Food Security, Soil and Climate Smart Agriculture Conference

“World Soil Day Celebration”

Improving soil health, food security, and livelihood of smallholder farmers in Mozambique through development and use of appropriate fertilizer blends

Rogério Borguete Alves Rafael, PhD
Assistant Professor & Head of Soil Science Division,
Faculty of Agronomy and Forestry Engineering

Sochi, 5-6th December 2019
Structure of presentation

1. Statement of the problem
2. Strategy to solve the problem
3. Preliminary results
4. Final Consideration
1. Statement of the problem

- 799,380 km²
- ~27,284,701 inhabitants (at Dec 2014).
- Poverty is concentrated in rural areas
1. Statement of the problem

- The itinerant agriculture system, without the use of inputs such as irrigation and fertilizers in Mozambique (Benson et al., 2012; Cungura et al., 2013) led to a very low productivity of food security crops;
1. Statement of the problem

- Agriculture challenges
  - Low use of fertilizers
  - Lack of input markets
  - Lack of farmers knowledge
  - Higher price of fertilizers and other inputs
  - Limited access to extension services
1. Statement of the problem

- Fertilizer rate per ha ~ 3kg/ha for food crops (corn, beans etc.)(Benson et al., 2012);
- Almost all imported fertilizer are used for tobacco and sugar cane (Benson et al., 2012; IFDC, 2011);
- Absence of fertilizer law and only is the fertilizer regulation (being updated)

<table>
<thead>
<tr>
<th>Product name</th>
<th>Fertilizers Price List</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Composition</td>
</tr>
<tr>
<td></td>
<td>N</td>
</tr>
<tr>
<td>Urea</td>
<td></td>
</tr>
<tr>
<td>Npk 23:21:0 +4S</td>
<td>23.00</td>
</tr>
<tr>
<td>Map</td>
<td>11.0</td>
</tr>
<tr>
<td>Npk 12:24:12</td>
<td>12.00</td>
</tr>
<tr>
<td>3.2.1. (38) + 0.5% Zn</td>
<td>19.2</td>
</tr>
<tr>
<td>1.1.1. (39)+0.5%Zn</td>
<td>13.0</td>
</tr>
<tr>
<td>1.1.1. (38) + 2.0%Zn</td>
<td>12.5</td>
</tr>
<tr>
<td>1.1.1. (33) +0.5%Zn+6.2%S+0.2%B</td>
<td>10.8</td>
</tr>
<tr>
<td>1.1.1. (38) + 0.5%Zn+0.13%Cu+0.25%B</td>
<td>12.7</td>
</tr>
<tr>
<td>KYNPLUS UREA</td>
<td>46.0</td>
</tr>
<tr>
<td>KYNOPOP</td>
<td>14.3</td>
</tr>
<tr>
<td>MILEIE OEMFF (Maize Foliar fert)</td>
<td></td>
</tr>
<tr>
<td>Foliar Fertilizer (Vegetables &amp;Horticulture)</td>
<td></td>
</tr>
<tr>
<td>VIGGIE OEMFF START</td>
<td></td>
</tr>
<tr>
<td>VIGGIE OEMFF FRUIT</td>
<td></td>
</tr>
<tr>
<td>VIGGIE OEMFF GRO</td>
<td></td>
</tr>
<tr>
<td>CALCIUM NITRATE WS</td>
<td>15.5</td>
</tr>
<tr>
<td>POTASSIUM CHLORIDE FINES</td>
<td>50.0</td>
</tr>
<tr>
<td>CALCIBOR 50KG</td>
<td>15.4</td>
</tr>
<tr>
<td>CALCIBOR 1200KG</td>
<td>15.4</td>
</tr>
<tr>
<td>GREENGOLD 30</td>
<td>30.0</td>
</tr>
<tr>
<td>NPK</td>
<td>14.0</td>
</tr>
</tbody>
</table>
1. Statement of the problem

- Soil fertility restoration must be the starting point to reverse both the current trend of pressure on land and soil degradation (Bekunda et al., 2002; Van Straaten, 2006; Van Raij, 2011)

