

# Effects of fertilizer policy on agriculture and household welfare in Benin

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## Executive summary

In Benin, the development of agriculture faces multiple constraints ranging from climatic disturbances to the decline in soil fertility, as well as the low use of mineral fertilizers and inappropriate agricultural tools and practices. Supporting the provision of agricultural fertilizers may contribute to food security and the improvement of livelihoods. Using a 2019 SAM for Benin, the economy-wide model STAGE is applied to simulate a public fertilizer subsidy paid to farmers at 23% of the market price in two scenarios. We first target only food crops and second, all crops.

As key findings, the fertilizer subsidy increases agricultural production, enhances household welfare, and affects positively macroeconomic indicators. When targeting only food crops, food production increases more and food prices drop more with therefore more positive effects on food security. When targeting all crops, production of some cash crops which are fertilizer intensive increases strongly, decreasing factor accessibility for crops which are less fertilizer intensive.

To realize the positive effects of a fertilizer subsidy, the fertilizer distribution system as well as extension services need to be efficient to assure that fertilizer reaches the targeted farmers and farmers have the capacity to use fertilizer efficiently.

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

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## Résumé

Au Bénin, le développement de l'agriculture est confronté à de multiples contraintes allant des perturbations climatiques à la baisse de la fertilité des sols, en passant par la faible utilisation d'engrais minéraux et des outils et pratiques agricoles inadaptés. Soutenir l'approvisionnement en engrais peut contribuer à la sécurité alimentaire et à l'amélioration des moyens de subsistance. À l'aide d'une Matrice de Comptabilité Sociale (MCS) de 2019 pour le Bénin, le modèle économique STAGE a été utilisé pour simuler une subvention publique des engrais versée aux agriculteurs à hauteur de 23 % du prix du marché dans deux scénarii. Nous avons d'abord ciblé les cultures vivrières et ensuite toutes les cultures.

Les principales conclusions sont que la subvention des engrais augmente la production agricole, améliore le bien-être des ménages et a un effet positif sur les indicateurs macroéconomiques. Lorsque l'on cible uniquement les cultures vivrières, la production alimentaire augmente davantage et les prix des produits vivriers baissent davantage, ce qui a des effets plus positifs sur la sécurité alimentaire. Lorsque l'on cible toutes les cultures, la production de certaines cultures commerciales à forte intensité d'engrais augmente fortement, ce qui réduit l'accessibilité des facteurs de production pour les cultures moins intensives en engrais.

Pour que les effets positifs d'une subvention des engrais se concrétisent, le système de distribution des engrais et les services de conseils agricoles doivent être efficaces afin de garantir que les engrais atteignent les agriculteurs ciblés et que ces derniers ont la capacité d'utiliser les engrais de manière efficace.

### 1. Background

Hunger is increasing in almost all African countries with a prevalence of undernourishment at nearly 20% (UNDP, 2021). Therefore, the need to improve agricultural productivity is real. Soil fertility and sufficient nutrient supply are important ingredients to improve productivity.

Agriculture is predominant in the Beninese economy, contributing about 50% to employment, 28% to GDP, 77% of export earnings and 15% of government revenue (MAEP, 2020). In addition, agriculture is important for secondary and tertiary sectors development by providing raw materials (Bjornlund *et al.*, 2020). The population of Benin is increasing, and to meet the increasing demand for agricultural products, farmers are intensifying their production by shortening fallow periods. This diminishes the natural capacity of soil fertility regeneration (Westerberg *et al.*, 2017).

In addition, inappropriate agricultural practices and climate change decrease soil productivity and contribute to land degradation, food insecurity and conflicts between farmers and herders (Honfoga, 2018). According to national statistics, overall agricultural yields have decreased considerably in recent years for all, except for vegetable crops such as tomatoes and chili peppers. At the same time, agricultural production has increased considerably as a result of a very large increase in the area planted at the cost of forests and other state-owned areas.

