediate inputs are combined using a CES function. Production factors are aggregated using CES functions at different levels, whereas the intermediate input component is aggregated using a Leontief production function (the second level). Aggregate primary factors (i.e., labour and land) are combined using CES functions (the third level).
- Producers sell their products either in the local or foreign markets, based on relative prices, as determined by a Constant Elasticity of Transformation (CET) function.
- Households supply production factors to productive activities through factor markets in exchange for wages that constitute a significant portion of their incomes. After paying taxes and making savings, households spend their income on purchasing products. Households maximise their utility subject to Stone-Geary utility functions, selecting the optimal mix of commodities and services while considering purchase prices, preferences, and income constraints.

We apply flexible exchange rate regime closure. The model is saving-driven. All production factors are fully employed across all markets and fully mobile across sectors. The model numéraire for the scenarios is the CPI. The government savings are fixed, and the household

tax rate is flexible. Therefore, any policy implemented in the model is financed through income tax on households.

2.3 Scenarios

Two scenarios were simulated. In the first scenario ("Food") the subsidy applies to food products except sugar (see Table 1), in the second scenario ("All crops") the subsidy applies to all crops (the government outlays for the second scenario are thus higher).

For both scenarios:

- A simulation of a 54% reduction in cost of fertilizers due to the fertilizer subsidy.
- The government outlays for the subsidy are compensated by a multiplicative change in income tax rates.
- The subsidy will especially affect the activities which have high input cost shares for fertilizer.

Table 1: Percent of chemical fertilizer in intermediate input and in total production cost

	Fertilizer input Kshs Million	% of chemical fertilizer in total intermediate input	% of chemical fertilizer in total production cost
Food			
Maize	1,641	13.8	2.4
Wheat	2,067	13.8	2.4
Rice	237	4.8	0.8
Cereals	1,037	12.8	2.2
Roots	130	17.3	3.1
Oilseeds and pulses	154	12.9	1.4
Fruit	1,858	13.0	2.3
Vegetables	4,256	13.8	2.5
Cash crops			
Sugarcane	742	3.5	1.8
Coffee	1,694	14.9	2.8
Tea	16,076	13.8	2.8
Other crops (mainly flowers)	9,198	8.0	2.5
Total	**39,090**	**11.1**	**2.5**

Source: Author's calculations based on the Kenyan SAM 2019.

Several assumptions are made when running the model:

- The decrease in price results in a 27% increase in fertilizer use (in technical terms: The own price elasticity of fertilizer demand is equal to -0.5).
- The elasticity of yield with respect to fertilizer quantity (production elasticity) is about 0.3 for most crops. It is assumed that yield increases by 8%. Exemptions are made for

roots and coffee (5% due to the already high degree of fertilizer use) sugar (5% due to the already intensively managed value chain), tea (3% due to the already high degree of fertilizer use) and other crops (mainly flowers, 1% due to the already high degree of fertilizer used and intensively managed farming systems).

- The model is run with a flexible exchange rate and fixed external balance, fixed saving rates and flexible investment and fixed government expenditure and savings and a variable income tax rate to compensate for additional government expenditure for the fertilizer subsidy.

3. Results

3.1 Domestic production

If fertilizer for all crops is subsidized ("All crops"), production of all crops increases (Figure 2). The increases would be highest for products with high-cost shares in fertilizer and high export shares, as they do not experience strong price declines in case of increasing production, as world market prices are constant. The dominant products falling into this category are tea (18.7%), followed by other crops (15.2%). and coffee and wheat production (2.3%). Production of important staple crops increases between 4% and 12%.