- N, P, and K inputs are required for optimum plant growth in these soils

- Organic amendments are alternative to optimize the fertilizer use
1. Statement of the problem

Focus on mineral fertilizer

Share of Nitrogen, Phosphate, and Potash Consumption in Selected Regions (2015)
1. Statement of the problem

Focus on mineral fertilizer/Adding nutrients: The ‘Green Revolution’

• A success in Asia and Latin America
  • External input use (mineral fertilizers & lime)
  • Improved varieties
  • Irrigation

• A disappointment in sub-Saharan Africa
  • Fertilizer is ‘too costly’
  • Fertilizer use is uneconomic in poorly responsive environments
  • Fertilizer recommendations were not tailored to farmer’s specific circumstances
    • Heterogeneous soil fertility
    • The farmer’s social and economic situation and goals
1. Statement of the problem

Implication on food security

• Mozambique has been suffering from food insecurity and chronic poverty
  ✓ “The first strategic objective defined under this priority is to increase the productivity of staple crops in order to increase food security and access to markets by farmers through access of improved inputs and technologies by smallholder farmers”

• Recent data from on station and on farm trials along the Beira Corridor in Central Mozambique, show maize and legume yields between 1.2 and 0.45 ton/ha, respectively (IIAM-AGRA-Beira corridor baseline report, 2009; Soil Fertility Consortium for southern Africa baseline study report, 2009 and IIAM-AGRA-Tete baseline project, 2012).
2. Strategy to solve the problem

- There is now strong evidence that addition of blended fertilizers in most soils leads to remarkable improvement in maize yields;
- Thus, fertilizers that contain macro-nutrients (N, P and K), secondary nutrients (sulphur (S), calcium (Ca), and magnesium (Mg)), and several important micro-nutrients (zinc (Zn), iron (Fe), molybdenum (Mo)) are now required;
- Moreover, application of lime and secondary macronutrients and have also resulted in increased yields, even though the responses have shown variability across different sites (Kihara et al, 2016);
- This shows a need to develop site-specific fertilizer blends based on soil analysis to get the expected benefits.
2. Strategy to solve the problem

• 6 institutions that will be working in coordination to address the fertilizer problem: IIAM, UEM, YARA/Greenbelt, Mozambique Fertilizer Company (MFC) and DINAS;

• Increasing the availability of improved fertilizers through soil sampling, analysis, mapping, formulation and production of new and appropriate blended fertilizers for maize and soybean;

• Validation of the new fertilizer blends

• Improving the availability of quality fertilizer to smallholder farmers by activating the functioning of the Mozambique Fertilizer Quality Control System
3. Preliminary results
3. Preliminary results

### Yara 5-6t Maize programs

<table>
<thead>
<tr>
<th>Program 1: 54-15-45 + 40% nitrogen</th>
<th>Program 2: 54-15-45 + 60% nitrogen</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Month</strong></td>
<td><strong>Month</strong></td>
</tr>
<tr>
<td>April</td>
<td>April</td>
</tr>
<tr>
<td>May</td>
<td>May</td>
</tr>
<tr>
<td>June</td>
<td>June</td>
</tr>
<tr>
<td>July</td>
<td>July</td>
</tr>
<tr>
<td>August</td>
<td>August</td>
</tr>
<tr>
<td>September</td>
<td>September</td>
</tr>
<tr>
<td>October</td>
<td>October</td>
</tr>
<tr>
<td>November</td>
<td>November</td>
</tr>
<tr>
<td>December</td>
<td>December</td>
</tr>
</tbody>
</table>