In response to these concerns, strategies have been developed by producers and research & development institutions (Yabi *et al.*, 2016), including improved water and soil management techniques (Sigue *et al.*, 2018). Among these strategies, fertilization techniques are important to improve agricultural productivity (Gerber, 2016). It is difficult in the current agricultural system to increase yields without increasing the use of fertilizers.

Although fertilizer is one of the key inputs for agriculture, its use remains below the target set in the Malabo Declaration (June, 2014) of "applying at least 50 kg/ha of nutrients of arable land". In this declaration, African leaders committed to accelerate farmers' access to affordable fertilizer as well as increase the level of fertilizer use. In Benin, the average quantity of nutrients applied per hectare was about 45 Kg in 2019 (MAEP, 2020).

In Benin, the prices of fertilizers delivered to farmers were stable at about XOF 240 per kg for many years. This amount paid to get fertilizer by farmers was supported by government subsidy of 33% of the market price before 2020. Several crises in 2008 (global inflation), 2019 (Covid 19), and 2021 (Russian invasion in Ukraine) have resulted in the government increasing expenditure for fertilizer subsidies. On the other hand, since the 1990ies, the market liberalization is considered to eliminate inefficiencies and welfare losses caused by subsidies. The literature on the effect of fertilizer subsidies in developing countries is controversial. The two schools of thought on fertilizer subsidies in Africa are summarized in Table 1.

The ambivalence of the evidence on the effects of fertilizer subsidies thus leaves space for governments to engage in fertilizer policies to varying degrees. The Beninese government has decided in 2022 to subsidize fertilizer prices for farmers by 44% (from XOF 500 to XOF 280 per ha), in order to cope with high international prices of agricultural products and fertilizer in the course of the Russian invasion of Ukraine and to contribute to food security. The effect of this fertilizer subsidy on the Beninese economy has not been subject of a prior scientific study.

**Table 1: Impact of fertilizer subsidy initiatives in developing countries**

Position	Arguments
Supporter	<ul style="list-style-type: none"> <li>• Increase food production and reduce imports ;</li> <li>• Support consumers by reducing food prices</li> <li>• Overcome missing and imperfect financial and insurance markets for farmers</li> <li>• Reduce negative externalities related to suboptimal fertilizer use (soil fertility depletion leading to deforestation, reduced carbon sequestration, etc.)</li> <li>• Offset effects of output price distortions to make food affordable</li> <li>• Reduce poverty and provide a safety net through targeting subsidies at low-income farmers</li> </ul>
Opponent	<ul style="list-style-type: none"> <li>• High fiscal cost</li> <li>• Inefficiencies at farm level, such as incentives to shift crops and neglect of other good agricultural practices</li> <li>• Crowding out other public investments and commercial fertilizers</li> <li>• High administrative costs at local levels and late delivery to farmers</li> <li>• Regressive distribution of benefits and rent seeking</li> <li>• Leakage to other farmers, commercial markets or neighbouring countries</li> <li>• Creation of vested political interests making it difficult to remove subsidies</li> </ul>

Source: Author's calculations based on Jayne and Rashid (2013) and Smale and Theriault (2019).

Apart from the financial access to fertilizer that is improved by price support, other barriers persist, notably the weak distribution system and the persistence of too many intermediaries in the distribution chain, increasing the cost of fertilizer at farm level. This can make government price support ineffective such as in Nigeria, which aimed at making fertilizer affordable for smallholders. This policy proved to be inefficient and fraudulent because of being captured by middlemen (Adesina, 2013).

The purpose of this study is to assess the impact of the fertilizer subsidy policy on the Beninese economy with the following research question: What are the effects of fertilizer subsidies on agricultural production, household income and macroeconomic indicators.

## 2. Methods

### 2.1 Database

We use an updated 2019 Social Accounting Matrix (SAM) based on Kinkpe *et al.* (2022), national accounts published by INStAD (2022) and additional data from DSA-MAEP (2022a, 2022b, 2022c). The two labour categories (skilled and unskilled) are disaggregated according to gender. Capital is disaggregated into agricultural and non-agricultural, and land is disaggregated into irrigated and non-irrigated. Households are disaggregated into rural poor and non-poor as well as urban 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

## Capacity building and advanced support for policy analysis using economic models

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.

