Introduction to the Conservation of PGR

terminology, ex situ and in situ conservation, germplasm exchange

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AVRDC – The World Vegetable Center

34th International Vegetable Training Course

Module 1: Vegetables: From Seed to Table and Beyond

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Kamphaeng Saen, Nakhon Pathom, Thailand

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Outline of presentation

- **Terminology**

- **<u>Steps in germplasm and genebank management:</u> maintaining accession identity; storage conditions; viability monitoring; characterization; core collections; screening and evaluation; documentation – linking conservation with use; safety duplication; germplasm exchange**

About 36% of assessed species (47,677) on earth are threatened by extinction

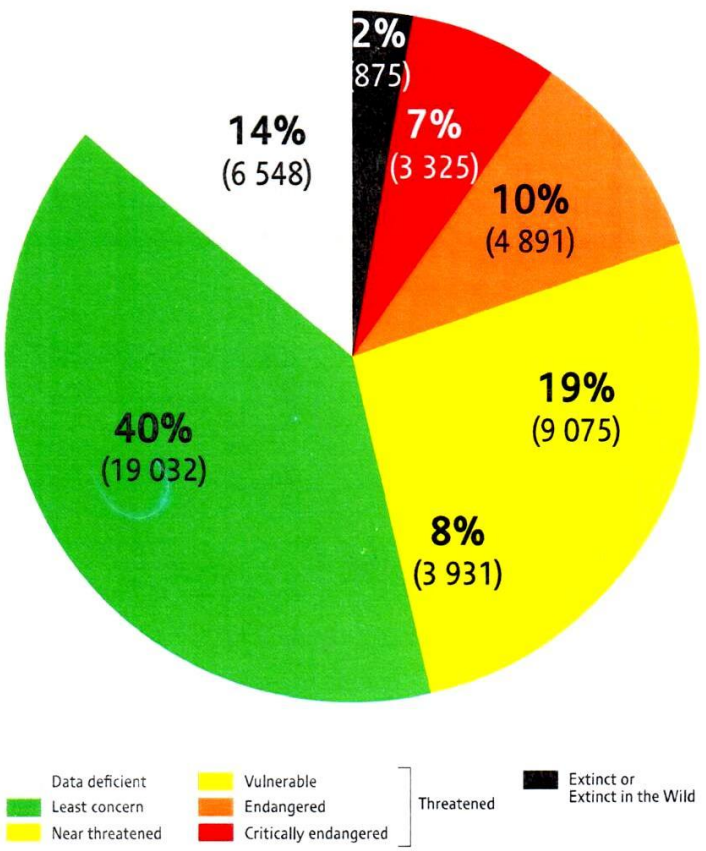

FIGURE 3 Proportion of species in different threat categories

Proportion of all assessed species in different categories of extinction risk on the IUCN Red List, based on data from 47,677 species.
Source: IUCN

Global Biodiversity Outlook 3 (2010)

