A spatial ex ante framework for guiding agronomic investments in Tanzania

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Africa’s R&D & investments

Huge yield gaps in staples → where to invest?

Agronomic research

- Traditionally aspatial
- Agronomic returns over economic returns (profit and risk as evaluation criteria)

Targeting investments

- Fails to incorporate farmer-level decision making.
- Public and private
Objectives

• Have a geospatial framework to predict fertilizer profitability for maize systems in SSA.

• Determine the profitability of different fertilizers across space and provide feedback on finding potential optimal fertilization recommendations for different scales.

• Potential effects of a subsidy policy
Spatial *ex ante* analytical framework

Yield = \( f(\text{agronomy}) \)

- **Agronomy**
  - Biophysical context
- **Prices**
- **Returns**
- **Stochasticity**
  - Rainfall Climate Price

**Inputs**
- Farmgate prices
- Markets

**Expected returns**
Yield model

N input

Soil nutrients
pH OC K Rain

N prices
Fertilization cost

Profitability

Yield

Maize farmgate prices

Revenue

N input

Soil nutrients

pH OC K Rain

Yield model

Maize farmgate prices

Rain

CIMMYT
Yield: Soil Nutrients - AfricaSoils

Soil covariates:
- MODIS and SRTM DEM land products,
- GlobeLand30 aggregated land cover data (30 m -> 250 m),
- SoilGrids 1km (global models)

Overlay / generate a regression matrix

Fit models and generate predictions (random forests + kriging)

Soil profiles and soil samples (model calibration data)

Collect new ground data (legacy data + new soil observations)

User community (extension workers, government agencies, agri-business)

Share / distribute

AfSoilGrids250m

- soil organic carbon,
- soil pH,
- sand, silt and clay fractions,
- coarse fragments,
- bulk density,
- cation-exchange capacity,
- total nitrogen,
- exchangeable acidity,
- Al content,
- exchangeable bases (Ca, K, Mg, Na),
- available water capacity
- ...

africasoils.net
Yield: Regression model

- N applied
- Soil nutrients
- Rainfall
- Accessibility
- Management
- Household
Stochasticity

Rainfall variability
Input price modeling

- Market price data from various MIS
- Price observations from georeferenced household survey data
Input price modeling
Prices: Maize market prices

Market access

Market price

$r^2 = 0.9$
Prices: Farmgate prices
## Scenarios

<table>
<thead>
<tr>
<th>Scenario</th>
<th>N input</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZERO</td>
<td>0 kg/ha</td>
</tr>
<tr>
<td>Blanket recommendation</td>
<td>100 kg/ha</td>
</tr>
<tr>
<td>Optimized by Yield</td>
<td>Highest yields</td>
</tr>
<tr>
<td>Optimized by Net revenue</td>
<td>Highest profitability</td>
</tr>
</tbody>
</table>
Net revenue

ZERO

Optimized for yield

BK

Optimized for net revenue

Percentile of income:
- <10%
- 10-30%
- 30-50%
- 50-70%
- 70-90%
- >90%

* Based on ZERO
Profitability by scenario

Net revenue distribution by scenario

Scenario

Net revenue (USD/ha)

Average Change:

ZERO 26% 44% 44%
Value-Cost ratio

BK

Optimized for net revenue

Mean Value-Cost ratio

- ≤ 2
- 2 - 2.5
- 2.3 - 3
- 3 - 3.5
- < 3.5
Price changes and Input
How much fertilizer is needed to increase maize production by 30%?

Where to bundle with insurance?

Returns to site-specific nutrient mgt?

Correlation with fertilizer usage

Market demand for new blend?

Rainfall variability

Returns to fertilizer versus new variety?
Acknowledgements

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Thank you for your interest!