As Benin uses a currency pegged to the Euro with a fixed parity, we apply a fixed exchange rate regime and flexible trade balance (deficit) closure. The model is savings-driven. Government savings are fixed and the household tax rate is flexible. Therefore, any policy change implemented in the model is financed through equiproportional changes in household income tax rates.

### 2.3 Scenarios

The government fertilizer subsidy effects are analyzed considering the fertilizer subsidy at farm level after the COVID19 crisis and the Russian invasion in Ukraine. The final fertilizer selling price is set up at FCFA 280 per kg at farm level (Ouin-Ouro, 2022), while the 2019 price was FCFA 360 per kg (about 23% of subsidy). Two scenarios were implemented:

- 1) Food: a subsidy of 23% only on fertilizer for food crops
- 2) All crops: a subsidy of 23% on fertilizer for all crops

These scenarios were implemented in three steps:

1. Implementation of the subsidy.
2. An increase in the input output coefficient of fertilizer with a standard own price elasticity of fertilizer demand of -0.5 based on expert talks with officers of the Ministry of Agriculture in Benin (MAEP). We assume that fertilizer use is less price responsive for crops which use fertilizer already quite intensively in the base (rice, maize) and does not at all increase for crops with very high use in the base (cotton and pineapple).
3. Higher fertilizer use also means high agricultural productivity. We increase yields based on an elasticity of production with respect to fertilizer use of 0.3 based on expert talks with officers of the MAEP in Benin.

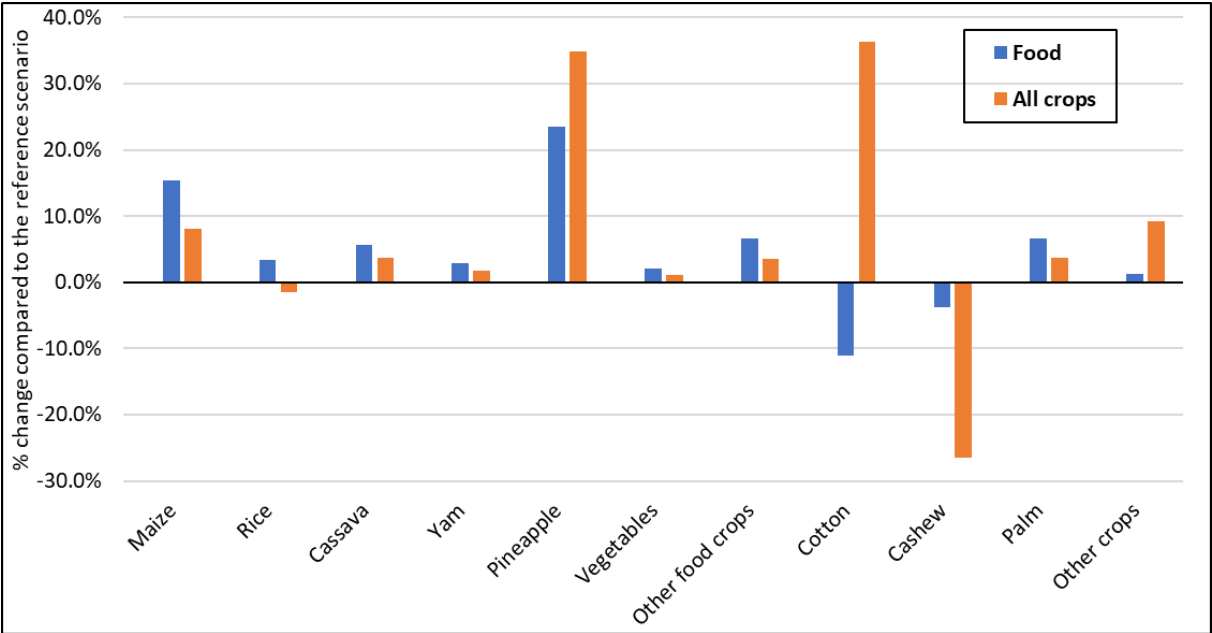
We assume that the fertilizer policy in Benin is financed by the government through relative increases in income tax rates for non-poor households.