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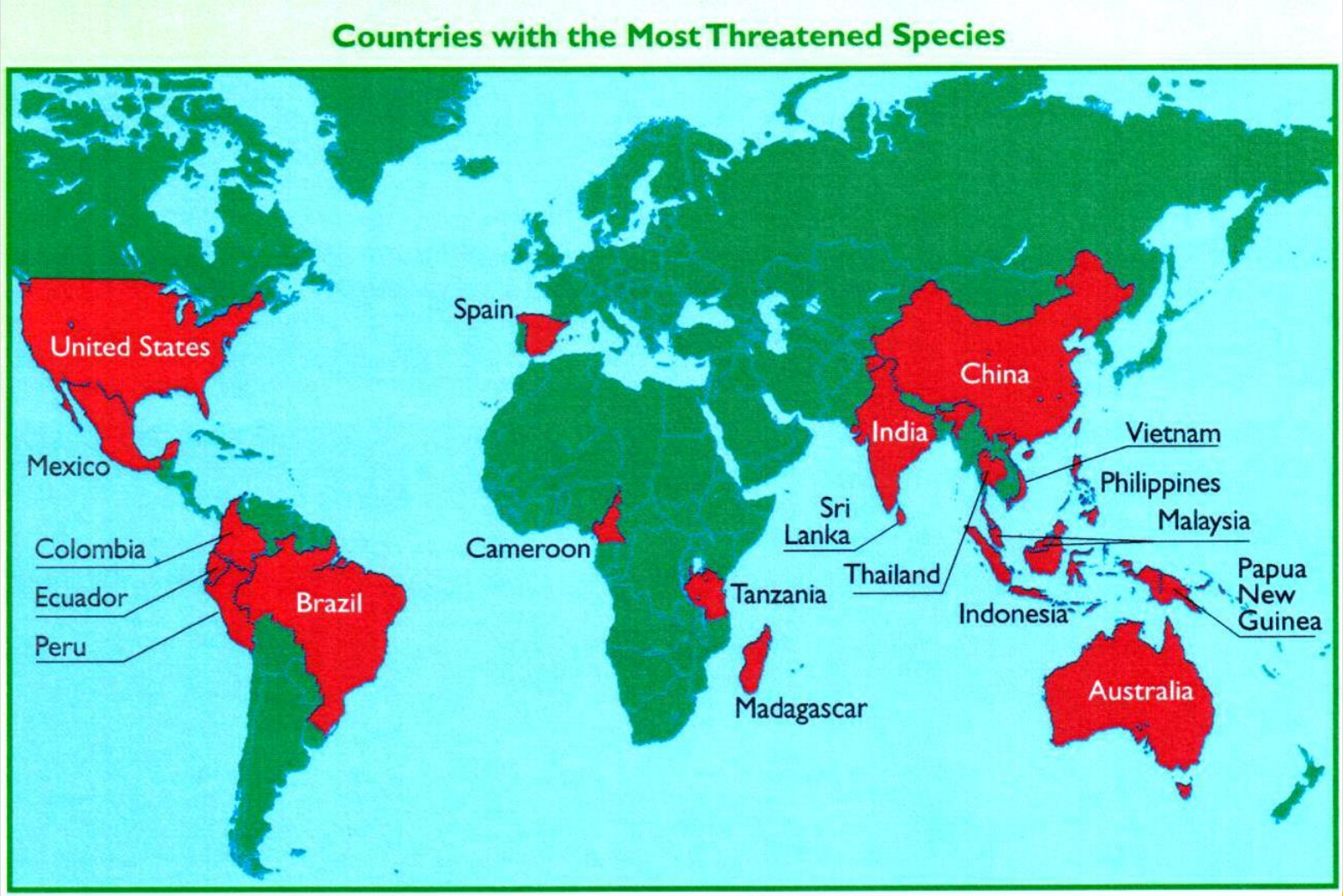
Countries with the most threatened species



CQ Global Researcher (2012)

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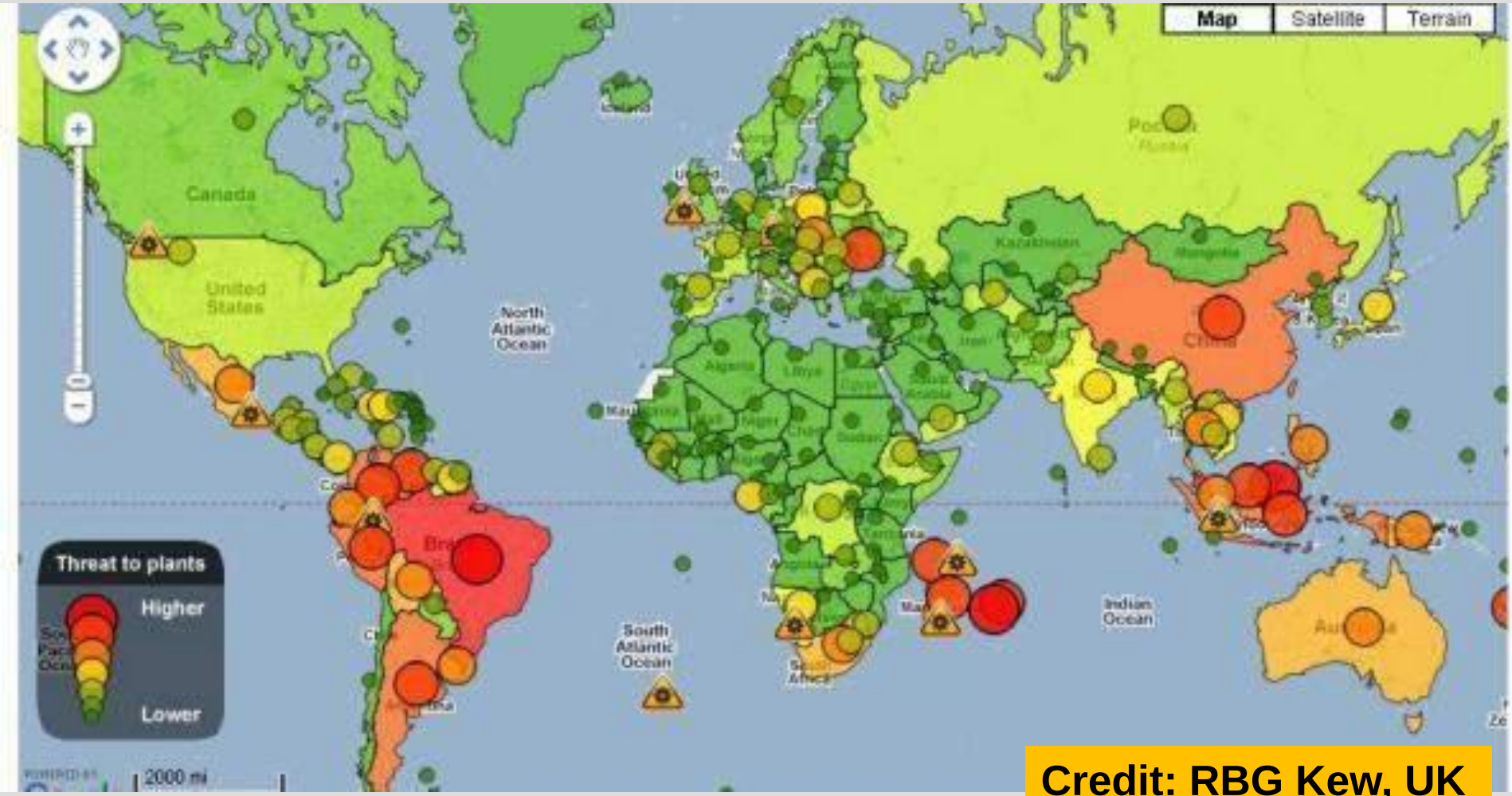
More than 1-fifth of world's plants threatened by extinction

