Nitrogen Fixation in Beans
Long Rain Season, Rwanda (2014)

Introduction

Common beans are the second most widely grown crop in East Africa. In Rwanda, they are the primary staple crop. As common beans are a leguminous plant (part of the general bean family), they have the ability to take nitrogen (N) from the air and use it for their growth. This process is referred to as biological nitrogen fixation. Most plants only use nitrogen from the soil. In modern agriculture, fertilizer nitrogen is one of the most costly yearly inputs for farmers. By focusing on low-cost ways to improve biological nitrogen fixation, farmers can maintain high bean yields while applying only a fraction of the normal amount of fertilizer.

| $92/ha | Fertilizer substitute value of N from fixation, in USD per hectare | $3/ha | Cost of commercial rhizobium product |
| No Change | Yield change with rhizobium inoculant compared to the control | 50% | Fertilizer savings from using biological inoculants |

Context and Trial Rationale

- Common beans are the most widely grown crop in Rwanda. The traditional fertilizer recommendation is to apply 100 kg/ha of Diammonium Phosphate (DAP), a common fertilizer. If nitrogen fixation can be increased at minimal cost, fertilizer use can be reduced with minimal to no effect on yield.

- Several techniques have been promoted by N2Africa to increase nitrogen fixation in common bean. These include rhizobia (symbiotic soil bacteria attached to the plant roots that fix the nitrogen) and micronutrients. However, in the A-season of 2014, only the rhizobia were tested.

Major Intervention Configurations

- Research: One Acre Fund consulted a range of experts at the International Center for Tropical Agriculture (CIAT), the International Institute for Tropical Agriculture (IITA), and N2Africa to identify promising methods to improve nitrogen fixation in legumes.

Calculated from the price of 50kg DAP and the concentration of N in the fertilizer.

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- **N-fixation Inoculants**: One Acre Fund trialed two inoculant products in Rugano and Nyaruzazi districts, Rwanda. These products were 1) URM 1597 (*Rhizobium tropici*) from RAB and 2) CIAT 899 (*Rhizobium tropici*) from Mea Fertilizer Company.

- **Trial Configurations**
  1) **Control (Rugango)**: Local climbing bean seed with 100 kg/ha DAP fertilizer and no inoculant.
  2) **CIAT 899**: Local climbing bean seed with 50 kg/ha DAP planting fertilizer and CIAT 899 inoculant.
  3) **URM 1597**: Local climbing bean seed with 50 kg/ha DAP planting fertilizer and URM 1597 inoculant.
  4) **Control (Nyaruzazi)**: Local climbing bean seed with 100 kg/ha DAP planting fertilizer and no inoculant.
  5) **CIAT 899**: Local climbing bean seed with 50 kg/ha DAP planting fertilizer and CIAT 899 inoculant.
  6) **URM 1597**: Local climbing bean seed with 50 kg/ha DAP planting fertilizer and URM 1597 inoculant.

**A. Yield and Profit**: The below table summarizes agronomic results.

<table>
<thead>
<tr>
<th>Trial</th>
<th>Configuration</th>
<th>Location/date</th>
<th>Yield (t/ha)</th>
<th>Profit (USD/ha)</th>
<th>Profit Change vs. Trial Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. <strong>Control</strong>: Local bean seed, 100 kg DAP/ha, no inoculant</td>
<td>58 farmers</td>
<td>Rwanda, Rugango district, A-season 2014</td>
<td>1.64</td>
<td>$662</td>
<td>N/A</td>
</tr>
<tr>
<td>2. <strong>CIAT 899</strong>: Local bean seed, 50 kg DAP/ha, CIAT 899 inoculant</td>
<td>58 farmers</td>
<td>Rwanda, Rugango district, A-season 2014</td>
<td>1.40</td>
<td>$601</td>
<td>-$61</td>
</tr>
<tr>
<td>3. <strong>URM 1597</strong>: Local bean seed, 50 kg DAP/ha, URM 1597 inoculant</td>
<td>58 farmers</td>
<td>Rwanda, Rugango district, A-season 2014</td>
<td>1.71</td>
<td>$762</td>
<td>+$100</td>
</tr>
<tr>
<td>4. <strong>Control</strong>: Local bean seed, 100 kg DAP/ha, no inoculant</td>
<td>23 farmers</td>
<td>Rwanda, Nyaruzazi district, A-season 2014</td>
<td>1.89</td>
<td>$789</td>
<td>N/A</td>
</tr>
<tr>
<td>5. <strong>CIAT 899</strong>: Local bean seed, 50 kg DAP/ha, CIAT 899 inoculant</td>
<td>23 farmers</td>
<td>Rwanda, Nyaruzazi district, A-season 2014</td>
<td>1.85</td>
<td>$829</td>
<td>+$40</td>
</tr>
<tr>
<td>6. <strong>URM 1597</strong>: Local bean seed, 50 kg DAP/ha, URM 1597 inoculant</td>
<td>23 farmers</td>
<td>Rwanda, Nyaruzazi district, A-season 2014</td>
<td>1.68</td>
<td>$746</td>
<td>-$43</td>
</tr>
</tbody>
</table>
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B. Adoption: Medium Adoptability

- In Rugano, farmer preference for adoption of the inoculants ranged from 25 – 33%. By comparison, farmer preference for the control was 26%.
- In Nyarusazi, farmer preference for both inoculants was 0%, despite lack of significant changes in yield and a 50% reduction in fertilizer use.

C. Operability at Scale: High Operability

- Rhizobial inoculants produced by Mea Fertilizer (BioFix – CIAT 899) come in hermetically sealed packages. These packets are lightweight, mass produced, easy to use, and relatively affordable (less than $3 for a hectare of production).
- The inoculants produced by RAB (URM 1597) do not have as advanced packaging technology.
- For both of the inoculant products, the rhizobia are live bacteria and have a limited shelf-life to remain viable. Because of this, distribution logistics for these inoculant products are more time sensitive and challenging than other products (e.g. seed and fertilizer).

Next Steps

In 2015, One Acre Fund will:

1) Continue to trial the inoculants in conjunction with other soil fertility management tools (e.g. lime and micronutrients) in the research station to boost the nitrogen fixation potential in common beans.

2) Focus on boosting nitrogen fixation with soybean through the use of inoculants and custom fertilizer (Sympal).