Centres of origin and diversity in crop plants—importance in management of PGR

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ex-NBPGR, New Delhi
Paroda & Arora, 1997: Plant Genetic Resources: Conservation and Management

Three significant theories- the law of homologous variation, the centers of origin for crop plants, and concept of genetic erosion

Centres of origin of major food crops originated from a central point, from which they successfully dispersed- exploration & evaluation to prove it.

predictions of unknown forms and species, diseases and pests coevolved at centers of origin for cultivated crops

The Bureau of Plant Industry- 1890s and early 1900s- the first long-term ex situ plant conservation genebank

specific genetic resources in locations for use in breeding programs in Russia viz. wheat and barley- working collections

>100 plant expeditions between 1920 and 1940
>250,000 accessions- >10,000 species from 5 continents represented in the All-Union Institute of Plant Industry - subsequent plant evaluation
Evaluation & identification of 19 sites of homologous variation
40 international explorations from 1940 through 1993

Hummer & Hancock, 2015: HORTSCIENCE VOL. 50(6) JUNE 2015
### Nuclear centres and regions of diversity of domesticated plants (Hawkes, 1983)

<table>
<thead>
<tr>
<th>Nuclear centres</th>
<th>Regions of diversity</th>
<th>Outlying minor centres</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Northern China</td>
<td>I China</td>
<td>1 Japan</td>
</tr>
<tr>
<td></td>
<td>II India</td>
<td>2 New Guinea</td>
</tr>
<tr>
<td></td>
<td>III South-East Asia</td>
<td>3 Solomon Islands, Fiji and South Pacific</td>
</tr>
<tr>
<td>B. The Near East</td>
<td>IV Central Asia</td>
<td>4 Northwestern Europe</td>
</tr>
<tr>
<td></td>
<td>V The Near East</td>
<td></td>
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<tr>
<td></td>
<td>VI The Mediterranean</td>
<td></td>
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<tr>
<td></td>
<td>VII Ethiopia</td>
<td></td>
</tr>
<tr>
<td></td>
<td>VIII West Africa</td>
<td></td>
</tr>
<tr>
<td>C. Southern Mexico</td>
<td>IX Meso-America</td>
<td>5 United States, Canada</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6 The Caribbean</td>
</tr>
<tr>
<td>D. Central to Southern Peru</td>
<td>X Northern Andes</td>
<td>7 Southern Chile</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Venezuela to Bolivia)</td>
</tr>
</tbody>
</table>

### Harlan's centres and non-centres (Harlan, 1971)

<table>
<thead>
<tr>
<th>Centre</th>
<th>Non-centre</th>
</tr>
</thead>
<tbody>
<tr>
<td>North Chinese Centre - B1</td>
<td>South-East Asian and South Pacific non-centre - B2</td>
</tr>
<tr>
<td>North East Centre - A1</td>
<td>African non-centre - A2</td>
</tr>
<tr>
<td>Meso American Centre - C1</td>
<td>South American non-centre - C2</td>
</tr>
</tbody>
</table>

Vavilovian centres - of diversity

Micro centres‘- small areas viz. Turkey & Africa (Harlan, 1975)- varietal diversity of several crops; disappearing with changing agricultural practices; “genetic vulnerability” and “genetic wipeout.”
CO/ CD in relation to PGR- providing the ‘Best-practices’ guidelines for PGR

1. CO/ CD as a working hypothesis of the geobotanical diversity- improved as we know more about crop diversity/genepool

2. A vast amount of referable material- in herbaria, and as seed samples collected and evaluated

3. Foundations of PGR- collection, evaluation of variation/ estimating diversity, conservation and use

<table>
<thead>
<tr>
<th>Aim for CP</th>
<th>Crop plants (CP)</th>
<th>Floristic diversity (FD)</th>
<th>Aim for FD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genetic basis of diversity</td>
<td>“ecological passport” for crops- 19 sites where different crops show similar shared characters- Vavilov, ’35; Genepools of crop plants- GP1, 2 &amp; 3, Harlan &amp; de Wet, 1971</td>
<td>Genecology- Turesson, 1922; Hall/ Clausen, Keck &amp; Heisey, 1940; Ford, 1940s; Stebbins, 1950; Heslop-Harrison, 1964; Dobzhansky, 1968; Biosystematics- Stebbins, 1950; Anderson, 1930s~</td>
<td>Genetic diversity and adaptation; ‘taking genetics to the field’ - Ford, ‘80; delineating the evolutionary unit &amp; evolutionary theory.</td>
</tr>
</tbody>
</table>
Indian region