Science Daily – Sept. 29, 2010



Credit: RBG Kew, UK

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Terminology

Keywords	Description
Access & Benefit Sharing	One of 3 objectives of CBD: “fair and equitable sharing of the benefits arising out of the utilization of GR, including by appropriate access to GR and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding”.
Accession	Plant material (plant, seed, or vegetative parts) collected and assigned a number to maintain its identity during evaluation, increase, and storage. The term 'accession' is always used in connection with genebanks or genetic resource collections.
Agrobiodiversity	The variability among living organisms associated with the cultivation of crops and rearing of animals, and the ecological complexes of which those species are part. Diversity within and between species and at the ecosystem level
Agro-ecological knowledge	Farmers’ knowledge of ecological interactions within the farming system

Terminology (2)

Keywords	Description
Alien species	A species growing outside of its natural range as a result of intentional or accidental dispersal by human activities (exotic or introduced species)
Ancestor	An organism from which later individuals or species evolved
Biodiversity	The diversity of life in all forms – of species, genetic variations within one species, and of ecosystems
Biome	A major portion of the living environment of a particular region (fir forest, grassland)
Biotechnology	Technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use
Buffer zone	The region adjacent to the border of a protected area; a transition zone between areas managed for different objectives
Center of crop diversity	Geographical area containing a high level of genetic diversity of crop species in *in situ* conditions

Terminology (3)

Keywords	Description
Center of origin	Geographical area where a plant species, either domesticated or wild, first developed its distinctive properties
Collection	A collection of plant genetic resources for food and agriculture maintained *in situ, ex situ*, on farm, *in vitro*
Connectivity	Structural and functional connectivity is equal to habitat connectivity and is measured by analyzing landscape structure
Conservation	System of genetic resources maintained
Conservation status	The sum of influences acting on a natural habitat and its typical species that may affect its long-term distribution, structure and functions as well as the long-term survival of its typical species
Corridor (ecological)	A strip of a particular type of land that differs from adjacent land on both sides with important ecological functions (conduit, barrier and habitat)
Domesticated species	Species in which the evolutionary process has been influenced by humans to meet their needs. Sin. Cultivated species.

Terminology (4)

Keywords	Description
Ecosystems	Dynamic, complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit
Ecosystem services	The ecological, social and economic benefits people obtain from ecosystems. These include provisioning of food and water; regulating services such as flood and disease control; cultural services such as spiritual and recreational benefits, supporting services such as nutrient cycling that maintain the conditions for life on earth.
Ecotourism	Travel undertaken to witness sites or regions of unique natural or ecologic quality
Ecotype	A type or subspecies of life that is especially well adapted to a certain environment
Endemic species	A species which is only found in a given region or location and nowhere else in the world.
Evolution	A gradual genetic change in organisms from generation to generation

Terminology (5)

Keywords	Description
Ex situ conserv.	Conserving biological diversity outside their natural habitats
In situ conservation	System of conservation of biological diversity inside their natural habitats
Extinction	Evolutionary termination of a species caused by the failure to reproduce, failure to adapt to environmental and human-induced change
Fauna	All the animals found in a given area
Flora	All the plants found in a given area
Habitat fragmentation	Breaking up of remaining habitat into smaller units
Gene	The functional unit of heredity; the part of the DNA molecule that encodes a single enzyme or structural protein unit
Genebank	Facility established for ex situ conservation of individuals (seeds), tissues, or reproductive cells of plants or animals