### 3. Results

#### 3.1 Domestic production

The average production levels increase for food crops under the fertilizer subsidy in the two scenarios (Figure 1). Rice production declines slightly under the subsidy for all crops because of cotton growing more under that scenario making the non-irrigated land less available for rice. When subsidizing fertilizer for only food crops, cotton and cashew production declines whereas cashew and rice decline under the subsidy for all crops.

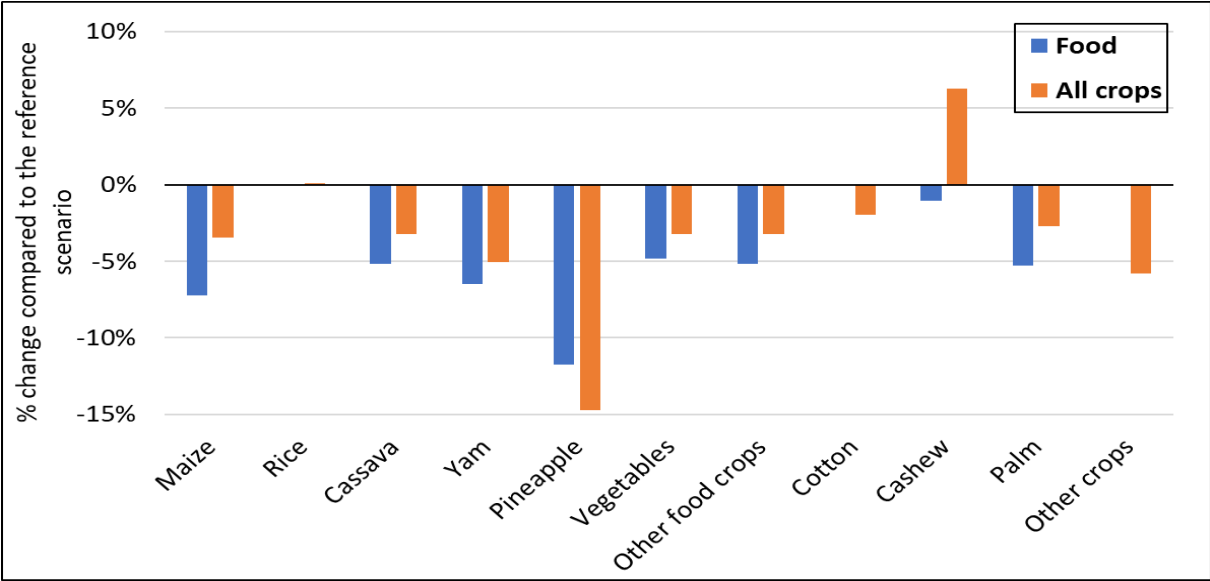
The effects on production are driven by the agricultural sectors that use fertilizer most intensively (cotton, maize and pineapple). These products demand more production factors (labor, land and capital) generating a disadvantage for other agricultural sectors such as cashew.



**Figure 1: Effects on quantities of domestic production, % change compared to the reference scenario**

Source: Author's calculations based on simulation results.

