

Plant Genetic Resources for Food and Nutritional Security

HD Upadhyaya, Naresh Dronavalli, Shivali Sharma, Shailesh Kumar Singh, Sube Singh and CLL Gowda

- Over three billion people are currently malnourished due to nutritional deficiencies (eg, iron, zinc, vitamin A), resulting in learning disabilities among children, increased morbidity and mortality rates, lower worker productivity, and high healthcare costs.
- Most staple food crops can be enriched (biofortified) with micronutrients using crop improvement tools.
- Access to plant genetic resources is essential for crop improvement.
- Globally, over 7.4 million accessions of economically important species are conserved in 1,750 genebanks (about 0.74 million in 11 CGIAR genebanks). The ICRISAT genebank at Patancheru, India conserves a collection of 119,739 accessions from 144 countries. (Table 1).

Table 1. Status of germplasm collections held at ICRISAT genebank.

Crop	Number of accessions conserved			No of samples distributed		
	Cultivated	Wild	Total	India	Other Countries	ICRISAT
Sorghum	37,491	458	37,949 (92)	130,170	128,728 (105)	236,542
Pearl millet	21,461	750	22,211 (50)	61,420	33,624 (79)	54,491
Chickpea	19,959	308	20,267 (60)	72,400	58,093 (86)	188,058
Pigeonpea	13,077	555	13,632 (74)	49,237	21,488 (110)	84,146
Groundnut	14,968	477	15,445 (92)	47,156	51,609 (93)	96,254
Small millets (6)	10,076	159	10,235 (50)	42,596	20,692 (58)	7,873
Total	117,032	2,707	119,739 (144)	402,979	314,234 (143)	667,364

Number of countries shown in parenthesis.

- However, only a small fraction (<1%) of this collection has been used in crop improvement due to lack of information on their genetic worth, especially of quantitative traits.
- As multi-environment evaluation of such large collections is expensive, the concept of assembling a small subset (~1%) of entire collection, (the 'mini core' collection) that represents most of the diversity, was developed at ICRISAT. It is now an "International Public Good" (Table 2).

Table 2. The size (no. of accessions) of entire and mini core collections of different crops.

Crop	Accessions used for assembling mini core	Mini core collection	Reference
Sorghum	22,473	242	Upadhyaya et al., 2009; Crop Sci. 49:1769-1780
Pearl millet	20,844	238	Upadhyaya et al., 2011; Crop Sci. 51:217-223
Chickpea	16,991	211	Upadhyaya and Ortiz., 2001; TAG 102:1292-1298
Pigeonpea	12,153	146	Upadhyaya et al., 2006; Crop Sci. 46:2127-2132
Groundnut	14,310	184	Upadhyaya et al., 2002; Crop Sci. 42:2150-2156
Finger millet	5,940	80	Upadhyaya et al., 2010; Crop Sci. 50:1924 -1931
Foxtail millet	1,474	35	Upadhyaya et al., 2011; Field Crop Res. 124:459-467

- The extensive and critical evaluation of the mini core collections have resulted in identification of high yielding and trait specific donor lines for biotic and abiotic stresses and agronomic and quality (protein, oil and micronutrients) traits.
 - ▶ **Drought tolerant:** Chickpea (18), groundnut (18), sorghum (10), finger millet (10) and foxtail millet (10)
 - ▶ **Salinity tolerant:** Chickpea (12), groundnut (14), pigeonpea (16), sorghum (10), pearl millet (13), finger millet (10) and foxtail millet (10)



Salinity tolerant (left), and susceptible (right) groundnut germplasm.