Terminology (6)

Keywords	Description
Genetic diversity	Heritable variation within & among populations which is created, enhanced or maintained by evolutionary/selective forces
Genetic engineering	Changes in the genetic constitution of cells resulting from the introduction or elimination of specific genes through molecular biology techniques
Genetic erosion	Loss of individual genes and of combinations of genes, such as those found in locally adapted landraces. Main cause is the replacement of local varieties by modern varieties. Other causes include the emergence of new pests, weeds and diseases, environmental degradation, urbanization and land clearing through deforestation and bush fires
Genetic material	Any material of plant, animal, microbial or other origin containing functional units of heredity
Gen. resources	Genetic material of actual or potential value
GMO	Organism into which one or more genes from an outside source that contains coding for desired characteristics (herbicide resistance) has been inserted

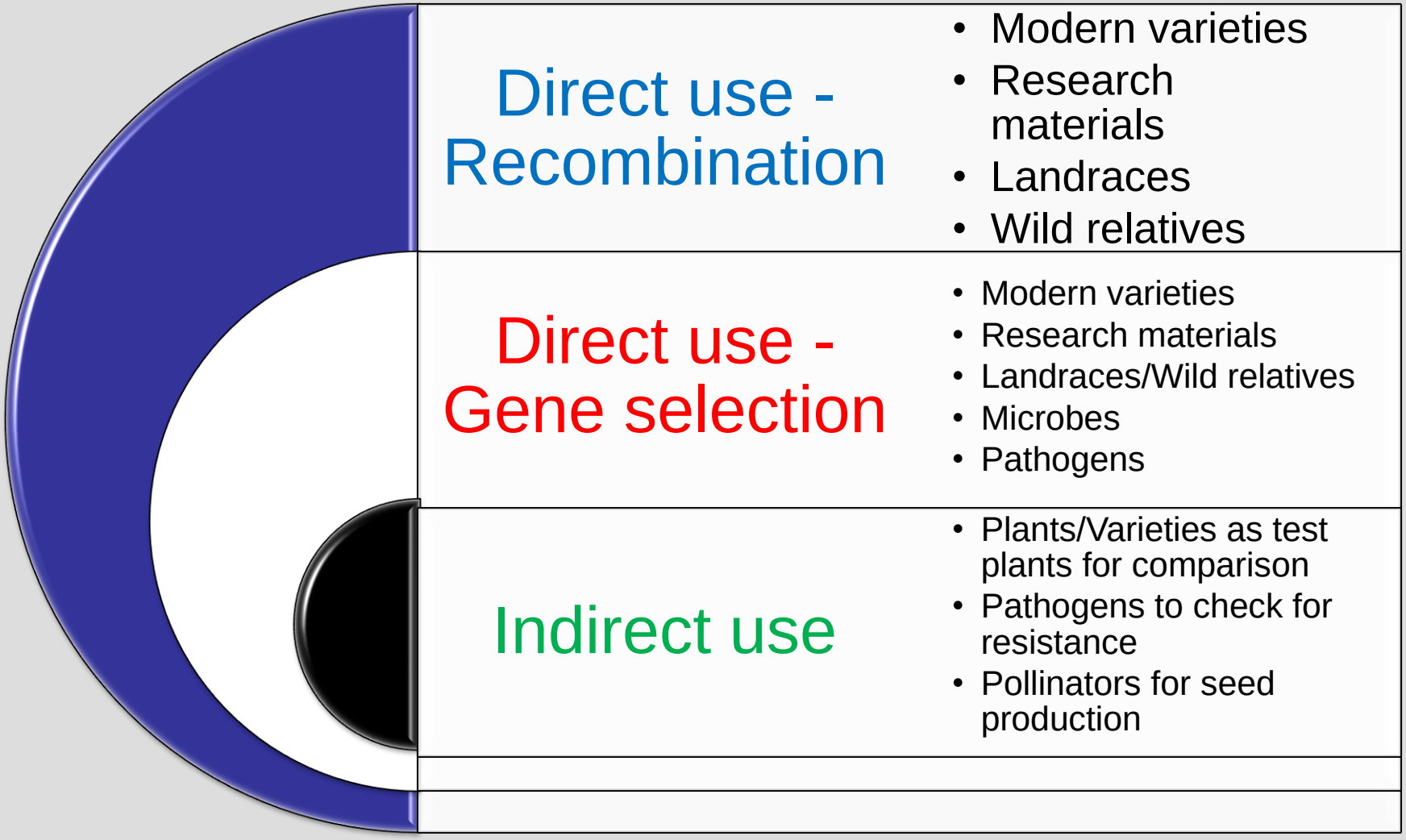
Terminology (7)