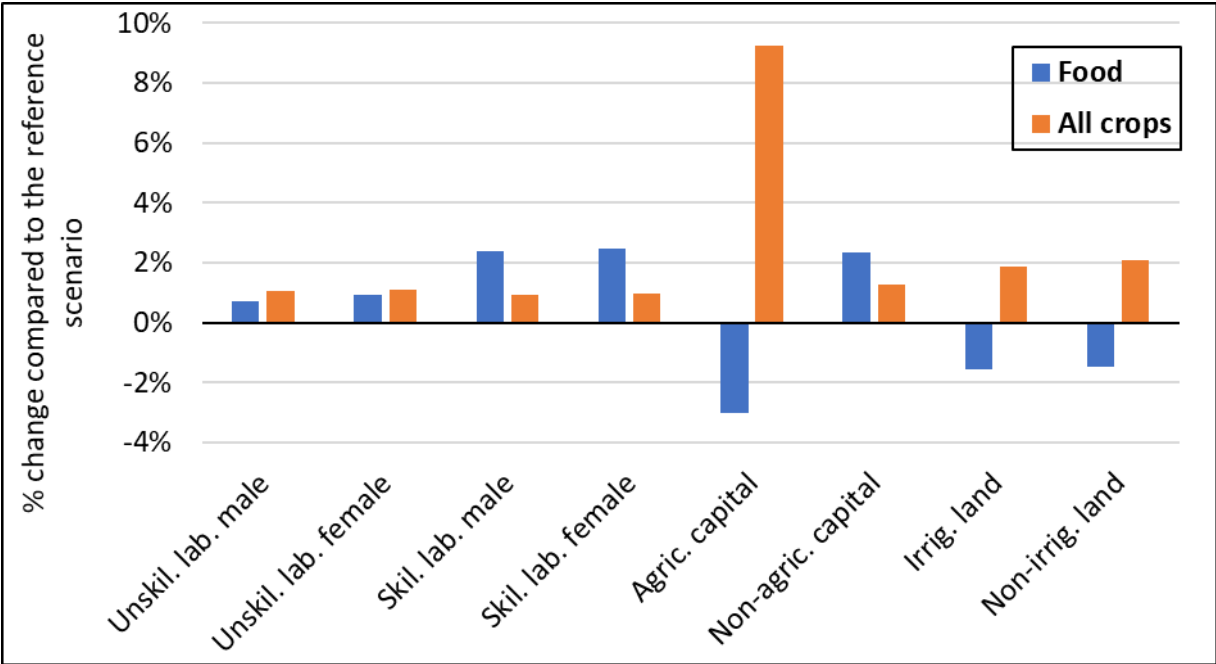
The results show a general drop in prices of crops under the two scenarios apart from the cashew price increasing under the subsidy for all crops because of the strong decline in its production (Figure 2). The higher the production increases, the more the price drops (Figure 1 & 2).



**Figure 2: Effects on consumer prices for supply, % change compared to the reference scenario**  
 Source: Author's calculations based on simulation results.

**3.2 Factor prices**

Under the fertilizer subsidy for only food crops, the prices for land and agricultural capital decline (Figure 3) because the cotton value chain (production and ginning), being highly intensive in these two factors, declines by more than 10%. Under the subsidy for all crops, prices of all production factors increase. Agricultural capital is the factor with the strongest price increase because of cotton increasing strongly and being capital intensive. The wage for female labour increases more than formal labour (Figure 3) because the positively affected sectors are comparatively intensive in female labour.



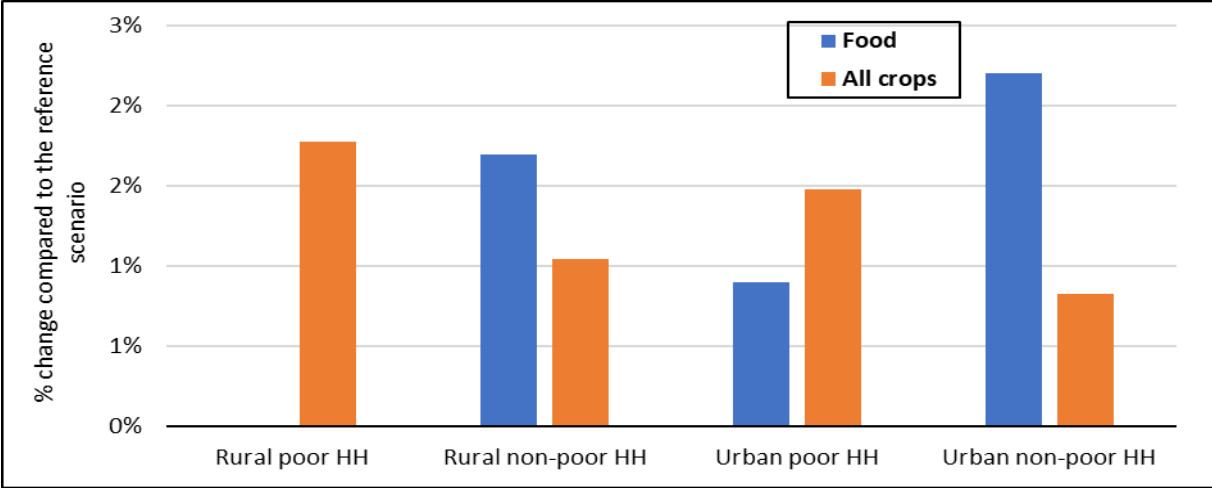
**Figure 3: Effects on consumer prices for supply, % change compared to the reference scenario**  
 Source: Author's calculations based on simulation results.