“..more varied than that of any other country of equal area in the Eastern Hemisphere, if not on the globe.” (Hooker, 1904)

Indo-Myanmar region & adjacent areas, a cradle of flowering plants (Takhtajan, 1969)

- Hindustani centre of origin (Vavilov, 1926);
  Megacentre of agro-diversity (Zhukovskii, 1968)
- Crops in India represent “a world synthesis” (Singh & Hardas, 1970, NBPRG)
- Two 'hot-spot' regions- > 0.5% of total endemics/lost 70% of original habitat (Myers, 2000)

Major aspects of study of Indian plants
- Phytogeographic analysis of native diversity: endemics, floristic regions, ‘hot spots’
- Floristic diversity
- Documentation & inventorisation of economic plants
- Ethnobotanical findings, ethnic uses
- Forestry wealth and documentation
- Genetic diversity of crop plants, wild relatives, its distribution & PGR management

Arora, Nayar & Pandey, 2006
Indian centre of diversity-

>166 crop plants with native diversity

>326 wild relatives of crops - WP 145 > NEI 132 > NWR 125 > EP 91 > EHR 82 > GP 66 > IP 45

Indian flora - SE Asian - 35%, Mediterranean - 5%, African - 3%

**Western Himalayas:** Cold & drought tolerance. Barley, bluish/black grain types (>3300 m) like local Tibetan types. Wheat, Lahaul and Spiti - resistance/tolerance to rust.

**North-eastern region/ Eastern Himalayas:** Tribal dominated belts - legumes; *Brassica, Perilla*; tree cotton; taro/yam and tuberous/rhizomatous/bulbous types; *Citrus, Musa* and bamboos.

**Western peninsular region/ Eastern peninsular region:** tuber crops/ rhizomatous types - *Curcuma* & ginger, pepper. East-tribal-dominated tract of Orissa and the Chotanagpur plateau; **Central tribal region:** Madhya Pradesh and adjoining tracts of Maharashtra

Arora, 1997; Arora et al., 2006; Arora & Nayar, 1984; Arora & Pandey, 1996
Crops of the Indian region

**primary centre of diversity**-
- rice, black gram, moth bean, pigeon pea, cucurbits like smooth gourd, ridge gourd and pointed gourd, tree cotton, *capsularis* jute, jack fruit, banana, mango, *Syzygium cumini/jamun*, large cardamom, black pepper and several minor millets and medicinal plants like *Rauwolfia serpentina* and *Saussurea lappa*.

**secondary centre of diversity**-
- for African crops, such as finger millet, sorghum, cowpea, cluster bean, okra, sesame, niger and safflower; tropical American crops, maize, tomato, pumpkin/*Cucurbita* spp., chayote or chou chou, chillies and *Amaranthus*;

**regional (Asiatic) diversity**-
- barley, amaranth, buckwheat, prosomillet, foxtail millet, mung bean/green gram, chickpea, cucumber, bitter gourd, bottle gourd, snake gourd and Brassicae, sugarcane.