Keywords	Description
Hotspot	Area on earth with unusual concentration of (endemic) species, often under serious threat by people
Indigenous knowledge (IK)	IK is the local knowledge that is unique to a given culture or society. Basis for local-level decision making in agriculture, health care, food preparation, education, natural resource management
Landrace	An early, cultivated form of a crop species, evolved from a wild population, generally composed of a heterogeneous mixture of genotypes
Native species	Flora and fauna species that occur naturally in a given are or region (indigenous species)
On farm conservation	System of conservation of biological diversity through farming
Overexploitation	Harvesting of specimens of flora and fauna species from the wild is out of balance with natural reproduction – species becomes extinct

Terminology (8)

Keywords	Description
Protected area	Geographically defined area meant to achieve specific conservation objectives
Resilience	A measure of resistance to disturbance and the speed of return to the equilibrium state of an ecosystem
Restoration	Return of an ecosystem or habitat to its original community structure, natural complement of species, and natural functions
Seedbank	Facility designed for the ex situ conservation of individual plant varieties through seed preservation and storage
Species	A group of organisms capable of interbreeding freely with each other but not with members of other species
Sustainable farming	Farming that makes use of nature's good and services while producing sufficient yield in an economically, environmentally, and socially rewarding way, preserving resources for future generations
Wild species	Organisms captive or living in the wild that have not yet been subject to breeding to alter them from their native state.

Use of genetic resources



Germplasm and genebank concept

HYV

- Breeding success of HYV at beginning of 20th century caused replacement and genetic erosion of landraces

PGR

- Sir Otto Frankel considered landraces as stores of genetic variability; he coined the term ‘genetic resources’ in 1968 and called upon breeders to preserve the genetic resources of crop plants

Genebanks

- Establishment of genebanks for long-term and short-term storage of germplasm
- Cryopreservation for storage of tissues, cells, DNA, and the genome

The genepool concept (primary, secondary, tertiary)

Left row:
2 types of wild beans (primary genepool; intra-specific)

2nd row:
domesticated beans (primary genepool)

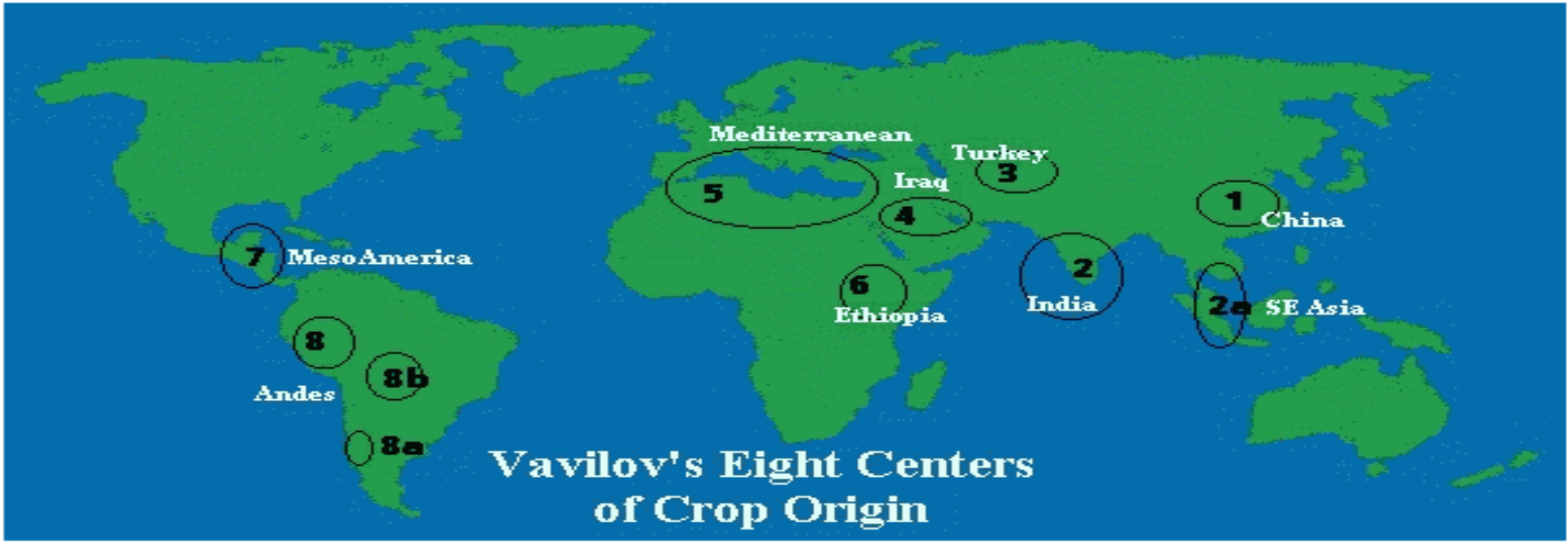
3rd row:
domesticated cultivars from secondary genepool (inter-specific)

