### Impact Pathway Worksheet (Feel free to expand rows and columns as needed).

**Name of your CRSP Project (Shorter version):** Material for J. Lynch on root traits as breeding tools  
**Lead PI:** J Lynch

<table>
<thead>
<tr>
<th>ID#</th>
<th>Project Outputs (expected by FY 12)</th>
<th>When to be achieved?</th>
<th>Next Users</th>
<th>Final Users</th>
<th>Vision of Impact pathway</th>
<th>Step 4.1</th>
<th>Step 4.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>???</td>
<td>validated root traits used in bean breeding programs</td>
<td>some deployed now, others in the pipeline</td>
<td>bean breeders</td>
<td>Farmers in bean growing region</td>
<td>identify traits</td>
<td>confirm utility of traits for bean performance in stressful soils</td>
<td></td>
</tr>
<tr>
<td>FY 10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>several traits have been identified - a new one may have been identified this year</td>
<td>ongoing in USA, South Africa, Mozambique</td>
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</tr>
<tr>
<td>FY 11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ongoing - this is discovery research - impossible to predict</td>
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</tr>
<tr>
<td></td>
<td>SES assessment, policy studies</td>
<td>2012 - first wave</td>
<td>IIAM field staff</td>
<td>Farmers in bean growing region, policy makers</td>
<td>Conduct ex ante impact assessment at SES experimental sites</td>
<td>Participatory Variety Selection at SES experimental sites</td>
<td></td>
</tr>
<tr>
<td>FY 10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Complete baseline assessment, including analysis of seed sharing networks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY 11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Train IIAM staff in PVS/conduct PVS at selected SES experimental sites</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY 12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Continue to conduct PVS at selected SES experimental sites</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note on an ex post Impact pathway (Lynch, email 8-30-10)

Here is what happened:

1) General concept of utility of root hairs for P acquisition was established in other crops over the 60s and 70s.
2) Early 1990s I showed with colleagues the magnitude of genetic variation for this trait in common bean.
3) Early 2000s we showed the substantial importance of such genetic variation for P acquisition in common bean, and identified QTL for breeding. Value of genetic variation for this trait and interaction with mycorrhizal colonization was confirmed in the field mid 2000s.
4) During all this time (ie 1987 through 2010) I emphasized the importance and value of this trait for bean breeding. Sources of this trait were used as parents in selection programs by CIAT in late 1990s, but no trait selection among progeny was employed. Juan Carlos Rosas learned of this work in the CRSP, and has begun more focused selection for root traits in his program, although I am not sure he is using root hairs per se as a selection criterion.
5) In mid 2000s I began training a bean breeder from Mozambique with support from the McKnight Foundation. In her PhD work she is specifically looking at introgression of this trait into adapted local material as a breeding tool. She plans to continue selection for this trait when she returns to her post at IIAM next year.
6) Impact in the field has been achieved through the use of long root hair parents in CIAT programs, but this is difficult to quantify as no direct trait selection occurred during line development. Direct trait selection is being conducted in IIAM; promising lines are in development; progress to farmer impact will be slow since cultivar certification is very slow in Mozambique, and formal seed dissemination mechanisms ineffective.

This well understood trait has substantial value for a primary yield limitation, but its use has been limited by the application of this tool by bean breeders, who have many competing priorities. Progress is now being achieved since I am training breeders directly. Potential impact is substantial once materials are delivered to farmers - the subject of Dr. Findeis’ research.
1) General concept of utility of root hairs for P acquisition was established in other crops over the 60s and 70s.
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**Vision of Impact pathway**

<table>
<thead>
<tr>
<th>ID#</th>
<th>Step 4.3</th>
<th>Step 4.4</th>
<th>Step 4.5</th>
<th>Step 4.6</th>
</tr>
</thead>
<tbody>
<tr>
<td>??</td>
<td>Vision of impact pathway</td>
<td>characterize genetic control of traits</td>
<td>evaluate agroecological effects of traits on bean production systems</td>
<td>work with breeders to use screen to identify promising sources and to assist introgression or recurrent selection for traits</td>
</tr>
<tr>
<td>FY 10</td>
<td>ongoing</td>
<td>ongoing</td>
<td>ongoing</td>
<td>ongoing</td>
</tr>
<tr>
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**SES**

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<td>??</td>
<td>Vision of impact pathway</td>
<td>Test selected seed with randomly-selected farm households</td>
<td>Work with NGOs, comm. seed producers and extension to improve low-P seed distribution</td>
<td>Provide policy makers with knowledge of documented impacts and constraints to low-P seed diffusion</td>
</tr>
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<td>??</td>
<td>Multiple varieties (5+) low-P bean seed available in local markets/through seed-sharing networks. Bean income higher; local food supply more secure.</td>
<td>impacts are already being observed - extension of impacts dependent on adoption of new bean seed by farmers - the subject of Dr. Findeis’ activities</td>
</tr>
<tr>
<td>SES</td>
<td>Multiple varieties (5+) low-P bean seed available in local markets/through seed-sharing networks. Bean income higher; local food supply more secure. Policy makers taking steps to improve bean seed system in Mozambique/region.</td>
<td>1) 2012 - local impacts observable in growing region; 2) 2015 - changes in national/national policy to reduce potential constraints to low-P seed diffusion</td>
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</table>