Pigeonpea Research and Development Efforts in Eastern and Southern Africa: A Success Story

## Supply and demand trends of pulses in India (million MT)

<table>
<thead>
<tr>
<th>Crop</th>
<th>2012</th>
<th></th>
<th>2017</th>
<th></th>
<th>2025</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Production</td>
<td>Consumption</td>
<td>Gap</td>
<td>Production</td>
<td>Consumption</td>
<td>Gap</td>
</tr>
<tr>
<td>Pigeonpea</td>
<td>2.7</td>
<td>3.2</td>
<td>-0.5</td>
<td>2.7</td>
<td>4.1</td>
<td>-1.5</td>
</tr>
<tr>
<td>Chickpea</td>
<td>6.5</td>
<td>6.7</td>
<td>-0.2</td>
<td>8.8</td>
<td>8.2</td>
<td>0.7</td>
</tr>
<tr>
<td>Black gram</td>
<td>1.8</td>
<td>2.0</td>
<td>-0.2</td>
<td>2.0</td>
<td>2.4</td>
<td>-0.4</td>
</tr>
<tr>
<td>Mung bean</td>
<td>1.6</td>
<td>1.8</td>
<td>-0.2</td>
<td>1.8</td>
<td>2.2</td>
<td>-0.4</td>
</tr>
</tbody>
</table>

Source: Tom walker et al., 2015
Pigeon pea Production ('000 t) trends

Asia
Africa
Carribean
## Global top ten pigeonpea producers in 2014

<table>
<thead>
<tr>
<th>Country</th>
<th>Area (ha)</th>
<th>Production (t)</th>
<th>Productivity (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>India</td>
<td>5,062,000</td>
<td>3,290,000</td>
<td>650</td>
</tr>
<tr>
<td>Myanmar</td>
<td>611,600</td>
<td>575,100</td>
<td>940</td>
</tr>
<tr>
<td>Tanzania</td>
<td>276,400</td>
<td>249,250</td>
<td>902</td>
</tr>
<tr>
<td>Kenya</td>
<td>276,124</td>
<td>274,523</td>
<td>994</td>
</tr>
<tr>
<td>Mozambique</td>
<td>248,000</td>
<td>120,979</td>
<td>486</td>
</tr>
<tr>
<td>Malawi</td>
<td>229,790</td>
<td>301,010</td>
<td>1309</td>
</tr>
<tr>
<td>Haiti</td>
<td>111,950</td>
<td>90,480</td>
<td>808</td>
</tr>
<tr>
<td>Uganda*</td>
<td>101,540</td>
<td>93,645</td>
<td>922</td>
</tr>
<tr>
<td>Dominican R</td>
<td>23,088</td>
<td>24,615</td>
<td>1066</td>
</tr>
<tr>
<td>Nepal</td>
<td>17,006</td>
<td>16,415</td>
<td>965</td>
</tr>
</tbody>
</table>

### Potential Countries in Africa
- Zambia
- Ethiopia
- DRC
- Burundi
- Ghana
- Nigeria

**Source:** FAO Stat 2014, TIA national surveys for Mozambique-2012, *2011 FAO
## Pigeonpea production trends in Africa

<table>
<thead>
<tr>
<th>Country</th>
<th>Production (000ha)</th>
<th>% increase</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2001</td>
<td>2014</td>
</tr>
<tr>
<td>Tanzania</td>
<td>87.1</td>
<td>249.3</td>
</tr>
<tr>
<td>Mozambique</td>
<td>31.6</td>
<td>120.9</td>
</tr>
<tr>
<td>Malawi</td>
<td>105.8</td>
<td>301.0</td>
</tr>
<tr>
<td>Kenya</td>
<td>73.46</td>
<td>274.5</td>
</tr>
<tr>
<td>Uganda*</td>
<td>80.0</td>
<td>93.6</td>
</tr>
<tr>
<td>Africa</td>
<td>380.6</td>
<td>1047.3</td>
</tr>
</tbody>
</table>

