A spatial ex ante framework for guiding agronomic investments in Tanzania

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AfricaGIS
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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
- Rainfall Climate
- Price

- Prices
- Stochasticity
- Returns

Inputs
- Farmgate prices
- Markets

Expected returns
Soil nutrients

pH
OC
K
Rain

N input

Yield model

Yield

N prices

Revenue

Maize farmgate prices

Fertilization cost

Profitability
Yield: Soil Nutrients - AfricaSoils

Soil covariates:
- MODIS and SRTM DEM land products,
- GlobeLand30 aggregated land cover data (30 m -> 250 m),
- SoilGrids1km (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)

Share / distribute

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

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

CGIAR

CIMMYT
Yield: Regression model
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
Yield model

pH
OC
K
Rain

Soil nutrients

N input

N prices
Fertilization cost

Profitability

Yield

Revenue

Maize farmgate prices

CGiAR

CIMMYT
# 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>
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</tbody>
</table>
Net revenue
Profitability by scenario

Net revenue distribution by scenario

Average Change:
- ZERO: 0%
- BK: 26%
- OPyield: 44%
- OPhetrev: 44%

Scenario

Net revenue (USD/ha)
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

![Graph showing the relationship between N input (kg/ha) and N input price change, with net revenue (USD/ha) as the color scale.](image-url)
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?
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Thank you for your interest!