### 3.3 Household income and welfare

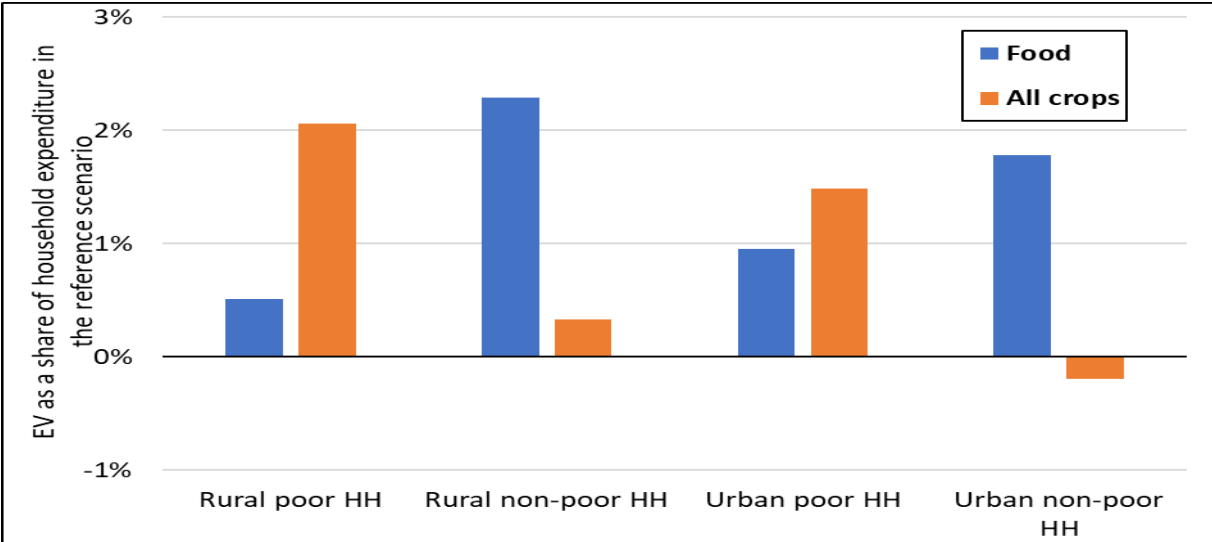
All household experience positive income effects under the two scenarios (Figure 4). The subsidy to all crops tends to be more pro-poor because wages of factors mostly held by poor households decline under the subsidy to only food crops while all factors wages increase under the subsidy to fertilizer for all crops.

The welfare effect is dominated by the income effect in general (Figure 5). But the welfare effects are less positive for non-poor households due to higher income tax rates to finance the subsidy. Non-poor households in urban areas even experience a slight welfare decline.



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

Source: Author's calculations based on simulation results.