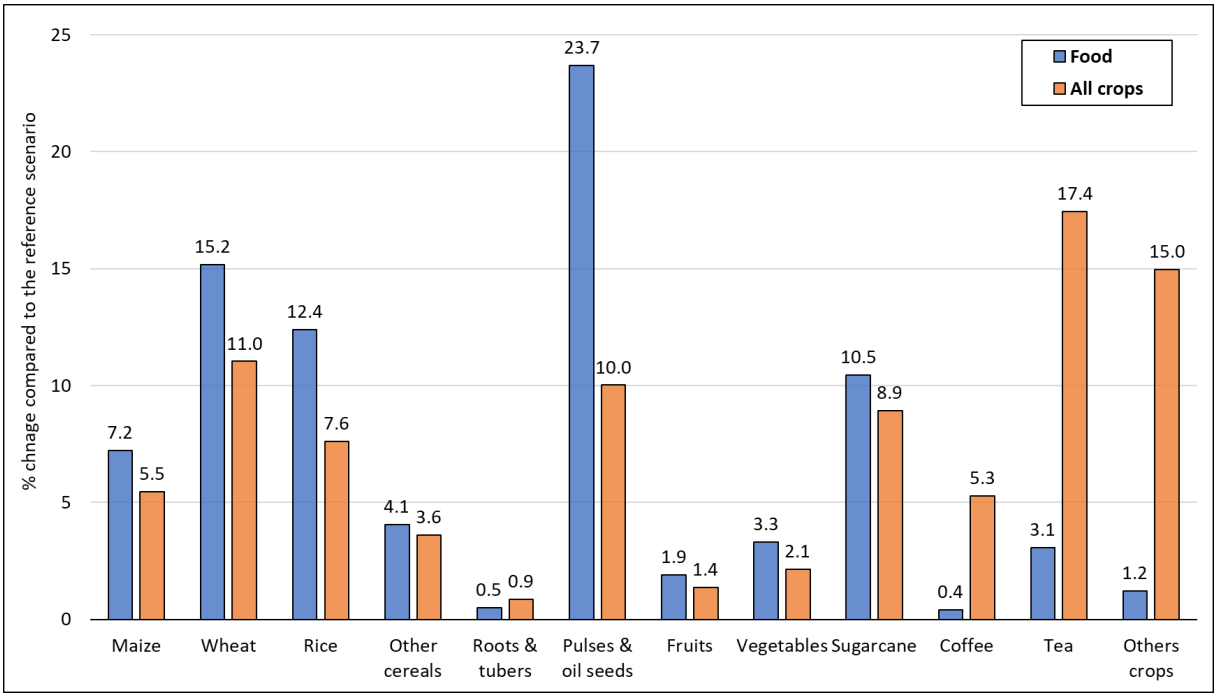


Figure 2: Effects on quantities of domestic production, % change compared to the reference scenario

Source: Authors' calculations based on simulation results.

If only fertilizer for the category "Food" is subsidized, production increases for these products are higher, and production increases for sugarcane, coffee, tea, and other crops are substantially lower. Still, their production slightly increases, which is due to declining land prices.

3.2 Factor prices

Changes in factor prices affect income received by institutions, particularly households. Figure 3 shows that factor prices increase for all factor categories if the fertilizer subsidy applies to all crops. Agriculture becomes more attractive, drawing resources into agriculture. As land is only used in agriculture, its supply to the sector cannot increase and therefore its price increases most. In case of the subsidy only applying to "Food" crops, the average positive effect on factor prices is lower, which is due to the lower level in total subsidy outlays. In addition, land prices slightly decline. This is because food products, on average, are more land intensive than cash crops. Increasing their productivity thus makes land relatively more abundant, resulting in a declining land price.