* 2011 data for Uganda, recent FAO data shows decline in productivity
Pigeonpea Success in ESA-Drivers of change

• High yielding, wilt resistant MD varieties
• SI through ICM with women participation
• Regional and International export and participation of large traders
• Innovative seed systems including CBS, QDS, Revolving seed
• Value addition and then export to regional and international markets
• Very strong participation of partners, donors (BMGF, USAID, Irish Aid etc.,) Governments initiatives - Kilimo Kwanza, Input subsidy prog.

Mrs. E. Molel of Kikatiti, Tanzania
In front of her old house of 1988

In front of her new improved house
Number subsistence smallholder farmers growing Pigeonpea in ESA

- 5-7 million smallholders depending on pigeonpea sub-sector

### Area growth in Mozambique

<table>
<thead>
<tr>
<th>Year</th>
<th>Area (ha)</th>
<th>Area in ha/house hold</th>
<th>Smallholder producers</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>68,814</td>
<td>0.10</td>
<td>695,286</td>
</tr>
<tr>
<td>2005</td>
<td>157,804</td>
<td>0.22</td>
<td>723,228</td>
</tr>
<tr>
<td>2006</td>
<td>170,252</td>
<td>0.23</td>
<td>727,142</td>
</tr>
<tr>
<td>2007</td>
<td>198,868</td>
<td>0.27</td>
<td>738,142</td>
</tr>
<tr>
<td>2008</td>
<td>190,368</td>
<td>0.25</td>
<td>748,593</td>
</tr>
<tr>
<td>2012</td>
<td>248,929</td>
<td>0.23</td>
<td>1,079,636</td>
</tr>
</tbody>
</table>
Varietal cafeteria in ESA

- 33 varieties released in ESA

- Kenya -8, Malawi-7, Mozambique-5, Tanzania-7, Uganda-2, Zambia-2, Sudan-1, Ethiopia-1

<table>
<thead>
<tr>
<th>Maturity group</th>
<th>Up to 2008</th>
<th>2009 onwards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short duration</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>Medium duration</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>Long duration</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>17</td>
<td>16</td>
</tr>
</tbody>
</table>

- 436 FPVS trials 981 demonstrations in ESA resulted in this fast track release with participation of 9498 farmers
Pigeonpea Breeding priorities in ESA

- High Grain yield
- Intercropping Compatibility
- Photoperiod Insensitivity and maturity
- Varietal targeting and on-farm research
- High yield potential during Ratoon
- Farmer & market preferred dry & fresh grains
- Resistance to Fusarium wilt
- Climate resilience with drought tolerance
- *Fusarium* wilt tolerance
- Pest tolerance esp. Pod borers
Plant types for inter cropping
Understanding modulation of T and P

- Qualitatively Short day plant but,
- Trials conducted across a transect
  - 50 to 2500 m asl and T varied from 30 - 15°C
  - Used artificial lighting P 12 h 20 min to 16 h 20 min
- Early flowering observed at 24°C for SD, 22°C for MD and at 18°C for LD
- MD varieties matured early (150 days) at equator and late (200 days) away from equator
Maize and pigeonpea intercropping with micro P-fertilization in Tanzania

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Total variable cost (US $)</th>
<th>Net income (US $)</th>
<th>Benefit-Cost ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAP</td>
<td>518</td>
<td>1137</td>
<td>2.2</td>
</tr>
<tr>
<td>Minjingu Phosphate granular</td>
<td>493</td>
<td>991</td>
<td>2.0</td>
</tr>
<tr>
<td>Minjingu Mazao</td>
<td>541</td>
<td>994</td>
<td>1.8</td>
</tr>
<tr>
<td>Sole maize with Minjingu Mazao</td>
<td>432</td>
<td>478</td>
<td>1.1</td>
</tr>
<tr>
<td>Farmer’s practice</td>
<td>345</td>
<td>496</td>
<td>1.4</td>
</tr>
<tr>
<td>s.e.d.</td>
<td>40.7</td>
<td>84</td>
<td></td>
</tr>
<tr>
<td>L.S.D</td>
<td>103.2</td>
<td>212.4</td>
<td></td>
</tr>
<tr>
<td>CV%</td>
<td>10.1</td>
<td>14.7</td>
<td></td>
</tr>
<tr>
<td>Significance at P=0.05</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>
## Doubled up legumes-Tanzania

