Sustainable Intensification of low-input agriculture Systems – Theme 3

Peter Setimela, Christian Thierfelder and Munyaradzi Mutenje
Summary of Activities

Scaling:
• Extension of CA and its components through mother and baby trials
• Promotion of direct seeding, rotation, intercropping and herbicide use
• Scaling green manure cover crops (CRS)
• Cowpea seed production initiated with COMACO
• Seed production of green manure cover crops by CIMMYT
• Breeders seed of QPM hybrids

Research:
• Double-up legume systems (ZARI)
• Green manure cover crops (CRS)
• Analysis of the performance of gliricidia-maize intercropping (COMACO)
• Manure handling (Grassroots Trust and CRS)
• Evaluation of QPM maize hybrids
Partnerships

- Zambian Agriculture Research Institute (ZARI)
- Ministry of Agriculture Extension (MoA)
- Total LandCare (TLC)
- Catholic Relief Services (CRS)
- Community Market for Conservation (COMACO)
- Grassroots Trust (GRT)
- Seed companies
## Targets based on FTF indicators

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Chipata</th>
<th>Sinda</th>
<th>Lundazi</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Target</td>
<td>Actual</td>
<td>Target</td>
<td>Actual</td>
</tr>
<tr>
<td># Rural Households benefiting directly</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2644</td>
<td>1342</td>
<td>2722</td>
<td>6708</td>
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<tr>
<td># of individuals who have received short-term agricultural sector</td>
<td>246</td>
<td>112</td>
<td>302</td>
<td>660</td>
</tr>
<tr>
<td>productivity or food security training</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># of farmers who have applied new technologies or management practices</td>
<td>5700</td>
<td>5656</td>
<td>2850</td>
<td>3544</td>
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<tr>
<td>as a result of USG Assistance</td>
<td>5700</td>
<td>6321</td>
<td>14250</td>
<td>15521</td>
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<tr>
<td>New</td>
<td>2000</td>
<td>1331</td>
<td>1000</td>
<td>1650</td>
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<tr>
<td>Continuing</td>
<td>3700</td>
<td>4325</td>
<td>1850</td>
<td>1894</td>
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<tr>
<td></td>
<td>4500</td>
<td>4741</td>
<td>10050</td>
<td>10960</td>
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Established work

<table>
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<tr>
<th>Trial name</th>
<th>Type</th>
<th>Target</th>
<th>Actual</th>
<th>Achievement</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA mother trials</td>
<td>On-farm</td>
<td>24</td>
<td>24</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Baby trials</td>
<td>On-farm</td>
<td>720</td>
<td>697</td>
<td>97%</td>
<td>Drought at planting</td>
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<tr>
<td>Double up legume</td>
<td>On-farm</td>
<td>5</td>
<td>5</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>GMCC trials</td>
<td>On-farm</td>
<td>48</td>
<td>36</td>
<td>75%</td>
<td>Drought at planting</td>
</tr>
<tr>
<td>Manure trials</td>
<td>On-farm</td>
<td>12</td>
<td>9</td>
<td>75%</td>
<td>Drought at planting</td>
</tr>
<tr>
<td>Gliricidia/maize</td>
<td>On-farm</td>
<td>108</td>
<td>72</td>
<td>70%</td>
<td>Farmers had harvested</td>
</tr>
<tr>
<td>QPM trials</td>
<td>On-station</td>
<td>12</td>
<td>12</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>GMCC evaluation</td>
<td>On-station</td>
<td>1</td>
<td>1</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Gliricidia</td>
<td>On-station</td>
<td>1</td>
<td>1</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Expanded step</td>
<td>On-station</td>
<td>1</td>
<td>1</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Long-term</td>
<td>On-station</td>
<td>1</td>
<td>1</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>
Targets based on FTF indicators

### # of new technologies or management practices in one of the following phases of development as a result of USG assistance:

<table>
<thead>
<tr>
<th>Phase</th>
<th>Target</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase 1: under research</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Phase 2: under field testing</td>
<td>29</td>
<td>29</td>
</tr>
<tr>
<td>Phase 3: made available for transfer</td>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>86</strong></td>
<td><strong>86</strong></td>
</tr>
</tbody>
</table>
Where are we in the execution?