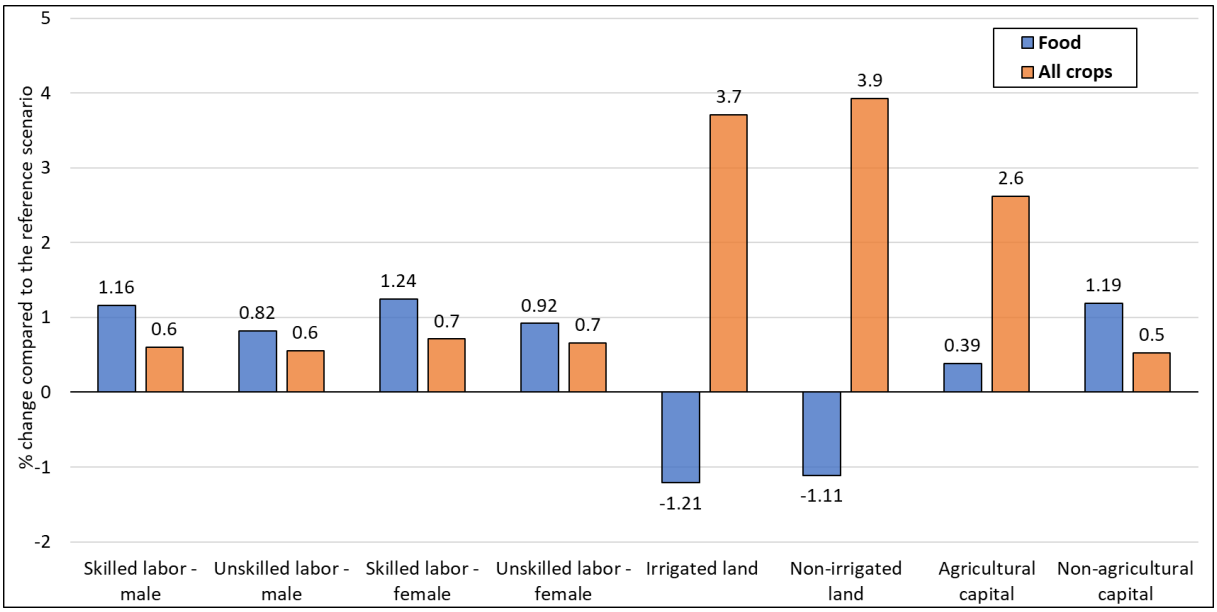


Figure 3: Effects on factor prices, % change compared to the reference scenario

Source: Authors' calculations based on simulation results.

3.3 Household income

Incomes for all household groups increases in both scenarios (by a range of 0.4-1.5%) (Figure 4). Under the "All crops" scenario, the incomes of poor households (both urban and rural) increase more than those of non-poor rural/urban households, respectively. This increase is brought about by the increase in all sources of household income, especially production factors. Rural households in general benefit more as they have a higher share of their income from agricultural production factors (land, agricultural capital), than rural households.

Under the "Food" scenario, rural households benefit less than urban households, mainly due to declining land prices. Still, the overall effect is positive for all household groups.

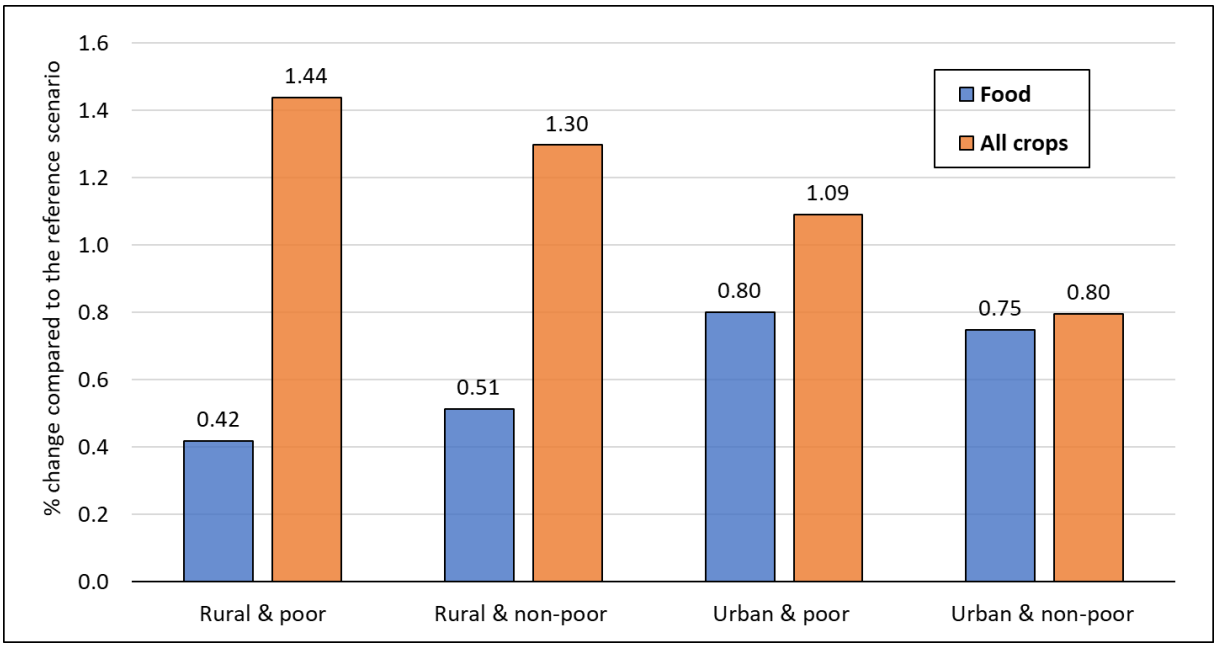


Figure 4: Effects on household income, % change compared to the reference scenario

Source: Authors' calculations based on simulation results.