4th row:
domesticated cultivars from tertiary genepool (inter-genera)

Origin of agricultural crops (De Candolle, 1882; Vavilov, 1926)

Vavilov's Centers of Origin:

1 China
2 India
2a Indochina
3 Central Asia (N. India, Afghanistan, Turkmenistan)
4 The Near East
5 Mediterranean Sea, coastal and adjacent regions
6 Ethiopia
7 Southern Mexico and Middle America
8 Northeastern South America, Bolivia, Ecudor, Peru
8a Isle of Chile



Field Guide Afghanistan: Flora and Vegetation

4500 flowering plants have been identified in Afghanistan; about 30% are endemic – not found anywhere else. Afghanistan's valleys acted as refuges for plants, allowed them to evolve over million of years into multiple new species. Afghanistan is also richer in fauna than Europe.

There are more than 600 species of legumes; more than 500 Compositae / daisy family; 225 species of Cruciferae / cabbage family; 205 species of Labiatae / mint family; 156 species of Liliaceae.

Edited by S.W. Breckle & M. Daud Rafiqpoor (2010), 868 p. , written in Dari and English

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Plants of Afghanistan 1: Centre of Global Biodiversity

posted: 10-06-2012

Among the hundreds of containers bound for Afghanistan which were impounded for over a year at Karachi docks because of a trade dispute were copies of a ground-breaking book on Afghanistan's plants. S W Breckle and M D Rafiqpoor's Field Guide Afghanistan: Flora and Vegetation, (1) is unique, the result of decades of work by several professors - Afghan, German and British – and written in both Dari and English. It is both scholarly and accessible and intended for practical use. The book has finally found its way to Kabul, more than a year after it was published, and more than 4000 free copies are finally being distributed to Afghan schools, universities and research institutes. AAN's Kate Clark has been leafing through the book and hearing from botanists as to why Afghanistan's plant life is quite so exciting - it is, they say, a globally important centre of biodiversity.

Afghanistan is particularly rich in flowering plants. This may be counter-intuitive, given how relatively dry the country is, but there are far more species and sub-species here than, for example, in damper central Europe which is much more favourable for plant growth. 4500 flowering plants have been identified so far in Afghanistan and many more, it is believed, are yet to be found and named.

A particularly high proportion of those plants – 30 per cent - are endemic, ie they are found nowhere else in the world. By way of comparison, the British

Levels of dependency on PGR for crop production

Table 6.3. Dependence of various regions of the world on outside crops. Dependence is based on percentage of total production (source – Kloppenburg, 1988).

Region	Dependence	Indigenous crops	Major imports	Origin of imports	Period of introduction
Africa	87%	Millet	Banana	South-East Asia	Ancient
		Sorhum	Cassava	South America	Post-Columbian
		Yam	Maize	Mesoamerica	Post-Columbian
			Sweet potato	South America	Post-Columbian
China	60%	Millets	Maize	Mesoamerica	Post-Columbian
		Rice	Peanut	South America	Post-Columbian
		Soybean	White potato	South America	Post-Columbian
			Sweet potato	South America	Post-Columbian
Europe	90%	Oats	Barley	Near East	Ancient
			Maize	Mesoamerica	Post-Columbian
			White potato	South America	Post-Columbian
			Wheat	Near East	Ancient
South America	56%	Cassava	Maize	Mesoamerica	Ancient
		Sweet potato	Wheat	Near East	Post-Columbian
		White potato			
		Yam			
North America	80%	Beans	Barley	Near East	Post-Columbian
		Maize	Wheat	Near East	Post-Columbian
		Squash	White potato	South America	Post-Columbian
			Soybean	China	Post-Columbian

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Case 1 – Grain and vegetable soybean - *Glycine max*

Centers of origin and genetic diversity

The genus *Glycine* consists of two sub-genera: *Glycine* and *Soja*

Sub-genus *Soja* (annual; primary genepool of soybean):

Species	Chromosome number (2n)	No. accessions in AVRDC genebank	Distribution area
Glycine max	40	13,996	Cultigen
G. soja	40	1212	Russia, China, Korea, Japan
G. gracilis	40	2	China
G. formosana	40	2	Taiwan

