



IMPETUS Benin

Fertilizer use improves food security and stability of agricultural income in Benin

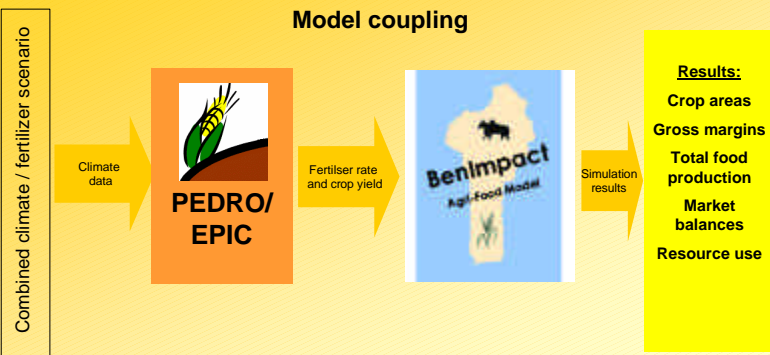
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Introduction

The sluggish increase in the area productivity of staple crops is a major explanatory factor for the increased dependency of African countries on imports of food. The use of mineral fertilizer may dramatically improve this situation. A coupling of the SDSS BenIMPACT and PEDRO developed within the IMPETUS project were used to simulate an enforced increase of mineral fertilizer use for eight staple crops and its impacts on crop yield, profitability of cropping, market balances, and resource use.

Models



The model coupling was carried out consecutively. Crop yield ratios between fertilised and unfertilised mean crop yields of eight major crops and the respective fertilizer rates were simulated by the EPIC model and transferred to the agro-economic simulation model BenIMPACT. BenIMPACT then simulated economic and production indicators based on these exogenous yield scenarios.

Conclusions

- Beneficial effects of mineral fertilizers:**
- Improve crop productivity
 - Maintain food security
 - Increase economic welfare
- Increasing costs for energy and mineral fertilizer may offset these effects.**

Scenario assumptions

Fertilizer scenario

Simulations with the EPIC model were based on low to moderate amounts of fertilizer used per hectare, oriented at the recommendations made by the state extension services. The model simulated two scenarios: (1) Without fertilizer input which is the most common practice except for cotton and, in some areas, rice; and (2) With use as recommended (Table 1). The yield ratio (YR) is defined as the average crop yield with fertilizer ($Y_{withfert}$) divided by the crop yield without fertilizer (Y_{nofert}).

Table 1: Mode of fertilizer application on maize and peanuts in the model calculations

Crop	Fertilizer 1	Amount (kg/ha)	Fertilizer 2	Amount (kg/ha)
Maize	NPK ¹⁾	100	Urea	50
Cassava	NPK	50	NPK	50
Cotton	NPK	100	Urea	50
Rice	NPK	100	Urea	100
Peanut	NPK	50		
Sorghum	NPK	100		

¹⁾ NPK 15-11-23



Results

Fertilizer use and crop productivity

Table 2 shows that the effects of fertilizer application is crop-specific. The seven crops can be subdivided with respect to their response to the moderate fertilizer application into three groups: (1) rice, maize and cotton being the crops showing strongest response with a mean yield ratio of 2.47, 1.7, and 1.49 respectively, (2) peanuts and sorghum with moderate response and (3) cassava and yam with very weak response (Table 1).

Table 2: Evolution of simulated yield ratios (YR) for seven major crops in Benin Republic in a climate scenario from 2000 to 2025

	2005	2010	2015	2020	2025	Mean
Maize	1.46	1.49	1.73	1.75	2.08	1.70
Rice	1.56	1.95	2.37	2.91	3.55	2.47
Cassava	1.06	1.04	1.12	1.07	1.17	1.09
Cotton	1.34	1.39	1.76	1.85	2.12	1.69
Peanuts	1.22	1.18	1.30	1.41	1.52	1.33
Sorghum	1.11	1.10	1.20	1.20	1.35	1.19
Yam	1.02	1.01	1.08	1.05	1.09	1.05

- Yield ratios of maize show that the application of moderate amounts of mineral fertilizer has the potential to increase yield by 50 percent on average (Figure 1)
- The yield ratio increases during the simulations due to shorter fallow periods and soil degradation without fertilizer application in the baseline scenario.
- The stronger increase of yield ratio in the Plateau department may be due to increasing humidity (longer rainy season with two crops per year) and therefore faster and stronger soil fertility degradation
- Yield ratios from EPIC are the basis of fertilizer scenario simulations by BenIMPACT (Figure 2)

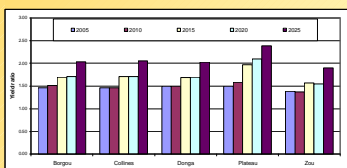


Figure 1: Yield ratio YR for maize in relation to the Department between 2005 and 2025



Figure 2: Yield levels for maize in 2025 in the BenIMPACT scenario simulations

Fertilizer use and food security

- A moderate application of mineral fertilizer increases production surpluses for major crops as compared to the baseline scenario without fertilizer use in 2025, except for sorghum.
- However, if crops do not sufficiently respond to fertilizer use (such as sorghum), the positive effect will not materialise
- The positive effects on food supply diminishes when higher prices for fertilizer are simulated!

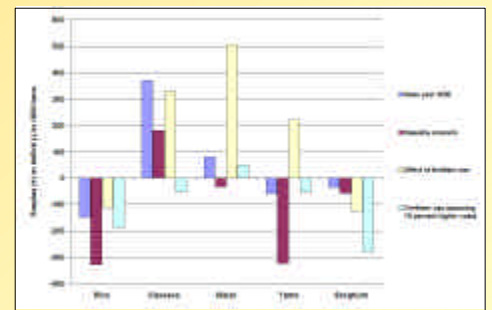


Figure 3: Surplus or deficit on food markets for important staple crops in Benin Republic in 2000 and 2025

Fertilizer use and profitability

- Moderate application of mineral fertilizer increases the profitability of most crops, and thereby incomes of farmers.
- The positive effect of fertilizer use on profitability is dampened or sometimes reversed with increasing prices for fertilizer

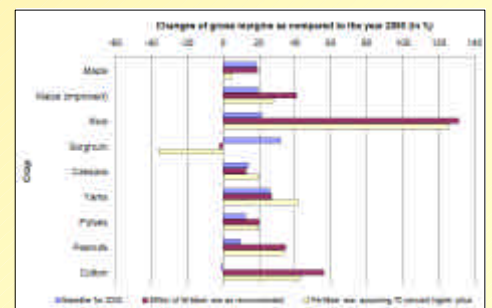


Figure 4: Changes in gross margins from 2000 to 2025 in Benin

Outlook

It is reasonable to assume that the observed low rates of use have their roots in higher prices for fertilizer than reported, particularly for the most recent years where world market prices for fertilizer have increased tremendously. It is planned to derive production functions from the EPIC model to estimate optimal fertilizer rates for different crops, fertilizer prices and spatial units.