3.4 Household welfare

Welfare changes include disposable income changes, but also price changes. A decline in price is considered a positive economic change for consumers. In addition, household welfare is affected by changes in income taxes. All these effects are combined in Figure 5, showing that all households experience positive welfare changes under both scenarios.

In the case of the "All crops" scenario, rural households benefit more than urban households, as their factor income increase more (see above). Poor households benefit substantially more than non-poor households, as non-poor households pay the taxes to fund the subsidy.

Under the "Food" scenario, welfare gains of rural households are smaller, due to their lower income increases (Figure 5).

3.5 Macroeconomic effects

Figure 6 shows that domestic production, domestic consumption and GDP increase under both scenarios: more so in the "All crops" scenario. For these variables, the changes under the "All crops" scenario roughly double those under the "Food" scenario. For the trade variables "imports" and "exports", the changes are approximately five times as high. This is, because the production of export crops increases and at the same time allows for more imports since there is a high import concentration on intermediate inputs.

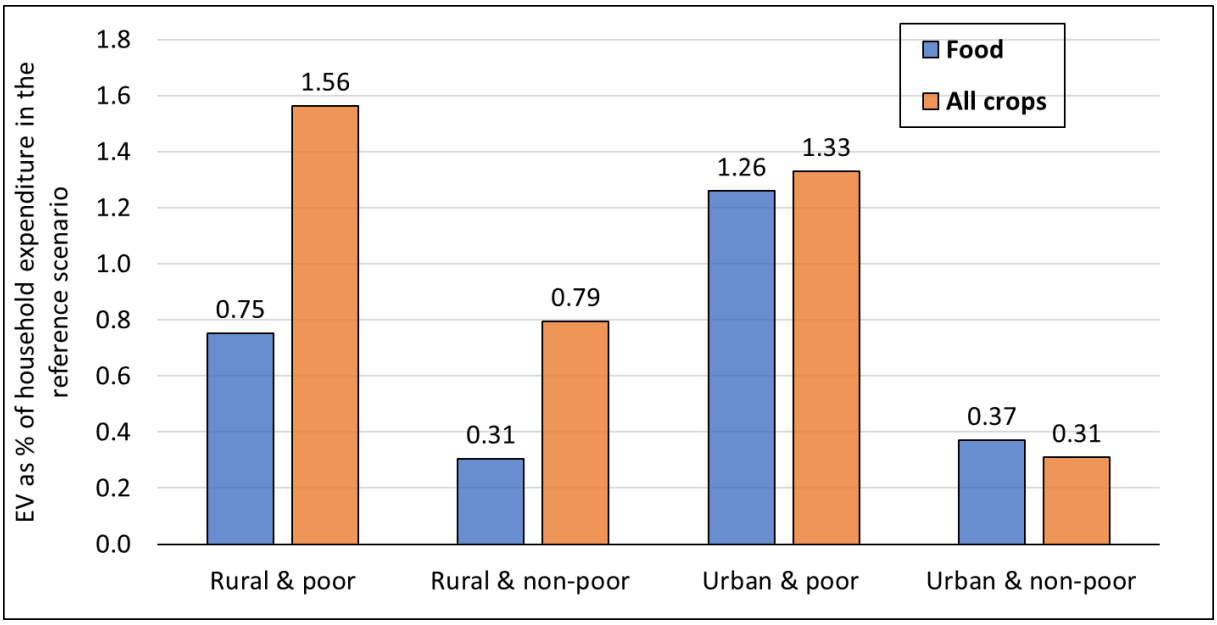


Figure 5: Effects on household welfare, Equivalent Variation (EV) as a share of household expenditure in the reference scenario[4]

Source: Authors' calculations based on simulation results.