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<table>
<thead>
<tr>
<th>Categories</th>
<th>Species diversity (50%) in India*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cereals and Millets</td>
<td>Millets, <em>Oryza</em></td>
</tr>
<tr>
<td>Grain legumes</td>
<td><em>Cajanus</em></td>
</tr>
<tr>
<td>Edible tubers</td>
<td><em>Flemingia</em></td>
</tr>
<tr>
<td>Vegetables</td>
<td><em>Abelmoschus</em></td>
</tr>
<tr>
<td>Miscellaneous</td>
<td><em>Saccharum</em></td>
</tr>
</tbody>
</table>

*Species less than 50% diversity in India*  
Millets, *Oryza, Sesamum, Vigna*

Arora, 1997; Nayar *et al.*, 2013
Abelmoschus esculentus - a native crop

*A. tuberculatus*: closest relative of okra

**Species described:** 1952 (Bot. Gaz., 455-463)

**Comparative studies:**
- Morphological characters of plant
- Pollen and seed characters
- Cytology: Ae, 2n=130, At, 58
- Crossability studies

**Taxonomic status:**
- Variety of Ae (BSI)/ New species (Kew)

**Abelmoschus caillei**, West African okra

Hybrid (Ae X Am) with YVMV resistance

*Abelmoschus tuberculatus* Pal & Singh HS5277 [NHCP], NBPGR, New Delhi

Wild species related to *Abelmoschus esculentus* (Bhindi) collected during search for material for breeding programme

**Locality:** Collected from Saharanpur, Uttar Pradesh (IW 130)

Plants raised in Plant Introduction fields of IARI, New Delhi on 15/12/1946; **Collector:** HB Singh
Crop species - their Centres of domestication

- Predominantly Asian:
  - *Echinochloa* [distinct genepools]
  - *Setaria* [Genome D (India), genome A (China)]
  - *Panicum* [*P. repens*, common relative]

- African - Asian:
  - *Brachiaria* [Grp IB]
  - *Digitaria* [Sect. Digitaria (India), Verrucipilae/Clavipilae (Afr)]

- African:
  - *Pennisetum*

- Asian domesticate:
  - *Paspalum*

African/Asian (widespread) - Asian - endemic components:

- *B. ramosa/B. deflexa* - *B. kurzii/B. remota* (EI/PI) - *B. semiverticillata* (PI)
- *B. reptans* - *B. villosa* (NE/PI) - *B. nilagirica* (SI)
- *D. ciliata* - *D. sanguinalis/cruciata complex* (widespread) - *D. duthieana* (EI)
Species relationships - elucidating relationships between crop and CWR

<table>
<thead>
<tr>
<th>Crop genus</th>
<th>Taxonomic/ biosystematic study</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brachiaria</td>
<td>Biology, agronomy &amp; improvement- emphasising fodder species</td>
<td>Miles et al., 1996</td>
</tr>
<tr>
<td>Digitaria</td>
<td>Study of spp- N America, SW Europe, Mexico, Pakistan; morphology of spikelet, morphology- based cladistics analysis</td>
<td>Vega &amp; Agrasari, 2001; Vega et al., 2009</td>
</tr>
<tr>
<td>Echinochloa</td>
<td>Study of weed complexes, biosystematics with emphasis on Japanese species</td>
<td>Yabuno, 1966; Yamaguchi et al., 2005</td>
</tr>
<tr>
<td>Panicum</td>
<td>Crops and weeds, phylogeny</td>
<td>Aliscioni et al., 2003; Ellstrand, 2010</td>
</tr>
<tr>
<td>Paspalum</td>
<td>Diversity within crop</td>
<td>de Wet et al., 1983</td>
</tr>
<tr>
<td>Pennisetum</td>
<td>Crossability, domestication and evolution</td>
<td>Dujardin &amp; Hanna, 1989; Remigereau et al., 2011;</td>
</tr>
<tr>
<td>Setaria</td>
<td>Diversity and distribution, genome identification in domesticated species in North America and Europe to Chinese regions</td>
<td>Dekkar, 2003; Zhao et al., 2013; Nani et al., 2015; Jia et al., 2013; Huang et al., 2014, 2016</td>
</tr>
</tbody>
</table>
**Sesamum**

21 spp. - Africa; 8 in Asia

**Sesamum spp. in NHCP**

Native diversity  
(Genepool I)

**Crop species:** *Sesamum indicum* L.; related wild & weedy forms *S. mulayanum* & *S. malabaricum*

Erect, annual herbs; leaves highly variable, lower ones lobed or digitate, opposite or alternate; flower white or pinkish-mauve, inferior lip not prominent, extrafloral nectaries prominent; seeds not winged but with a conspicuous double fringe, testa smooth or somewhat venous, black, brown or white at maturity.

