Advances in Chickpea Crop Improvement for Improved Productivity and Resilient Cropping Systems in Ethiopia

Mekasha Chichaybelu1, Million Eshete1, Lijalem Korbu1, Ridwan Mohammed1, Nigusie Girma1, Dagnachew Bekete1, Tesfaye Geleta1, Asnake Fikre2, Ganga Rao NPVR2, Chris O Ojiewo3, Emmanuel Monyo4, Pooran M Gaure4 and Rajeev K Varshney5

1Debre Zeit Agricultural Research Center, Ethiopian Institute of Agricultural Research (EIAR), Debre Zeit, Ethiopia. 2EIAR, Addis Ababa, Ethiopia. 3ICRISAT-Regional Research Program for Eastern and Southern Africa, Nairobi, Kenya. 4ICRISAT Genetic Gains Program – Ethiopia. 5Kenya and India

I. Introduction

- Chickpea (Cicer arietinum L.) is an important food legume (Figure 1) in Ethiopia with wide potential (Figure 2).
- In 2016, over one million household farmers produced 0.47 million tons of chickpea on 258,486.29 ha in Ethiopia. (Source: FAOSTAT, 2000–2015)
- Chickpea is a cheap protein source, especially for those who cannot afford animal protein (Figure 3).
- Ethiopia leads chickpea production in Africa and was ranked fifth in the world in the year 2013.
- It is becoming an important export commodity for the nation (Figure 4).
- The national productivity of chickpea doubled (1.9 ton ha⁻¹) compared to what it was a decade ago.
- Currently Ethiopia is the top chickpea producer in Africa (Figure 6) and fifth in the world in 2014.
- However, the country’s share in the global chickpea export market is only about 4%.
- Further improvement of the crop and its management is critical to meet export market requirements.
- This has to be coupled with enhancement of the marketing supply chain.

II. Methodology

- Chickpea improvement started with collection, characterization and evaluation of the local diversity (Figure 5).
- Chickpea lines and segregating populations introduced (from ICRISAT and ICARDA) and evaluated (Table 1).
- Lines either released as new varieties or used to improve local landraces through parental crossing (Figure 7).
- Molecular breeding streamlined into the national breeding program in close collaboration with ICRISAT (Figure 8).
- Production options evaluated (Figure 9).
- The informal seed system was strengthened through establishment and technical backstepping of farmers’ seed producer associations.
- Different platforms were used at different times to enhance research-extension-farmer linkage (Table 2).
- Farmers Participatory Variety Selection (FPVS) approach has been launched by the Tropical Legumes II project to improve uptake efficiency (Figure 10).
- The selected varieties are demonstrated and visited by large number of farmers.

III. Results

Crop Improvement

- Released 27 improved varieties with respective management packages.
- The TL project made significant contributions to the development of the recently released varieties (Table 3).
- Tremendous achievements in seed size, resistance to major diseases, pest management and agronomic practices were made.
- The national average yield advantage was more than double when compared to what it was a decade ago.
- Under best production conditions the packages for chickpea can yield more than 4t ha⁻¹.
- There is untapped ‘gene × environment × management’ potential to be exploited.

Impact of R&D on Chickpea Production and Productivity

- Chickpea production in Ethiopia is challenged by low productivity, poor farming practices, biotic and abiotic stresses.
- The national productivity and production increased considerably (Figure 11).
- Under best production conditions the packages for chickpea can yield more than 4t ha⁻¹.
- There is untapped ‘gene × environment × management’ potential to be exploited.
- The TL project made significant contributions to the development of the recently released varieties.
- Farmers Participatory Variety Selection (FPVS) approach has been launched by the Tropical Legumes II project to improve uptake efficiency.
- The selected varieties are demonstrated and visited by large number of farmers.

Impact of R&D on Chickpea Export

- Chickpea is becoming an important export commodity for Ethiopia.
- The nation’s export volume and earning showed moderate increase (Figure 12).
- However, the country’s share in the global chickpea export market is only about 4%.
- The country is the sixth top chickpea exporter in the world and leads Africa (Figure 13).
- Further improvement of the crop and its management is critical to meet export market requirements.
- This has to be coupled with enhancement of the marketing supply chain.

Impact of R&D on Chickpea Export

- Chickpea is becoming an important export commodity for Ethiopia.
- The nation’s export volume and earning showed moderate increase (Figure 12).
- However, the country’s share in the global chickpea export market is only about 4%.
- The country is the sixth top chickpea exporter in the world and leads Africa (Figure 13).
- Further improvement of the crop and its management is critical to meet export market requirements.
- This has to be coupled with enhancement of the marketing supply chain.

Table 1. Seed production of improved chickpea varieties by the informal and formal seed system (2008-2015).

<table>
<thead>
<tr>
<th>Seed class</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breeder</td>
<td>3.8</td>
<td>4.5</td>
<td>5.3</td>
<td>6.0</td>
<td>6.8</td>
<td>7.4</td>
<td>8.1</td>
<td>8.1</td>
<td>50.0</td>
</tr>
<tr>
<td>Basic</td>
<td>39.5</td>
<td>76.5</td>
<td>89.1</td>
<td>100.7</td>
<td>107.8</td>
<td>165.7</td>
<td>136.5</td>
<td>72.1</td>
<td>787.9</td>
</tr>
<tr>
<td>Certified/QDS</td>
<td>632.7</td>
<td>1,048.4</td>
<td>1,386.8</td>
<td>1,607.6</td>
<td>2,125.9</td>
<td>2,347.1</td>
<td>2,389.8</td>
<td>2,040.7</td>
<td>14,495.4</td>
</tr>
<tr>
<td>Total</td>
<td>632.7</td>
<td>1,145.8</td>
<td>1,481.2</td>
<td>1,714.3</td>
<td>2,240.5</td>
<td>2,520.2</td>
<td>3,434.4</td>
<td>2,120.9</td>
<td>15,333.3</td>
</tr>
<tr>
<td>% increment</td>
<td>69.5</td>
<td>29.3</td>
<td>15.3</td>
<td>30.7</td>
<td>12.5</td>
<td>36.3</td>
<td>-38.3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Technology Transfer

- Different platforms were used at different times to enhance research-extension-farmer linkage.
- FPVS approach (Figure 3) built farmers’ confidence on new varieties.
- Demonstration (Figure 4) of selected varieties and farmers’ field day visits enhanced technology uptake.
- Salient research highlights in 2016.

Figure 1. Share of major pulse crops to total pulse production in Ethiopia, 2011. (Source: Compiled from CSA, 2014)

Figure 2. Productivity potential of chickpea in Ethiopia, 2015. (Source: Compiled from CSA, 2016)

Figure 3. Participatory variety selection by farmers.

Figure 4. Chickpea technology demonstrated to farmers participating in a field day.

Figure 5. Chickpea production area, productivity and production in Ethiopia.

Figure 6. Ethiopia’s position in Africa’s chickpea production. (Source: FAOSTAT and CSA data, 1995–2015)

Figure 7. Chickpea production statics, productivity and production in Ethiopia. (Source: FAOSTAT and CSA data, 2000–2015)

Figure 8. Chickpea export volume and earnings of top exporter countries. (Source: FAOSTAT, 2016)

Figure 9. Chickpea export volume and earnings in Ethiopia. (Source: FAOSTAT, 2000–2015)