**Fertilizer Application**

- **Phosphorus**
  - April: 1.5 tonnes/ha + 20% as 1X1 + 80% as 1X2
  - May: 1.5 tonnes/ha + 20% as 1X1 + 80% as 1X2
  - June: 1.5 tonnes/ha + 20% as 1X1 + 80% as 1X2
- **Potassium**
  - April: 1.5 tonnes/ha + 20% as 1X1 + 80% as 1X2
  - May: 1.5 tonnes/ha + 20% as 1X1 + 80% as 1X2
  - June: 1.5 tonnes/ha + 20% as 1X1 + 80% as 1X2
  - July: 1.5 tonnes/ha + 20% as 1X1 + 80% as 1X2
  - August: 1.5 tonnes/ha + 20% as 1X1 + 80% as 1X2
  - September: 1.5 tonnes/ha + 20% as 1X1 + 80% as 1X2
  - October: 1.5 tonnes/ha + 20% as 1X1 + 80% as 1X2
  - November: 1.5 tonnes/ha + 20% as 1X1 + 80% as 1X2
  - December: 1.5 tonnes/ha + 20% as 1X1 + 80% as 1X2

**Fertilizer Recommendations**

- **MAP 15-30**
  - 1 tonne/ha
  - 2.0 tonnes/ha

- **Zinc Sulfate**
  - 1 tonne/ha
  - 2.0 tonnes/ha

**Transport Cost**

- 3.000 Tonnes

---

### Marks-A-Crop

<table>
<thead>
<tr>
<th>Program 1: 54-15-45 + 40% nitrogen</th>
<th>Program 2: 54-15-45 + 60% nitrogen</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Month</strong></td>
<td><strong>Month</strong></td>
</tr>
<tr>
<td>April</td>
<td>April</td>
</tr>
<tr>
<td>May</td>
<td>May</td>
</tr>
<tr>
<td>June</td>
<td>June</td>
</tr>
<tr>
<td>July</td>
<td>July</td>
</tr>
<tr>
<td>August</td>
<td>August</td>
</tr>
<tr>
<td>September</td>
<td>September</td>
</tr>
<tr>
<td>October</td>
<td>October</td>
</tr>
<tr>
<td>November</td>
<td>November</td>
</tr>
<tr>
<td>December</td>
<td>December</td>
</tr>
</tbody>
</table>

**Fertilizer Application**

- **Phosphorus**
  - April: 1.5 tonnes/ha + 20% as 1X1 + 80% as 1X2
  - May: 1.5 tonnes/ha + 20% as 1X1 + 80% as 1X2
  - June: 1.5 tonnes/ha + 20% as 1X1 + 80% as 1X2
  - July: 1.5 tonnes/ha + 20% as 1X1 + 80% as 1X2
  - August: 1.5 tonnes/ha + 20% as 1X1 + 80% as 1X2
  - September: 1.5 tonnes/ha + 20% as 1X1 + 80% as 1X2
  - October: 1.5 tonnes/ha + 20% as 1X1 + 80% as 1X2
  - November: 1.5 tonnes/ha + 20% as 1X1 + 80% as 1X2
  - December: 1.5 tonnes/ha + 20% as 1X1 + 80% as 1X2

- **Potassium**
  - April: 1.5 tonnes/ha + 20% as 1X1 + 80% as 1X2
  - May: 1.5 tonnes/ha + 20% as 1X1 + 80% as 1X2
  - June: 1.5 tonnes/ha + 20% as 1X1 + 80% as 1X2
  - July: 1.5 tonnes/ha + 20% as 1X1 + 80% as 1X2
  - August: 1.5 tonnes/ha + 20% as 1X1 + 80% as 1X2
  - September: 1.5 tonnes/ha + 20% as 1X1 + 80% as 1X2
  - October: 1.5 tonnes/ha + 20% as 1X1 + 80% as 1X2
  - November: 1.5 tonnes/ha + 20% as 1X1 + 80% as 1X2
  - December: 1.5 tonnes/ha + 20% as 1X1 + 80% as 1X2

**Fertilizer Recommendations**

- **MAP 15-30**
  - 1 tonne/ha
  - 2.0 tonnes/ha

- **Zinc Sulfate**
  - 1 tonne/ha
  - 2.0 tonnes/ha

**Transport Cost**

- 3.000 Tonnes

---

### Additional Remarks

- **Bench Options** (discounts taken into account; valid for winter seasons only)