1. *S. indicum*: HS8956, MS, VD Verma, 7/10/1991
2. *S. indicum* wild pod, HS10371, Delhi, A Pandey et al., 15/7/1999
3. *S. indicum*: HS8956, flower
4. *S. indicum*: HS8956, LS of mature pod
5. *S. indicum* cultivated: SEM of seed
6. *S. malabaricum*: seed
7. *S. indicum* wild: seed

**21 spp. - Africa; 8 in Asia**
Native diversity (Genepool III)

Wild species- S. prostratum, S. laciniatum
Prostrate habit, leaves short petioled, rounded with crenate margin; flowers solitary in axils (no rudimentary structures), pedicellate, bracteate, with purple corolla; capsule ovoid compressed with tough pericarp, opening loculicidally from top to a short distance below. Seeds few, deeply reticulate with thick testa.

1. S. prostratum: HS13418, Karur, Tamil Nadu, Z. Abraham et al., 26/10/1999
2. S. prostratum: HS5296, Botany Division, IARI, S. Singh, 772, 15/10/1951 [voucher for crossability with sesame]
4. & 5. S. prostratum: SEM of seeds, surface and side view
**Vigna sublobata** and **V. silvestris** - wild related species of mung and urid

<table>
<thead>
<tr>
<th></th>
<th>Domesticated form</th>
<th>Wild form</th>
</tr>
</thead>
<tbody>
<tr>
<td>Habit</td>
<td>Trailing to erect</td>
<td>Trailing/ climbing</td>
</tr>
<tr>
<td>Flower</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Pod partitions between seeds</strong></td>
<td><strong>Absent</strong></td>
<td><strong>Present</strong></td>
</tr>
<tr>
<td>Pod at maturity</td>
<td>Less dehiscent</td>
<td>Dehiscent</td>
</tr>
<tr>
<td>Seed size*</td>
<td>Larger (5-fold approx.)</td>
<td>Small</td>
</tr>
<tr>
<td><strong>Seed surface</strong></td>
<td><strong>Generally smooth</strong></td>
<td><strong>With periderm deposits</strong></td>
</tr>
<tr>
<td>Seed coat hardness</td>
<td>Less</td>
<td>More; resistance to insect attack</td>
</tr>
<tr>
<td>Seed colour</td>
<td>Variously coloured</td>
<td>Brown to black</td>
</tr>
</tbody>
</table>

*Gigantism in plant, leaf, flower, seed

Similar aminoacid profile, crossability studies

**V. sahyadriana** - seed with rough surface, with well developed aril, very hairy long pods, and horizontal position
**Cajanus cajan**: Native crop

- *Cajanus cajan* (Arhar, tur/pigeon pea) native to India
- Semi-wild and naturalized plants in Asia and Africa
- Primary genepool (Sec. Cajanus), Secondary genepool (Sec. Volubilis) and tertiary genepool represented in Asia/Australia
- Endemic species in S/SE Asia
- Majority of species in Australia endemics – centre of speciation

*Closely related taxa; ** Tertiary genepool

Monograph: van der Maesen, 1985. *Cajanus DC.* and *Atylosia*

Gap analysis [https://www.cwrdiversity.org/](https://www.cwrdiversity.org/)
Saccharum and related genus Miscanthus:
Species distribution- global: Nearly 40 species, extending from probable centre of origin in New Guinea to the Asian region.
Indian region: 17 species. Species diversity in north eastern and north western parts of India.
- Species endemic to the Indian subcontinent occurred in north western hills (S. stewartii), or the Himalayas and eastern plains (S. sikkimense).
- Maximum build-up of species widespread over the Indian subcontinent, China, Indo-China and Malesia (Saccharum, 5, Miscanthus, 2); within the Indian region these occurred north-eastern region and Eastern Himalaya, most extending to the north-western hills and plains, only one extending to peninsular India.
- As per past collections, north eastern areas were areas of availability of the natural introgressed materials.
Stresses: Peninsular and eastern India, followed by north western plains and hills maximum incidence of disease. Widespread species, S. spontaneum and S. arundinaceum, sources of resistance for several diseases; abiotic stresses, drought and waterlogging tolerance (S. spontaneum and S. arundinaceum) and salinity (S. spontaneum), cold tolerance (S. longisetosum and S. rufipilum).
**Oryza in the Indian subcontinent**