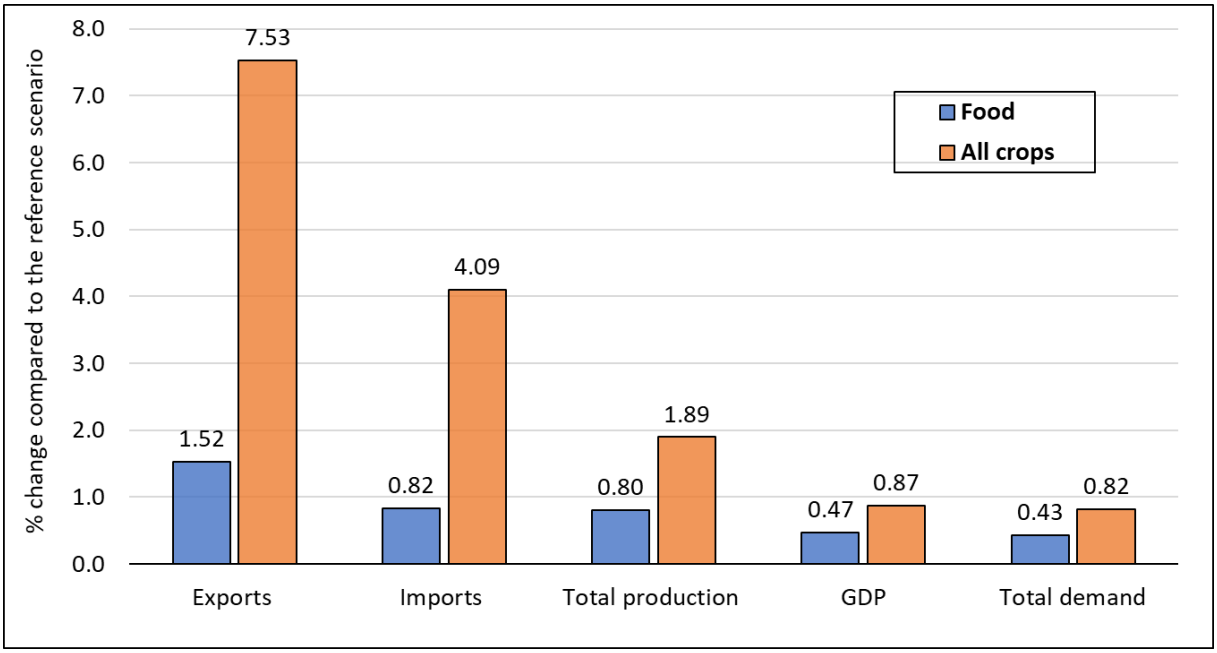


Figure 6: Effects on economy-wide indicators, % change compared to the reference scenario

Source: Authors' calculations based on simulation results.

[4] Equivalent variation (EV) refers to a change in income that would have an equivalent effect on utility as all price and income changes combined.

4. Conclusions

The analysis sought to establish the impact of the fertilizer subsidy on domestic crop production and resulting effects on agricultural production as well as other sectors of the Kenyan economy and private household welfare. Several conclusions can be made:

- Fertilizer is an important intermediate input in agriculture constituting for approximately 11% of total intermediate input cost and 2.5% of domestic production cost.
- Subsidizing fertilizer has the potential to increase agricultural production, economy-wide income and household welfare.
- Focusing fertilizer subsidies on food crops results in food crops increasing more, compared to fertilizer subsidies being paid for all crops.
- If fertilizer subsidies are paid for all crops, factor prices for production factors specific to agriculture (land, agricultural capital) increase the most, resulting in rural households benefitting more than urban households.
- Focusing fertilizer subsides on food crops compared to all crops results in a more unequal development of factor prices: Land prices tend to decline, while other factors increase. Therefore, the outcome in terms of income is less pro-poor.
- Given the assumption that the fertilizer subsidy is financed by income taxes mainly being charged from non-poor households adds to the total welfare effects being pro-poor in both scenarios.
- The increased production of main food crops makes their domestic prices decline, which improves food security especially of the landless rural poor and the urban poor. This effect is stronger, when the subsidy is focused on food products.

5. Policy implications

The following policy implications are derived:

- The income effects of fertilizer subsidies are complex. They include indirect effects mediated for example through factor prices. One example for such an indirect effect is that fertilizer subsidies focused on food crops may result in lower land prices, affecting the incomes of landowners.
- Subsidizing fertilizers is only one ingredient to make fertilizers better available to farmers. Other important ingredients are enhancing public distribution systems and extension services as well as vocational training.
- A fertilizer subsidy is difficult to target to specific farmers, as fertilizers are a tradable good. However, enhancing public distribution systems and extension services in focus regions may be a way to address the products/farm groups which are considered especially important.
- Trade-offs are important. Focusing fertilizer subsidies on food crops makes their domestic prices decline more, than the subsidy being paid to all crops. On the one hand, this improves food security, especially for the landless rural poor and the urban poor more. On the other hand, this results in lower income increases for the rural poor, as land prices tend to decline, if the subsidy is focused on food crops.

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