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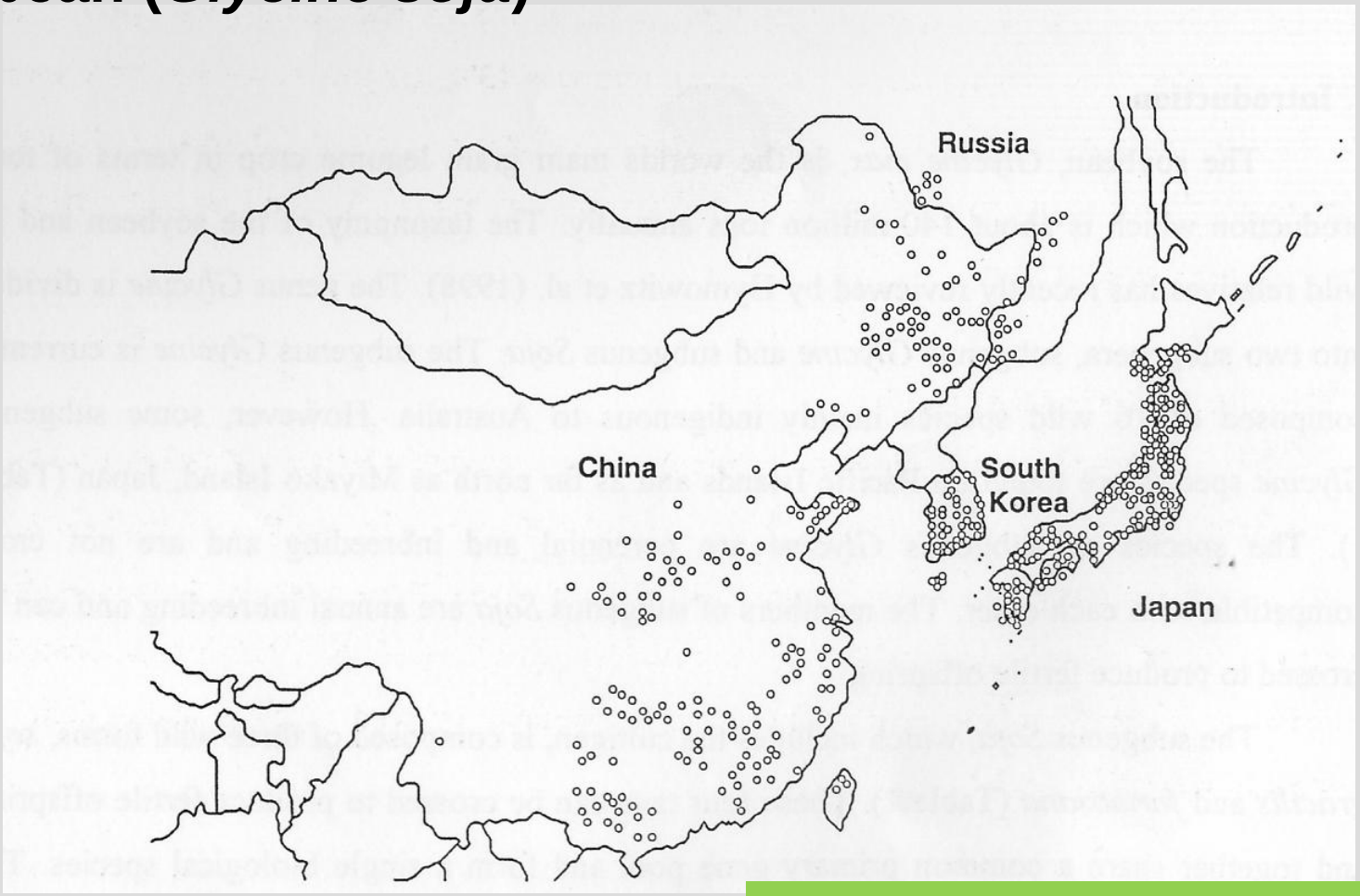
Fig. 1 Geographic distribution of known sites of wild soybean (*Glycine soja*)



Source: Shimamoto 2000. Research on wild legumes with an emphasis on soybean germplasm