*Oryza sativa complex* (AA genome) H. Morishima and M. Akimoto

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**0. granulata complex** (Deciduous forests/ primary and secondary forests; **complete shade**)

<table>
<thead>
<tr>
<th>Species</th>
<th>CC</th>
<th>Region</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>O. granulata</em> Nees et Arn. ex Watt</td>
<td>GG</td>
<td>Asia</td>
</tr>
<tr>
<td><em>O. meyeriana</em> (Zoll. et Mor. ex Steud.)Baill.</td>
<td>GG</td>
<td>Asia</td>
</tr>
</tbody>
</table>

**0. officinalis complex** (Forest/forest edges; **seasonally wet, full sun/partial shade**)

<table>
<thead>
<tr>
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<th>CC</th>
<th>Region</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>O. officinalis</em> Wall ex Watt</td>
<td>CC</td>
<td>Asia</td>
</tr>
<tr>
<td><em>O. minuta</em> J.S. Presl. ex C.B. Presl.</td>
<td>BBCC</td>
<td>Philippines</td>
</tr>
<tr>
<td><em>O. rhizomatis</em> Vaughan</td>
<td>CC</td>
<td>Sri Lanka</td>
</tr>
<tr>
<td><em>O. eichingeri</em> Peter</td>
<td>CC</td>
<td>Africa, Sri Lanka</td>
</tr>
<tr>
<td><em>O. punctata</em> Kotschy ex Steud.</td>
<td>BB,BBCC</td>
<td>Africa</td>
</tr>
<tr>
<td><em>O. latifolia</em> Desv.</td>
<td>CCDD</td>
<td>Central &amp; South America</td>
</tr>
<tr>
<td><em>O. alta</em> Swallen</td>
<td>CCDD</td>
<td>Central &amp; South America</td>
</tr>
<tr>
<td><em>O. grandiglumis</em> (Doell) Prod.</td>
<td>CCDD</td>
<td>South America</td>
</tr>
<tr>
<td><em>O. australiensis</em> Domin</td>
<td>EE</td>
<td>Australia</td>
</tr>
</tbody>
</table>

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3. *O. longistaminata*
4. *O. barthii*, perennial type
5. *O. rufipogon*, annual type
6. *O. meridionalis*
7. *O. glumaepatula*
Wild economic/underutilised species, local domesticates

<table>
<thead>
<tr>
<th></th>
<th>India</th>
<th>China</th>
<th>Australi a</th>
<th>Oceania</th>
<th>Africa</th>
<th>Americas</th>
<th>Eur</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cajanus</td>
<td>15</td>
<td>7</td>
<td>14</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Flemingia</td>
<td>18</td>
<td>15</td>
<td>4</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

*Flemingia prostrata* (syn. *Moghania vestita*)
Fam. Fabaceae
Local names:
Soh-phlong (market sample), Singh & Arora, '73
**Khey (edible tubers sold with perilla seed chutney), K. Pradheep, '11**
Wild plants plentiful (NW Himalaya), roots eaten by herd boys (Watt, 1890); “if systematically cultivated ..a useful new vegetable”
Domesticate probably of *jhum* areas of Khasi & Jaintia hills (Hooker, 1878; Gait, 1896; Agric. Bull. 1898; Singh & Arora, '73)
**Cultivation done on slopes (45°); promoted by KVK, W. Khasi Hills** (K. Pradheep, Nov., '11)

