PARI Policy Brief No 8

PARI

January 2018

# DOUBLING THE MAIZE YIELD IN AFRICA THROUGH BETTER CROP MANAGEMENT

## Results from a crop simulation model to inform policy and research

Despite the importance of maize as a staple crop for food security in Africa, yields in the region are very low in comparison to the rest of the world. To keep up with growing demand, increasing the productivity of Africa's smallholder farmers, who produce 75 percent of Africa's maize, is crucial. New crop modelling results suggest that by implementing improved crop management practices, notably supplementary irrigation schemes and fertilizer use, current yields in Africa could potentially double at many locations. Policy makers and researchers should further investigate the applicability of these findings to regional contexts, and build the capacity of farmers in each country to adopt and sustainably apply the most effective combination of management practices.

## Maize: A key ingredient for African food security

Maize is among the most important crops on the African continent. It provides a source of food security and is essential to the livelihood of an estimated 208 million people in Sub-Saharan Africa. In Eastern and Southern Africa, almost half the calories and protein consumed come from maize. Its importance as a staple crop is due to its high energy content, its many uses, and its adaptability to a range of weather conditions.

At 2 tonnes per hectare, average maize yields in Sub-Saharan Africa are much lower than the global average of 5.6 tonnes. The average yield in Africa represents 20 percent of the attainable yield, while European, Asian and North American farmers manage to reach 56 to 84 percent of attainable yield. Additionally, the world average yield continues increasing faster than that of Africa, further widening the gap. Maize, along with rice, is therefore the crop with the highest potential for further yield increases.

### What is the attainable yield?

Attainable yield is the highest yield farmers can achieve using the best available management practices and technology, where nutrients are not limiting. It varies by season and year, depending on climate. Observed yields are often lower than the attainable yield because of constraints, including water availability, pests and diseases, and poor crop and nutrient management practices.

### Why are maize yields in Africa so low?

Africa's maize yield gap (i.e. the difference between attainable yields and actual yields) has many causes. Yields are affected by rainfall, temperature, solar radiation and CO2 levels in the atmosphere, and depend on the type of maize being cultivated. The main limiting factors in Africa are droughts and low soil fertility. Others include damage caused by living organisms or abnormal weather and environmental conditions. Many of these factors can be addressed through different crop management practices, such as the variety of maize cultivated (cultivar) and water and nutrient management. Other factors related to the socio-economic constraints faced by producers require different strategies.

### Closing Africa's yield gaps: Simulation results

A comprehensive crop modelling exercise comparing high-potential crop management practices was conducted by Rezaei and Gaiser (2017) to determine whether these could increase maize yields in Africa. The main findings include:

1. A **combination of increasing nitrogen fertilizer use, implementing supplementary irrigation and new cultivars led to the highest simulation increase**, from 1.2 to 2.9 tonnes of maize per hectare for the whole continent.
2. In the **Sahel region** specifically, the combination of nitrogen fertilizer use and supplementary irrigation resulted in the most significant yield improvements.
3. In **Sub-Saharan Africa**, the increase in yield was mainly driven by the application of nitrogen regardless of the combination of management practices simulated.

4. **Over the entire continent, supplementary irrigation reduced the yield variability.** Since 90 percent of the maize cultivated in Africa is rain-fed, farmers depend on good weather. Supplementary irrigation gives farmers more flexibility in deciding when to sow their maize. The effect of supplementary irrigation was particularly high if combined with increased fertilizer application.

## Methodology of the study

To test the efficiency of changing management practices on the national or continental scale, crop models are a feasible alternative to field experiments, which can be costly, time consuming and limited by the environmental conditions of the study site.

The study used a computer model which simulated how crop growth interacts with climate, soil and management practices based on historical data on climate in Africa (1980-2010) and sowing and harvest dates, as well as fertilizer application rates for maize (1998-2002). The researchers inputted different management scenarios to observe the effect on maize yields in 36 African countries between 2000 and 2010.

The following management practices were included in the simulation:

- **Nitrogen fertilizer application**: The results cited here were for the application of 60 kg of fertilizer per hectare.
- **Supplementary irrigation:** Irrigating crops at crucial times in the growing season (usually only once or twice) to avoid the stress to plants due to rainfall variability. In the simulation, supplementary irrigation was applied when soil water content was under 50% of field capacity.
- **New cultivar:** 20% higher radiation use efficiency.

## Recommendations

To increase food security and reduce weather-related risk for farmers, policy-makers and extension services should encourage the use of the aforementioned practices by:

- **Investing in the development of technology packages** that include fertilizer and the tools to harvest rainwater for supplementary irrigation (i.e. pumps and pipes)
- **Creating incentives to increase nitrogen fertilizer use** and strengthen the networks for distributing fertilizer, while increasing farmers' knowledge about optimal fertilizer use.
- Increasing farmers' capacity to set up simple, low-cost supplementary irrigation systems.

The general findings from the maize modelling exercise can also inform the direction of **future agricultural research** in specific climatic regions. Research efforts should focus on:

- **Combining these simulation results with economic modelling** to assess the costs and benefits of applying different combinations of crop management practices for smallholder farmers in different regions.
- **Conducting experiments on test plots** to corroborate the simulation results in different climatic areas. Other areas of high potential for field experiments include using a combination of nitrogen and phosphorous fertilizer and manure application.
- **Directing breeding activities** by identifying crop characteristics that further increase maize yields in Africa and defining site-specific cultivars of maize that are suitable for low-input systems in in the region.

This Policy Brief is based on the study:
Rezaei E and Gaiser T (2017) *Change in crop management strategies could double the maize yield in Africa.* ZEF-Discussion Papers on Development Policy No. 239.
Bonn: Center for Development Research.
Available at www.research4agrinnovation

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PARI is funded by the German Federal Ministry for Economic Cooperation and Development (BMZ).

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