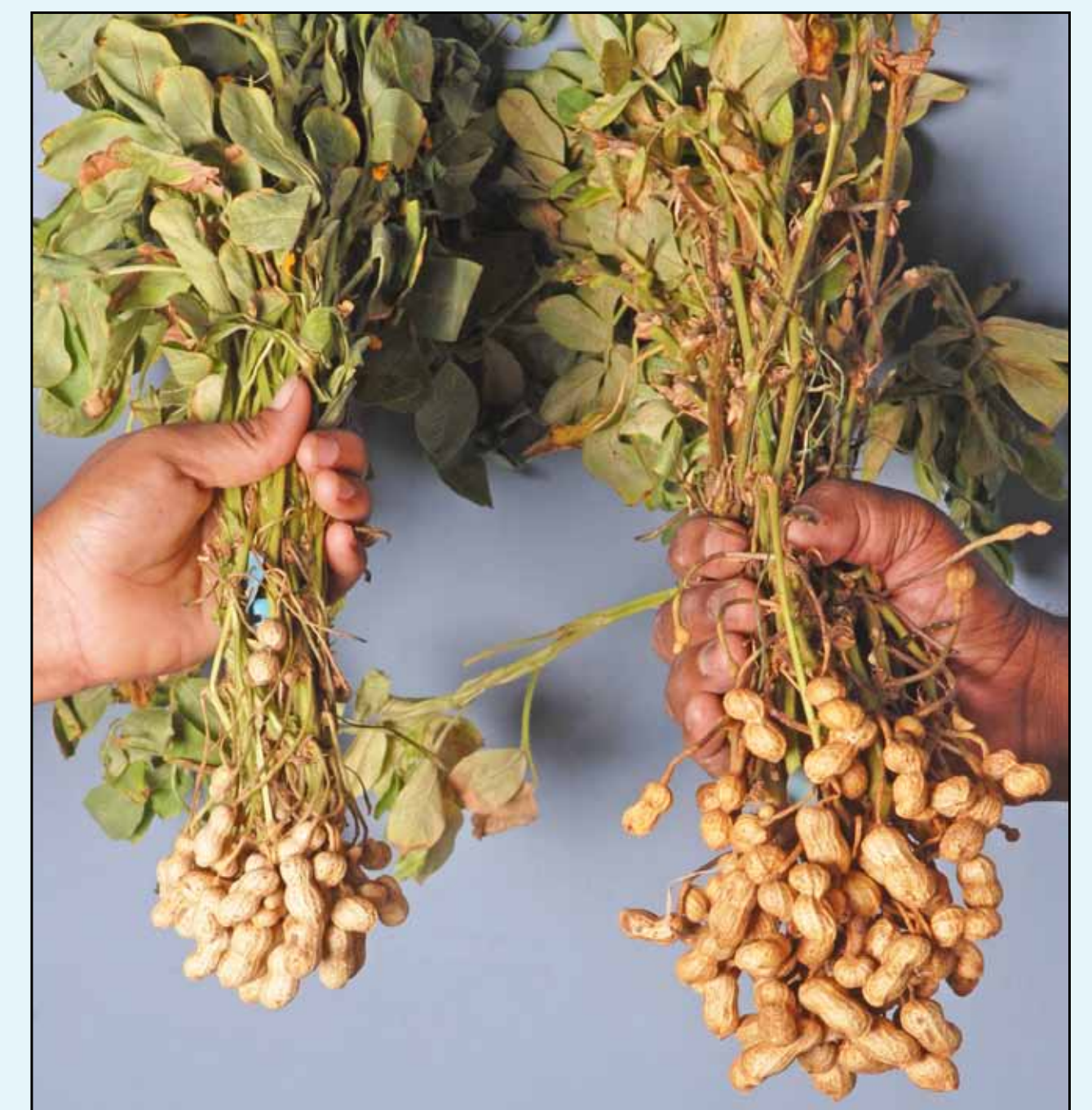
Salinity tolerant (left), and susceptible (right) chickpea germplasm.

- ▶ **Low and high temperature tolerant:** Chickpea (10), groundnut (24) and pearl millet (10).
- ▶ **Water-logging tolerant:** Pigeonpea (24)



Pigeonpea tolerant to water-logging.

- ▶ **Disease resistant/tolerant:** Chickpea [67(WR), 6 (DRR), 3 (AB), 55 (BGM), 18 (MR)], groundnut [BW (14), Rosette (3), BDN (3), MR (6, ELS,LLS, Rust)], pigeonpea [28 (SMD), 8 (WR), 78 (PB)], sorghum [50 (GM), 6 (DM), 13 (Anthracnose), 27 (LB), 6 (Rust), 7 (MR)], pearl millet [9 (Rust), 15 (DM)], finger millet 23 (NB&FB) and foxtail millet [7 (NB&PB), 7 (Sheath blast)]
- ▶ **Insect tolerant:** Chickpea (10), groundnut (14) and pigeonpea (11)
- ▶ **Grain yield:** Chickpea (39), groundnut (60), pigeonpea (49), sorghum (10), pearl millet (20), finger millet (15) and foxtail millet (21)
- ▶ **Large seed size:** Chickpea (65), groundnut (12), pigeonpea (3), sorghum (15), pearl millet (16)
- ▶ **Early maturity:** Chickpea (28), groundnut (21), pigeonpea (20), sorghum (5), pearl millet (10), finger millet (10) and foxtail millet (10)
- ▶ **Nutritional trait:** Chickpea 5 (protein), groundnut 18 (protein, oil, O/L, oleic acid, iron, zinc), pigeonpea 14 (iron, zinc), sorghum 10 (iron, zinc, calcium), pearl millet 10 (iron, zinc), finger millet 15 (protein, iron, zinc, calcium) and foxtail millet 21 (protein, iron, zinc, calcium) (Table 3).



High yielding groundnut germplasm.

Table 3. Range of best five germplasm accessions and popular control cultivars (in parenthesis) for iron (Fe), zinc (Zn) and protein.

Crop	Fe (mg kg ⁻¹)	Zn (mg kg ⁻¹)	Protein (%)
Pearl millet	104.2 – 123.6 (55.5 – 86.6)	83.7 – 88.3 (54.5 – 70.3)	12.0 – 13.8 (7.4 – 9.8)
Finger millet	56.1 – 88.4 (24.7 – 40.3)	27.2 – 31.1 (17.8 – 22.9)	10.4 – 12.7 (6.7 – 8.2)
Foxtail millet	63.7 – 66.0 (40.1 – 48.6)	58.3 – 74.2 (41.3 – 51.9)	17.2 – 18.5 (11.3 – 17.2)
Sorghum	58.2 – 87.0 (21.0 – 29.8)	33.4 – 39.1 (17.6 – 23.9)	Not analyzed
Groundnut	32.4 – 33.2 (21.0 – 23.3)	42.0 – 45.4 (30.6 – 37.1)	30.1 – 31.3 (18.1 – 25.1)
Pigeonpea	43.3 – 45.0 (31.2 – 38.1)	38.9 – 41.4 (29.0 – 36.2)	24.2 – 24.6 (20.0 – 22.6)
Chickpea	Not analyzed	Not analyzed	22.5 – 23.8 (17.8 – 18.7)

- The mini core collections have been characterized using SSR markers to identify genetically diverse germplasm for breeding programs to develop crop cultivars with a broad genetic base.
- Limited quantities of germplasm samples are available from ICRISAT genebank for the global research community following SMTA of the International Treaty.