- Implementation of trial work from the original team is going well
- New partnerships needed some time to develop working relationships
- Some technologies are scaling extremely well
- Some trials need more season’s data

### Adoption of practices in Lundazi

<table>
<thead>
<tr>
<th>Treatment</th>
<th>M</th>
<th>F</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct Seeding</td>
<td>91</td>
<td>72</td>
<td>163</td>
</tr>
<tr>
<td>Herbicides</td>
<td>326</td>
<td>231</td>
<td>557</td>
</tr>
<tr>
<td>Intercrop</td>
<td>74</td>
<td>38</td>
<td>112</td>
</tr>
<tr>
<td>Crop Rotation</td>
<td>120</td>
<td>117</td>
<td>237</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>608</td>
<td>458</td>
<td>1,067</td>
</tr>
</tbody>
</table>
CA response to EL NINO

Maize grain yield, CA mother trial, Mtaja 2015/2016

Maize grain yield (kg ha⁻¹)

- Esneya Banda
- Maleni Tembo
- Mateyo Ngoma
- Soka Mshanga
- Mean

Legend:
- Control
- DS+maize
- DS+maize/leg int
- DS-maize-leg rot
Summary CA, all mother trials, 2015/2016

Maize grain yield kg ha\(^{-1}\)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Chanje</th>
<th>Mtaya</th>
<th>Vuu</th>
<th>Kawalala</th>
<th>Hoya</th>
<th>Kapara</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ridge/Furrow, maize</td>
<td>a</td>
<td>a</td>
<td>a</td>
<td>a</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>CA-DS, maize</td>
<td>b</td>
<td>b</td>
<td>b</td>
<td>b</td>
<td>b</td>
<td>b</td>
</tr>
<tr>
<td>CA-DS, Mz/Cp intercrop</td>
<td>c</td>
<td>c</td>
<td>c</td>
<td>c</td>
<td>c</td>
<td>c</td>
</tr>
<tr>
<td>CA-DS, Mz-Cp rotation</td>
<td>ab</td>
<td>ab</td>
<td>ab</td>
<td>ab</td>
<td>ab</td>
<td>ab</td>
</tr>
<tr>
<td>CA-DS, Mz/Cp rotation</td>
<td>a</td>
<td>a</td>
<td>a</td>
<td>a</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>CA-DS, Mz/Sb rotation</td>
<td>a</td>
<td>a</td>
<td>a</td>
<td>a</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>CA-Ripper, maize</td>
<td>a</td>
<td>a</td>
<td>a</td>
<td>a</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>CA-Ripper, Mz-Sb rotation</td>
<td>a</td>
<td>a</td>
<td>a</td>
<td>a</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>CA-Direct seeder, Mz-Sb rotation</td>
<td>a</td>
<td>a</td>
<td>a</td>
<td>a</td>
<td>a</td>
<td>a</td>
</tr>
</tbody>
</table>

Note: Different letters indicate significant differences at p < 0.05.
Maize grain yield, CA LT trial, Msekera, 2015/2016

Maize grain yield (kg/ha) vs Cropping system:

- Conventional ridge tillage, mouldboard, sole maize
- Conventional ridge tillage, sole maize
- Basins, sole maize
- Dibble stick, sole maize
- Direct seeding, sole maize
- Direct seeding, maize/Cp intercropping
- Direct seeding, Maize-CP rotation
- Direct seeding, maize-Sb rotation

Notations: a, ab, abc, bcd, d, cd, bc

- Dibble stick - Maize/Cowpea intercrop
- Dibble stick - Maize - Cowpea rot
- Dibble stick Maize continuous
- Ridge & furrow Maize continuous

Low rainfall & medium elevation

Mechanised Sustainable Intensification Practices Net Benefits (2012-2016)

- Ripper Maize soybean Rotation
- Ripper Maize Sole
- CP maize sole

High rainfall & medium elevation

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<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Ripper Maize soybean Rotation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ripper Maize Sole</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CP maize sole</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Adoption patterns

% Farmers Practising

Minimum tillage Mulching Intercropping Drought tolerant varieties

- Hoya
- Vuu
- Chanje
- Kapara
- Mtaya
- Mtaya
- Kawala

Varieties:
- Hoya
- Vuu
- Chanje
- Kapara
- Mtaya
- Mtaya
- Kawala
COMACO/CIMMYT/ZARI - Gliricidia intercropping study

Objective:

- To get a better understanding of the productivity of Gliricidia-maize intercropping systems
- Collaborative work between COMACO, CIMMYT, ZARI
Cluster design of 4 clusters:

- Distances between furthest plots not more than 10km
- 10 reps per cluster
COMACO/CIMMYT/ZARI Yield study, excluding unweeded plots, 2015/2016

Maize grain yield (kg/ha)

- 2 year loam
- 2 year sandy clay
- 4 year loam
- 4 year sandy clay
- Overall average

- Gliricidia/maize
- Maize fertilized
- Maize unfertilized
Major outcomes

- Substantial savings in mineral fertilizers can be achieved
- 66% (760kg ha\(^{-1}\)) yield benefit between maize/gliricidia and a non-fertilized control
- Study needs to be repeated to confirm results
CRS/CIMMYT/ZARI GMCC trial on-station