<table>
<thead>
<tr>
<th>Program 1</th>
<th>Program 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAP 15-30</td>
<td>MAP 15-30</td>
</tr>
<tr>
<td><strong>Fertilizer Application</strong></td>
<td><strong>Fertilizer Application</strong></td>
</tr>
<tr>
<td>April</td>
<td>April</td>
</tr>
<tr>
<td>May</td>
<td>May</td>
</tr>
<tr>
<td>June</td>
<td>June</td>
</tr>
<tr>
<td>July</td>
<td>July</td>
</tr>
<tr>
<td>August</td>
<td>August</td>
</tr>
<tr>
<td>September</td>
<td>September</td>
</tr>
<tr>
<td>October</td>
<td>October</td>
</tr>
<tr>
<td>November</td>
<td>November</td>
</tr>
<tr>
<td>December</td>
<td>December</td>
</tr>
</tbody>
</table>

**Fertilizer Recommendations**

- **MAP 15-30**
  - 1 tonne/ha
  - 2.0 tonnes/ha

- **Zinc Sulfate**
  - 1 tonne/ha
  - 2.0 tonnes/ha

**Transport Cost**

- 3.000 Tonnes

---
3. Preliminary results

Control

T1: 15N-30P-5K+5S+0.2B+0.5Zn+0.2Mn

T2: 15N-30P-5K+5S+0.2B+0.5Zn

T3: 29N-10P-5K+5S+0.2B+5Zn+0.2Mn

T4: 29N-10P-5K+5S+0.2B+5Zn

T5: 14N-28P-14K

T6: 23N-21P-0K+4S

T7: 12N-24P-12K+2S
3. Preliminary results

- Control
- T1: NPK 5-30-0+9S+0.2B+0.5Zn+0.2Mn
- T2: NPK 5-30-0+8.5S+0.2B+0.5Zn
- T3: NPK 5-25-0+5S+0.2Mn
- T4: NPK 14-28-14
4. Final Consideration

- **Continue with validation trials**
  - 54 trials planned
  - Inputs (fertilizer and seed) already in place
  - Fields already prepared

- **Introduce lime trials**
  - 6 trials planned
  - Lime already in place and characterized

- **Introduce small packs of fertilizer to farmers**
  - 5000 farmers targeted
  - Best blends (according to preliminary results) to be distributed
  - Farmer identification and registration in course (extension)

- **To carry out a results dissemination workshop**
  - National/regional level
  - To include relevant actors

- **Train other stakeholders**
  - Extension staff, VBA’s, Farmers and other technicians

- **Produce and distribute extension material**
  - Materials in development (to include preliminary results)
4. Final Consideration

Interesting research questions

• After IDAI cyclone, what soil changes occurred in Central Areas that need more soil research to understand what impact it brought to rural population?

• How to improve livelihood and resilience of rural communities affected by cyclone IDAI in center of Mozambique through sustainable soil management and participative education, contributing to poverty alleviation and resilience?
4. Final Consideration


Dr. Rebbie Harawa
Head of Soil Fertility & Fertilizer Systems

Dr. Rebbie Harawa is currently Head of Soil and Fertilizer Systems with the Alliance for a Green Revolution in Africa (AGRA) responsible for implementing soil health and fertilizer strategy to catalyze an agricultural transformation in Africa. Previously she was Interim Head for Farmer Solutions Program responsible for research and development, and capacity development. Before joining AGRA, Rebbie worked as a Team Leader and Science Coordinator for the UNDP/Columbia University-Millennium Villages Project, a multi-sectoral project which aimed at achieving the Millennium Development Goals (MDG’s). Rebbie also worked as an Adjunct Associate Research Scholar (part-time) for Global Health and Economic Development, Columbia University. Previously she also worked for World Agroforestry Center as a Research Specialist where she implemented projects on evaluating agroforestry technologies.

RHarawa@agra.org
Thank you for your attention
Спасибо за внимание