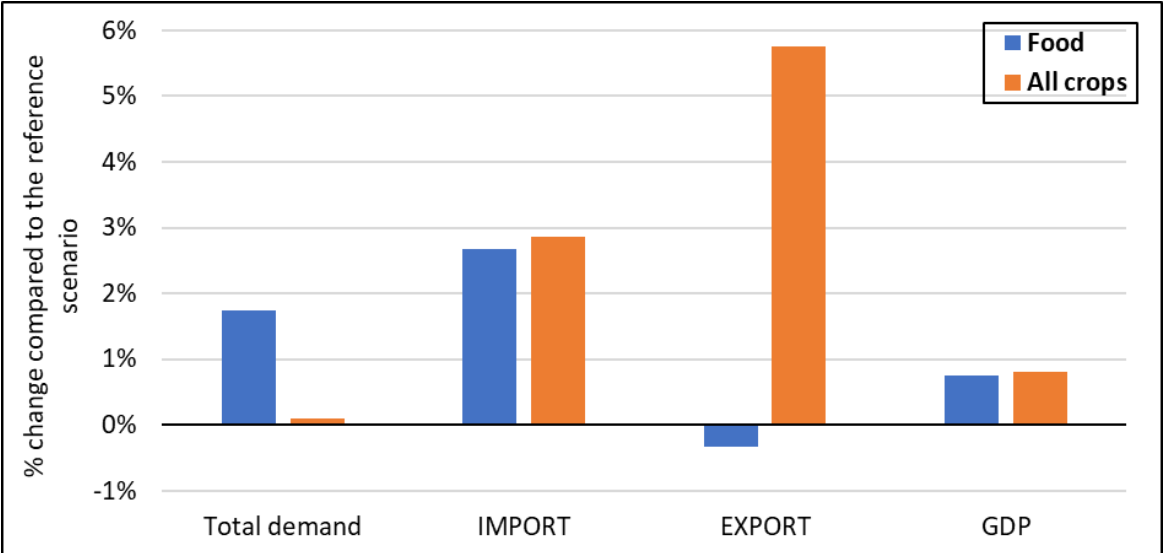
**Figure 5: Effects on household welfare, Equivalent variation (EV) as a share of household expenditure in the reference scenario<sup>1</sup>**

Source: Author's calculations based on simulation results.

<sup>1</sup> Equivalent variation (EV) refers to a change in income that would have an equivalent effect on utility as all price and income changes combined.

**3.4 Macroeconomic effects**

Under the fertilizer subsidy to only food crops, exports decline slightly because of decreasing cotton production (Figure 6). However, the general macroeconomic effects are positive for both scenarios. Total domestic demand and GDP are higher under the fertilizer subsidy. Exports increase strongly under the subsidy to all crops because non-staple food crops have high export shares in Benin.



**Figure 6: Effects on macroeconomic indicators, % change compared to the reference scenario**

Source: Author's calculations based on simulation results.

**4. Conclusions**

This paper points out positive effects of a fertilizer subsidy on crop production, household income and welfare and the economy as a whole. The base period fertilizer use intensity drives the relative effects among different crops.

A fertilizer subsidy to food crops only has higher effects on food production and results in stronger declines in food prices, therefore improving food security more. On the other hand, a fertilizer subsidy to all crops has stronger positive income and welfare effects on poor households as well as higher export effects.

**5. Policy implications**

This paper shows that a fertilizer subsidy targeting food crops results in a strong increase in food production and strongly declining food prices. Therefore, such a policy would make staple food more accessible and would improve food security. This suggests that to improve the food security level in Benin, the government could target fertilizer subsidies to food crops.

Targeting all crops with a fertilizer subsidy, results in higher export effects but lower food production effects. This suggests that to assure higher foreign income inflow to the country, the government could target all crops. In addition, this scenario is more pro-poor in terms of welfare effects, as the wages held by poor households increase more.

To realize the full positive effect shown in this paper, the fertilizer distribution system as well as extension services need to be efficient to assure that fertilizer reaches the targeted farmers and farmers have the capacity to use fertilizer efficiently. It would therefore be important to improve the effectiveness and the efficiency of the current fertilizer distribution system in Benin. In addition, the government may need to improve the accessibility and the efficiency of extension services and vocational training.

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