Comparing Farmer Perceived Soil Quality And Measured Soil Quality In Tanzania: Do They Align?

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Outline

• Motivation: Agricultural Yield Gaps
• Theory: Identifying Causes of Yield Gaps
• Methods, Data, and Findings:
  • Comparing conceptions of “Soil Quality”
  • Comparison of Measured and Perceived Soil Quality
• Conclusion
Defining Agricultural Yield Gaps

• “Yield Gaps” - discrepancies between potential agricultural yields and actual agricultural yields.

• Estimated mixed-maize small farm production in Sub Saharan Africa:
  • Potential yields (Theoretical): 5 -10 tons/ha
  • Actual yields: 1 - 3 tons/ha

• Tanzanian maize production:
  • Potential yields (90th Percentile): 2 tons/ha
  • Actual median farmer yields: 0.66 tons/ha
Addressing Agricultural Yield Gaps

• Programs encourage: fertilizer use, soil conservation, composting, crop cover use, and other techniques.

• Lower than expected adoption rates.

• Potential explanations for variation in adoption: farmer education level, age, farm size, land tenure, and many others.

• No universal consensus has emerged.
Identifying Causes of Yield Gaps

Do Soil Quality Assessments Align?

- Adoption of soil improvement techniques is lower than expected.
- Experts believe low soil quality drives yield gaps.
- Adoption of new techniques requires awareness of a problem.
- Do farmer and soil scientist assessments of soil quality align?
Comparing Conceptions of “Soil Quality”

**Soil Science**
- Phosphorous
- Nitrogen
- Potassium
- Sulfur
- Porosity
- Total carbon
- Electrical conductivity
- Soil temperature
- Effective root depth
- Mechanical resistance
- Soil Aggregates
- Bulk density
- Clay content
- Soil pH

**Local Knowledge**
- Organic matter
- Soil macro fauna (Earthworms)
- Soil color
- Water content/
- Water retention/
- Moisture
- Soil workability
- Soil depth
- Soil workability
- Soil workability
- Stoniness / Soil texture
- Crop yield/Crop vigor
- Crop health /Crop growth rate/Plant development
- Manure Requirements
- Indicator weeds /
- Spontaneous vegetation/
- Presence of local plants
- Fertility
- Erosivity
- Acidity

**Shared**
- Water content/
- Water retention/
- Moisture

Source: Anderson et al., 2013.
## Measured Soil Quality

<table>
<thead>
<tr>
<th>Soil Qualities</th>
<th>Soil Characteristics (HWSD)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nutrient availability</strong></td>
<td>Soil texture, soil organic carbon, soil pH, total exchangeable bases</td>
</tr>
<tr>
<td><strong>Nutrient retention capacity</strong></td>
<td>Soil Organic carbon, Soil texture, base saturation, cation exchange capacity of soil and of clay fraction</td>
</tr>
<tr>
<td><strong>Rooting conditions</strong></td>
<td>Soil textures, bulk density, coarse fragments, vertic soil properties and soil phases affecting root penetration and soil depth and soil volume</td>
</tr>
<tr>
<td><strong>Oxygen availability</strong></td>
<td>Soil drainage and soil phases affecting soil drainage</td>
</tr>
<tr>
<td><strong>Excess salts.</strong></td>
<td>Soil salinity, soil sodicity and soil phases influencing salt conditions</td>
</tr>
<tr>
<td><strong>Toxicity</strong></td>
<td>Calcium carbonate and gypsum</td>
</tr>
<tr>
<td><strong>Workability (constraining field management)</strong></td>
<td>Soil texture, effective soil depth/volume, and soil phases constraining soil management (soil depth, rock outcrop, stoniness, gravel/concretions and hardpans)</td>
</tr>
</tbody>
</table>

Source: Fisher et al., 2008.
Soil Quality Perceptions

• Tanzania National Panel Survey – Integrated Survey on Agriculture (TZNPS)
  • Nationally representative
  • 3,280 households
  • October 2008 and October 2009

Soil Quality Questions:
• How do you know the quality of your soil?
  • Response options: “Scientifically tested” (0.59%), “Own experience” (97.95%), and “Other” (1.46%)

• What is the soil quality of this plot?
  • Response options: “Good” (50.8%), “Average” (44.26%) or “Bad” (4.95%)
Linking Soil Quality Assessments

Data Sources: Fisher et al. 2007; GADM 2011; ILRI 2011.

Tanzania Nutrient Availability

- Ocean
- No or Slight Constraint
- Moderate Constraint
- Severe Constraint
- Very Severe Constraint
- Mainly Non - Soil
- Water
- Region
- District
  - TZNPS Households

N = 1,703 Households with 3,638 plots
Comparisons of Perceptions and Measurements

- **Good / No Constraint**
  - Perception: 4.95%
  - Measurement: 31.34%
  - Measurement is lower than perception.

- **Average / Moderate Constraint**
  - Perception: 50.80%
  - Measurement: 57.53%
  - Perception is higher than measurement.

- **Bad/Severe Constraint**
  - Perception: 11.13%
  - Measurement: 4.95%
  - Perception is lower than measurement.

In general, soil quality perceptions are higher than measurements.
### Cross Tabulation of Soil Perception and Measurement (Nutrient Availability)

<table>
<thead>
<tr>
<th>Perception</th>
<th>Measurement</th>
<th>No or Slight Constraint</th>
<th>Moderate Constraint</th>
<th>Severe Constraint</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good</td>
<td></td>
<td>536</td>
<td>1,065</td>
<td>247</td>
<td>1,848</td>
</tr>
<tr>
<td><strong>Row %</strong></td>
<td></td>
<td>29.00</td>
<td>57.63</td>
<td>13.37</td>
<td>100.00</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td>563</td>
<td>918</td>
<td>129</td>
<td>1,610</td>
</tr>
<tr>
<td><strong>Row %</strong></td>
<td></td>
<td>34.97</td>
<td>57.02</td>
<td>8.01</td>
<td>100.00</td>
</tr>
<tr>
<td>Bad</td>
<td></td>
<td>41</td>
<td>110</td>
<td>29</td>
<td>180</td>
</tr>
<tr>
<td><strong>Row %</strong></td>
<td></td>
<td>22.78</td>
<td>61.11</td>
<td>16.11</td>
<td>100.00</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>1,140</td>
<td>2,093</td>
<td>405</td>
<td>3,638</td>
</tr>
<tr>
<td><strong>Row %</strong></td>
<td></td>
<td>31.34</td>
<td>57.53</td>
<td>11.13</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Pearson chi²(4) = 41.0382  Pr < 0.000

**Strong mismatch between measurement and perception.**

Mismatch between measurement and perception.
Conclusion and Continued Research

• In general soil quality perceptions are than measurements.

• In our sample, 39.61 percent of plots have perceptions higher than measured assessments and 19.63 percent have perceptions lower than measurements.

• Low adoption of soil improving activities could be linked to a mismatch in soil quality assessments.

• Are mismatches driven by different comparatives in use by farmers and researchers?
Thank You!

• Thank you to the IPWSD3 planning committee.

• Thank you to the Agricultural Development group at the Bill and Melinda Gates Foundation for their generous support of this research.

• Questions or comments?