The role of phosphorus in smallholder production systems and its sustainable management to improve crop yields and farm profit while reducing environmental impacts

By

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The views expressed are those of the author and do not necessarily reflect the views of UNCTAD.
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Kaushik Majumdar
OUR MISSION
Enhanced plant nutrition for a resilient and food-secure Africa.

OUR VISION
Prosperous African farmers sustainably managing crop nutrition to provide consumers with a secure supply of nutritious foods at a reasonable price.
Our Strategic Themes

Climate & Weather-Smart Plant Nutrition
Soil Health for Improved Livelihoods
Precision Nutrient Management

Key Achievements in 2021

Countries we work in: 11

In-field trials: 14,682
On-farm trainings: 362
R&D partners & collaborators: 120
Scientific publications: 36

Scientific presentations: 36
Awards granted: 17
On-going research projects: 15
New research proposals: 8
Soil health at the core of agricultural sustainability in Africa

**The Soil Health Crisis**
- 30 kg nutrients ha$^{-1}$ lost from 50% of the cropland in Africa’s ($4-10$ B yr$^{-1}$)
- Overgrazing in livestock systems
- 65% of cropland degraded
- Land degradation cost: $\sim 68$ B yr$^{-1}$
- Higher risk of ‘non-responsive soils’

↑ Extensive agricultural systems
↑ Carbon & biodiversity losses
↓ Ecosystem services
↑ GHG (burning biomass)
↑ Climate change aggravation

| 300 million people malnourished | 5 |

**Building Soil Health & System Resilience**
- Farmer-centric, integrated soil fertility, crop and water management interventions for soil health sustainability & climate change resilience to meet SDGs
- Context-specific targeting of investments & technologies
- Optimize return of investment and reduce investment risks
Fertilizer value-chain constraints

**Importation**
- Low & fragmented demand
- Inefficient importation of small volumes
- Poor port infrastructure
- High financing costs

**Distribution**
- Limited dealer network & reach
- Limited storage capacity
- Inconsistent subsidy programs
- Inconsistent availability of fertilizer
- Limited access to agronomic & market information

**Local Distribution**
- Limited technical knowledge
- High prices & low accessibility of fertilizer
- Inconsistent subsidy programs
- Risks: land degradation, rainfall & output price volatility
- Limited access to storage / processing channels

**Farmer**
- Poor transport infrastructure
- Poor transport logistics
- Limited working capital
- Limited storage

**Output Market**
- Output markets poorly developed, especially for staple crops
- Poor transportation infrastructure
- Limited post-harvest storage & value-added processing
Uncertainties faced by farmers

METRIC
Uncertainty about the precision of input to achieve an outcome

TRANSLATIONAL
Uncertainty related to issues external to the decision

TEMPORAL
Uncertainty related to past / future events

STRUCTURAL
Uncertainty about impact of other internal factors relevant to the decision
Yield gaps in Africa

Adiele et al., 2021; Ronner et al., 2016; Schut et al., 2018; Tanaka et al., 2017; Van Ittersum et al., 2016; APNI Research
African soils are low in phosphorus

Global Phosphorus Institute, Unpublished 2022
Modified from Hengel et al. (2021) and iSDA
Nutrient-induced yield gaps and fertilizer use efficiency

<table>
<thead>
<tr>
<th>Crop yield response</th>
<th>Mean regional yield responses</th>
<th>Performance indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>P</td>
</tr>
<tr>
<td>Maize</td>
<td>2.2</td>
<td>1.0</td>
</tr>
<tr>
<td>Rice</td>
<td>1.4</td>
<td>0.8</td>
</tr>
</tbody>
</table>

Zingore et al., 2022
Response to P increases with decreasing soil fertility

Zingore et al., 2022
Balanced P application can resolve yield limitations from P deficiency

Njoroge et al., 2019
Nutrient Yield Gaps: Potential Nutrient Needs in SSA

Maize Scenario

Production gap = 120 M t

Area = 40 M ha
Average yield = 2.0 t/ha
Attainable yield = 5.0 t/ha
Manageable yield gap = 3.0 t/ha

Nutrient rate requirement:
N = 129 kg/ha
P$_2$O$_5$ = 41 kg/ha
K$_2$O = 38 kg/ha

Total potential nutrient demand = 8.32 M t
Total N = 5.16 M t
Total P$_2$O$_5$ = 1.64 M t
Total K$_2$O = 1.52 M t

Total current NPK fertilizer use = 4.3 Mt
The imperative need for investment in increased use and improved management of FERTILIZER

Maize yield in relation to sub-regional N fertilizer use

N-dominated yield response in Ethiopia
(SOC ~ 1.5%)

Multiple nutrient responses in Ghana
(SOC ~ 0.7%)
Nutrient-Catalyzed Agricultural Transformation (NUTCAT) Remote Sensing to Support OFE

Farmer-centric & farm-scale research focused on the adoption of precision nutrient management.

- 340 locations in nine countries
- Protocols deployed for collecting high quality, site-specific yield data in Africa
- Deployment of survey tool for collecting farmer perceptions of within-field variability
- Discussion in progress with several institutions for co-investment and scaling to new regions
Target: Improve the livelihoods of **80,000** smallholder farmers with 4R practices

Activities led by

- Identification of crop production constraints
- Development of site-specific 4R-based recommendations
- Dissemination & scaling of 4R recommendations

**Activities led by:**

**Ethiopia**
- Amhara Agricultural Research Association
- Ethio-Wetlands & Natural Resource Association

**Ghana**
- Send Ghana
- Savanna Agricultural Research Institute

**Senegal**
- ONG 7a
Fertilizer Crisis: Prices in Africa have risen sharply (Kenya)

Source: AfricaFertilizer.org
Fertilizer Crisis: Impacts and responses differ

**Rwanda**
October 2021
- Higher prices
- Increased demand
- No reported shortages

**Malawi**
October 2021
- Higher prices, even with subsidies
- Increased demand but low fertilizer use due to high prices

**Ghana**
Mid-2022
- Supply deficits
- Commonly used fertilizer unavailable
- Various organic products on the market

**Burkina Faso**
August 2021
- High Prices
- Fertilizer difficult to find
- Blending factories at standstill

Source: AfricaFertilizer.org
Fertilizer Crisis: APNI Research Questions

1. To what extent have the prices, availability, accessibility and use of fertilizer in Africa been affected by the current fertilizer crisis?

2. What have been the responses to the fertilizer crisis at the macro-level by various stakeholders, including government, non-government, private sector, and fertilizer industry?

3. How is the fertilizer crisis affecting farmers' investment decisions and the consequent impact on crop productivity?

4. What coping strategies have micro-level actors (farmers and local stakeholders) adopted to mitigate the impact of the fertilizer crisis?

5. What insights have been gained from the current crisis for managing and building resilience to future shocks?