Objective:

• To evaluate the performance of green manure cover crops on crop productivity, soil quality and residual effects
Main treatments:

- Maize – sole cropping (control)
- Maize – pigeonpea intercropping
- Lablab – sole cropping (in rotation with maize in year 2)
- Maize – lablab intercropping planted at the same time as maize
- Maize – lablab intercropping planted 1 week later than maize
- Maize – lablab intercropping planted 3 weeks after the maize
- Cowpea - sole cropping (in rotation with maize in year 2)
- Maize - Cowpea intercropping planted at the same time as maize

Sub-treatments (split plot design):

- No fertilizer addition
- Application of half the recommended fertilizer rate
Maize grain, CRS GMCC trial, Msekera 2015/2016

Maize grain yield (kg ha\(^{-1}\))

- **Maize sole**
  - no fert: AB
  - fert: a

- **Maize/PP**
  - no fert: B
  - fert: a

- **Maize/lablab 0 days**
  - no fert: AB
  - fert: a

- **Maize/lablab 7 days**
  - no fert: AB
  - fert: a

- **Maize/lablab 21 days**
  - no fert: A
  - fert: a

- **Maize/cowpea**
  - no fert: AB
  - fert: a

Legend:
- **no fert**
- **fert**
GMCC intercropping trials on-farm (N=19), Chipata, 2015/2016

Maize grain yield (kg ha⁻¹)

- Maize control
- Maize/Pp
- Maize/Pp +Cp
- Maize/Lablab

Maize control: a
Maize/Pp: ab
Maize/Pp +Cp: ab
Maize/Lablab: b
Manure management trials:

- **To evaluate** the effects of improved manure handling on the productivity of low-input agriculture systems
- First year trials established and yields available - farmers collected manure in new structures for implementation in year 2
Double-up legume trials:

- To evaluate the performance of pigeonpea in association with groundnuts under CA and CP
Key results all sites: Groundnuts

<table>
<thead>
<tr>
<th></th>
<th>Conventional agriculture</th>
<th>Conservation agriculture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomass and grain yield (kg ha(^{-1}))</td>
<td>Grain</td>
<td>Biomass</td>
</tr>
<tr>
<td>Full pop Gn</td>
<td>AB</td>
<td>BC</td>
</tr>
<tr>
<td>Full pop Gn / Half Pp</td>
<td>BC</td>
<td>C</td>
</tr>
<tr>
<td>Full pop Gn / Full Pp</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Biomass and grain yield (kg ha\(^{-1}\))
Key results Hoya: Pigeonpea

Biomass and grain yield (kg ha\(^{-1}\))

- **Conventional agriculture**
  - Grain
  - Biomass

- **Conservation agriculture**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Grain</th>
<th>Biomass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sole Pp</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full pop Gn / Half Pp</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full pop Gn / Full Pp</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sole Pp</td>
<td></td>
<td></td>
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<tr>
<td>Full pop Gn / Half Pp</td>
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<td></td>
</tr>
<tr>
<td>Full pop Gn / Full Pp</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Legend:
- a
- b
- c
Major outcomes

- Double-up legume systems are viable options to increases productivity and income
- CRS and GRT are very interested to try and expand this system
- Jerry Glover/Sieg Snapp excited!
- Expand into double up with soybeans as well
QPM work

QPM hybrids

Trials yielding > 3t/ha
Trials yielding <3t/ha
Best QPM genotypes mean and stability

QPM germplasm CZH132044Q was found to be stable and high yielding across different environments
Which activities are working well?

- Scaling work with NGOs and extension service is making good progress
- Adoption of Good Agriculture Practices increasing...!
- New partnerships (COMACO, CRS and GRT) are functioning – good working relationships established
- Cross program activities between DTMASS and Africa RISING starting
Which activities need improvement?

- Negotiations for workplan and budget took too long
- Initial establishment arrangements with MAWA did not work so well –MAWA staff not familiar with establishment of research
- Manure trials need more researcher input on-site
- Gliricidia-study had a lot of variability in the dataset
- Seed multiplication by COMACO just starting (SCCI delayed approval)
- Seed inspection and oversight of legume seed production – CIMMYT is not specialized
Proposed solutions to the challenges?

- ZARI/CIMMYT is now taking leadership in implementation of CRS/GMCC trial implementation (CRS)
- ZARI/CIMMYT will take a larger responsibility to ensure more precision on manure trials (GRT)
- CIMMYT will provide maize germplasm to COMACO to reduce variability on the Gliricidia – aim at taking a soil sample to add value to the study (COMACO)
- Seed inspection and oversight of legume seed production - need to be done by IITA/ICRISAT