Herbarium specimens
Uttarakhand: 3116 ('68), 6769 ('83), 8682 ('88), 18404 ('87)
Meghalaya: 9453 ('89)
HP: 16804 ('04), 17525 ('04)

Seed samples
Uttarakhand: IC201905 (1996)
Meghalaya: IC20314 (1973); IC330063/ 65 (2001)

**Khey**: tubers with perilla seed chutney, sold in NEH (K. Pradheep, W Khasi Hills, 20/11/11; KC Bhatt, 2011)
**Plukenetia corniculata**, Meetha Patta/ Borneo pea [Euphorbiaceae]

Leafy vegetable (cultivated last 10 years, Assam; gathered from the wild/grown in homesteads (Nagaland, Assam)
Cultivated (~70-1200m), wild (50-800m)

Medicinal use in AP

SE Asian region, upto Philippines; Sumatra max., elsewhere scattered. significant among tribes of SE Asia

*Plukenetia* (Forest peanut)
No latex in sap
21 spp.: 20, S. America; 6, Africa; 1, Asia.
N. Peru ‘C-D’

Other edible spp.:
*P. conophora*: Nigeria
*P. volubilis* (Inca nut),
*P. huayllabambana* 2008 &
*P. carolis-vegae* 2013, N. Peru

Pradheep et al., 2015
KP/SC-1585, IC614466, HS21667 (cult)
21668 (market)
PGR Activities

- Collection
- Introduction & Exchange
- Quarantine
- Evaluation
- Conservation
- Documentation
- Management - national and global
- Utilisation

Breeder - mainly vegetable crops

Collection and introduction -

Botanist -
Set up a herbarium - got it recognized (PI)
Common weeds of crops (with Mr. Khanna)

Dr. Harbhajan Singh

Dr. R. K. Arora

Head, Exploration

Collection in Western Ghats, cold arid tracts, north eastern India, especially tribal tracts

Wild relatives of crop plants in India (Arora & Nayar, 1984)

Wild edible plants of India (Arora & Pandey, 1996)

Diversity in underutilised plant species - Asia-Pacific (2014)
Wild relatives of crop plants in India - Documentation

Search for new genes (BP Pal, 1937 Agriculture and Livestock in India, 7: 573-578)

Wild relatives of crop plants in India (Arora and Nayar, 1984, NBPG, New Delhi)

Wild relatives of cultivated plants in India (Pradheep, Bhandari and Bansal, 2014, NBPG, New Delhi)

Search for YMV-resistant & collection of *Abelmoschus tuberculatus* (IW 130), Saharanpur, raised in Plant Introduction Plots, HS5277, 15/12/1946, HB Singh.

Collection of diversity in wild forms of brinjal, *Solanum melongena* var. *insanum* identified by the place of their collection - Potangi type from Koraput, Odisha, also used in crosses Pal & Singh, 1943, ‘46

*Sesamum prostratum* and *S. lacinatum*
Chromosome numbers and cytogenetical studies.
Ramanujam, 1941, ‘42; Ramanujam & Joshi, 1947; Ragavan & Krishnamurti, 1945, ‘47.

Collection of *Vigna sublobata*, progenitor species of mung, from Western Ghats: Arora & Singh, 1974
Delineating wild relatives:

1. Species related to the crop genus (also related genera)
2. Work out areas of concentration of species
3. Grouped on the basis of differences in morphology and distributional patterns
4. Crossability patterns used to delineate - primary genepool, secondary genepool and tertiary genepool (with reducing success of crosses, techniques such as embryo rescue needed for obtaining hybrids)
5. Quantitative and qualitative differences and trends in growth, reproductive patterns, response to biotic and abiotic stresses and nutritional parameters
6. Tissue compatibility in vegetatively propagated plants

>320/1270 species, priority species related to major crops (1984)
Wild relatives of crops: Issues

- Wild relatives account for 7% of total wild species diversity
- Priority given for diversity collection and conservation of species of wild related species of crop plants at the NBPGR

Diversity collected by NBPGR: 2409 accessions of wild relatives out of 23243 accessions of wild species collected (10.47%)