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Pigeonpea yield (kg/ha)</th>
<th>Naliendele</th>
<th>Nachingwea</th>
<th>On-farm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pigeonpea + Maize inter crop</td>
<td></td>
<td>920</td>
<td>1010</td>
<td>960</td>
</tr>
<tr>
<td>Pigeonpea + Groundnut inter crop</td>
<td></td>
<td>1133</td>
<td>1183</td>
<td>1030</td>
</tr>
<tr>
<td>SE</td>
<td></td>
<td>78.25</td>
<td>43.85</td>
<td>52.76</td>
</tr>
</tbody>
</table>
Vegetable and grain types

Vegetable type
• East Africa and Caribbean is best source
• Larger seeds
• High % of soluble sugars
• High shelling % and ease of shelling
• Have more edible portion, protein, Ca, Mg, Carotene

Grain characteristics
• White/cream seed coat
• Bold and round seeds
• Aroma
• Cook fast
## Pod feeding-Lepidoptera

<table>
<thead>
<tr>
<th>Species</th>
<th>Seedling foliage</th>
<th>Flower buds &amp; flowers</th>
<th>Developing seeds</th>
<th>Maturing &amp; drying seeds</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Helicoverpa</em></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><em>Maruca</em></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td><em>Etiella</em></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

### Pest incidence vis-à-vis weather

<table>
<thead>
<tr>
<th>Insect group</th>
<th>Warm</th>
<th>Cool</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pod sucking bugs</td>
<td></td>
<td>Uniform</td>
</tr>
<tr>
<td>Pod borers</td>
<td>More</td>
<td>Less</td>
</tr>
<tr>
<td>Pod fly</td>
<td>Less</td>
<td>More</td>
</tr>
</tbody>
</table>
Incorporation of purple pods, constricted pods

<table>
<thead>
<tr>
<th>Line</th>
<th>Plant no.</th>
<th>Plant yield(g)</th>
<th>Seed colour</th>
<th>100-seed mass(g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MZ 2/9/36/2</td>
<td>3</td>
<td>158</td>
<td>cream seed</td>
<td>26</td>
</tr>
<tr>
<td>MZ 2/9/36/2</td>
<td>10</td>
<td>142</td>
<td>cream seed</td>
<td>25</td>
</tr>
<tr>
<td>MZ 2/9/36/2</td>
<td>12</td>
<td>129</td>
<td>cream seed</td>
<td>26</td>
</tr>
<tr>
<td>MZ 2/9/36/2</td>
<td>11</td>
<td>108</td>
<td>cream seed</td>
<td>25</td>
</tr>
<tr>
<td>MZ 2/9/36/2</td>
<td>14</td>
<td>103</td>
<td>cream seed</td>
<td>25</td>
</tr>
<tr>
<td>MZ 2/9/36/2</td>
<td>7</td>
<td>64</td>
<td>cream seed</td>
<td>27</td>
</tr>
<tr>
<td>MZ 2/9/36/2</td>
<td>14</td>
<td>52</td>
<td>cream seed</td>
<td>28</td>
</tr>
<tr>
<td>MZ 2/9/36/2</td>
<td>2</td>
<td>41</td>
<td>cream seed</td>
<td>28</td>
</tr>
</tbody>
</table>
Potential fodder genotype
Seed systems:

- Seed demand is 11,417 t to saturate present area and 2280 t @ 20% seed replacement
- About 4258 t pigeonpea seed produced (recorded) during last 10 years

honey bees facilitated outcrossing

Off-season seed increase

Cleisto

Normal
## Cajanus Cajan germplasm

<table>
<thead>
<tr>
<th>Africa</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethiopia</td>
<td>14</td>
</tr>
<tr>
<td>Kenya</td>
<td>343</td>
</tr>
<tr>
<td>Malawi</td>
<td>245</td>
</tr>
<tr>
<td>Mozambique</td>
<td>32</td>
</tr>
<tr>
<td>Rwanda</td>
<td>5</td>
</tr>
<tr>
<td>S. Africa</td>
<td>25</td>
</tr>
<tr>
<td>Tanzania</td>
<td>262</td>
</tr>
<tr>
<td>Uganda</td>
<td>98</td>
</tr>
<tr>
<td>Zaire</td>
<td>13</td>
</tr>
<tr>
<td>Zambia</td>
<td>85</td>
</tr>
<tr>
<td>Nigeria</td>
<td>182</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1304</td>
</tr>
</tbody>
</table>

### Asia

<table>
<thead>
<tr>
<th>Region</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICRISAT</td>
<td>1676</td>
</tr>
<tr>
<td>India</td>
<td>9201</td>
</tr>
<tr>
<td>BGD</td>
<td>75</td>
</tr>
<tr>
<td>Myanmar</td>
<td>81</td>
</tr>
<tr>
<td>Nepal</td>
<td>120</td>
</tr>
<tr>
<td>Philippines</td>
<td>61</td>
</tr>
<tr>
<td>Thailand</td>
<td>41</td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>110</td>
</tr>
<tr>
<td>Indonesia</td>
<td>21</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>11386</td>
</tr>
</tbody>
</table>

### Caribbean

<table>
<thead>
<tr>
<th>Country</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barbados</td>
<td>25</td>
</tr>
<tr>
<td>Dominican R</td>
<td>63</td>
</tr>
<tr>
<td>Grenada</td>
<td>15</td>
</tr>
<tr>
<td>Guadeloupe</td>
<td>22</td>
</tr>
<tr>
<td>Guyana</td>
<td>28</td>
</tr>
<tr>
<td>Jamaica</td>
<td>64</td>
</tr>
<tr>
<td>Puerto Rico</td>
<td>78</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>295</td>
</tr>
</tbody>
</table>

- Australia-61
Filling germplasm gaps:

- Additional germplasm was collected in Uganda, Kenya, Tanzania and Mozambique
- LD accessions - to develop varieties for cooler temp.
- MD varieties from Uganda - for high temperature and pest tolerance
Hybrid Pigeonpea

- 8 CMS, 52 test crosses
- African germplasm - More restorers
- Most of the maintainers from India are brown seeded
- Use of diverse gene pools for HV over African OPV
- Hybrids are with early vigour and more branches
Genomics research

- Assemble a diverse panel based on available germplasm/ elite lines/ breeding lines/ released varieties in African countries
- **Genotype diverse panel** using identified markers associated with breeding traits
- Initiate molecular breeding **for breeding traits** desirable in African countries
- Identified improved lines/molecular breeding products in India tested in African countries
Future Direction

- Genetic enhancement using diverse genepools
- Trait specific and multiple trait donors be used in pre-breeding
- More focus on MD with ratoonability
- Dissemination of new varieties, SI including double-up legumes
- Continue supporting effective seed system models
- Greater engagement with market players
- Value addition and utilization at household, community and village level
- Integration of hybrid technology, genomic and genetic resources and innovative breeding
ACKNOWLEDGEMENTS

• Farmers, NGOs, CBOs
• KALRO, EU, DRD, DARTS, IIAM, NARO, EIAR, ZARI
• BMGF, USAID, Irish Aid, AGRA and others
Thank you!