Diversity conserved by NBPGR: 1125 accessions of wild relatives out of 13583 accessions of wild species conserved (8.25%)

83 species of wild relatives out of 580 wild species conserved at the NBPGR (14.26%):

- Genebank (GB): 564 accessions (43 species)
- Cryobank (CB): 504 accessions (69 species)
- In vitro (IV): 48 accessions (16 species)

140 species represented as herbarium specimens in NHCP AKMU database

>3100 accessions cultivated/wild status unknown;
F W Went, (1903-1990); Desert Research Institute, University of Nevada, USA—pioneer in establishing the idea of a seed vault and the need for preservation under safer and more controlled conditions.

Fritz Went and Philip Munz long-term seed longevity experiment- 100 different native species from a wide range of families and habitats, 20 sets seeds to run for 360 years/ until 2307; dried down to very low moisture content, and placed into glass tubes sealed under vacuum.

**Went and Munz Test Species**

<table>
<thead>
<tr>
<th>Crop category</th>
<th>Spp</th>
<th>Intrd</th>
<th>Conserv (GB/FGB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Cereals/ millets (a)</td>
<td>38</td>
<td>71</td>
<td>13</td>
</tr>
<tr>
<td>2 Grain legumes (b)</td>
<td>19</td>
<td>43</td>
<td>9</td>
</tr>
<tr>
<td>3 Fruits (c)</td>
<td>13</td>
<td>14</td>
<td>10</td>
</tr>
<tr>
<td>4 Vegetables (d)</td>
<td>14</td>
<td>38</td>
<td>11</td>
</tr>
<tr>
<td>5 Oilseeds (e)</td>
<td>13</td>
<td>21</td>
<td>8</td>
</tr>
<tr>
<td>6 Pseudocereals (f)</td>
<td>3</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>7 Spices/ condiments (g)</td>
<td>5</td>
<td>5</td>
<td>-</td>
</tr>
<tr>
<td>8 Fodder/ forage grasses (h)</td>
<td>35</td>
<td>53</td>
<td>2</td>
</tr>
<tr>
<td>9 Fodder/ forage legumes (h)</td>
<td>124</td>
<td>190</td>
<td>7</td>
</tr>
<tr>
<td>10 Ornamentals (i)</td>
<td>11</td>
<td>11</td>
<td>8</td>
</tr>
<tr>
<td>11 Medicinal/ aromatic plants (j)</td>
<td>23</td>
<td>31</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>298</td>
<td>482</td>
<td>22</td>
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</tbody>
</table>

Exotic specimens in the NHCP, NBGPR- record of germplasm under global exchange, as seed or planting material 1946-2006.
Wild Relatives: Major Taxa  
Collected & Conserved

<table>
<thead>
<tr>
<th>Accessions/sp.</th>
<th>Species conserved</th>
<th>Species collected</th>
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<tr>
<td></td>
<td></td>
<td>Species no.</td>
</tr>
<tr>
<td>&gt;100</td>
<td>2</td>
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<tr>
<td>&gt;50-100</td>
<td>4 25.3%</td>
<td>7 24.6%</td>
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<tr>
<td>&gt;25-50</td>
<td>9</td>
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</tr>
<tr>
<td>&gt;12-25</td>
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<td>13</td>
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<td>&gt;6-12</td>
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<td>12</td>
</tr>
<tr>
<td>&gt;3-6</td>
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<td>20</td>
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<td>&gt;1-3</td>
<td>19</td>
<td>22</td>
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<tr>
<td>=1</td>
<td>17</td>
<td>32</td>
</tr>
</tbody>
</table>
Global priority genetic reserve locations for wild relatives of 12 food crops

- **Pisum**, wheat & faba bean
- Sweet potato, potato & maize
- Pearl millet & garden pea
- Oryza spp.: locations for rice/Brook's wild relatives
- Barley, potato & cassava
- Finger millet & cowpea
- Central America - grains
- South America - grains
- Southern Africa - sorghum/teff wild relatives