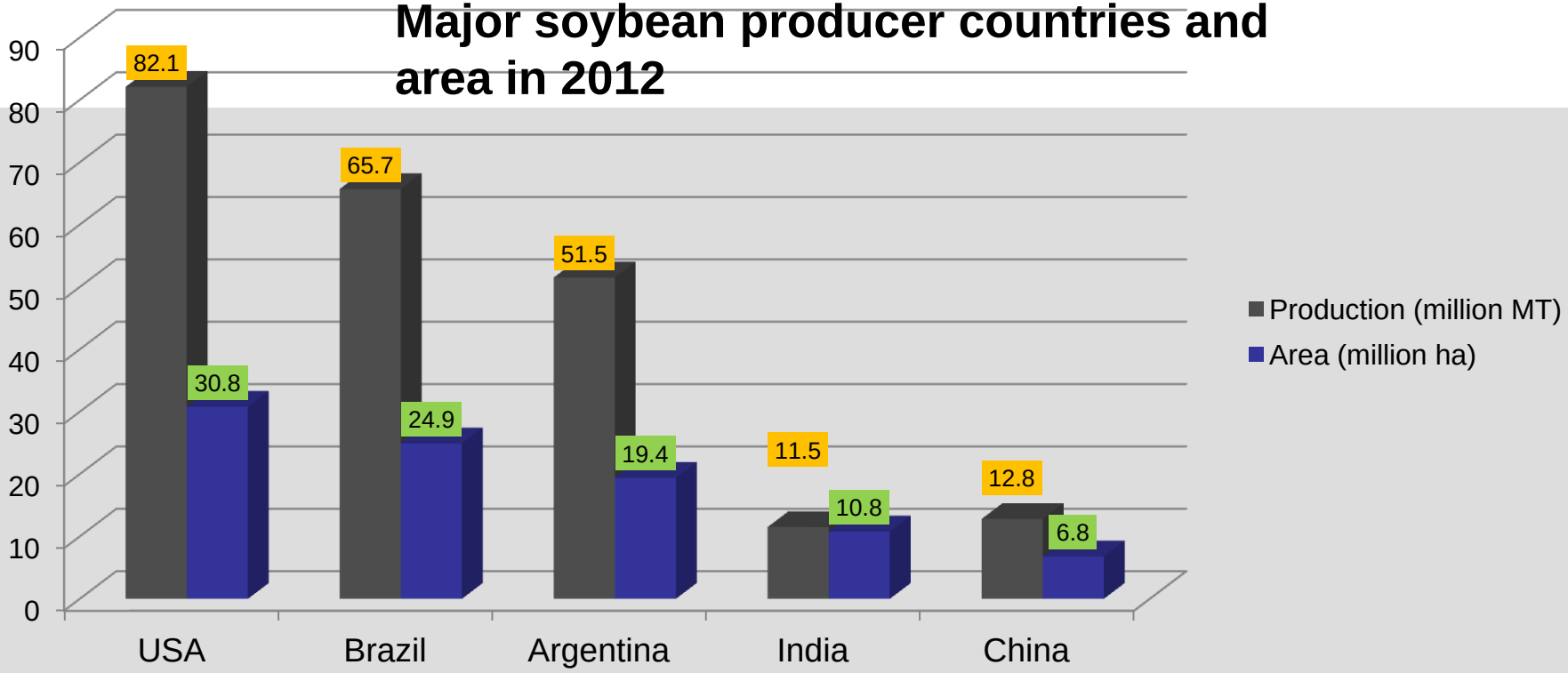
Sub-genus *Glycine* (perennial; inbreeding; not cross compatible):

Species	2n	*No . Acc.	Distribution area
Glycine albicans	40	0	Australia
G. arenaria	40	0	Australia
G. argyrea	40	3	Australia
G. cansecens	40	21	Australia
G. clandestina	40	8	Australia
G. curvata	40	1	Australia
G. cyrtoloba	40	5	Australia
G. falcata	40	4	Australia
G. hirticaulis	40, 80	0	Australia
G. javanica	22, 44		

Species	2n	*No . Acc.	Distribution area
G. lactovirens	40	0	Australia
G. latifolia	40	8	Australia
G. latrobeana	40	2	Australia
G. microphylla	40	5	Australia
G. pindanica	40	0	Australia
G. tabacina	40, 80	14	Australia, West, Central & S. Pacific Islands, Taiwan, Japan
G. tomentella	38, 40, 78, 80	15	Australia, P.N. Guinea, Indonesia, Philippines, Taiwan

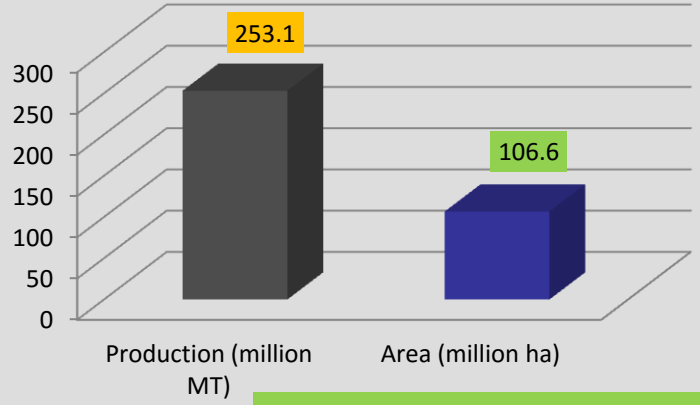
***No. of accessions maintained in AVRDC genebank**

Major soybean producer countries and area in 2012



Source: FAOSTAT 2013

Worldwide soybean production and area in 2012



Source: FAOSTAT 2013

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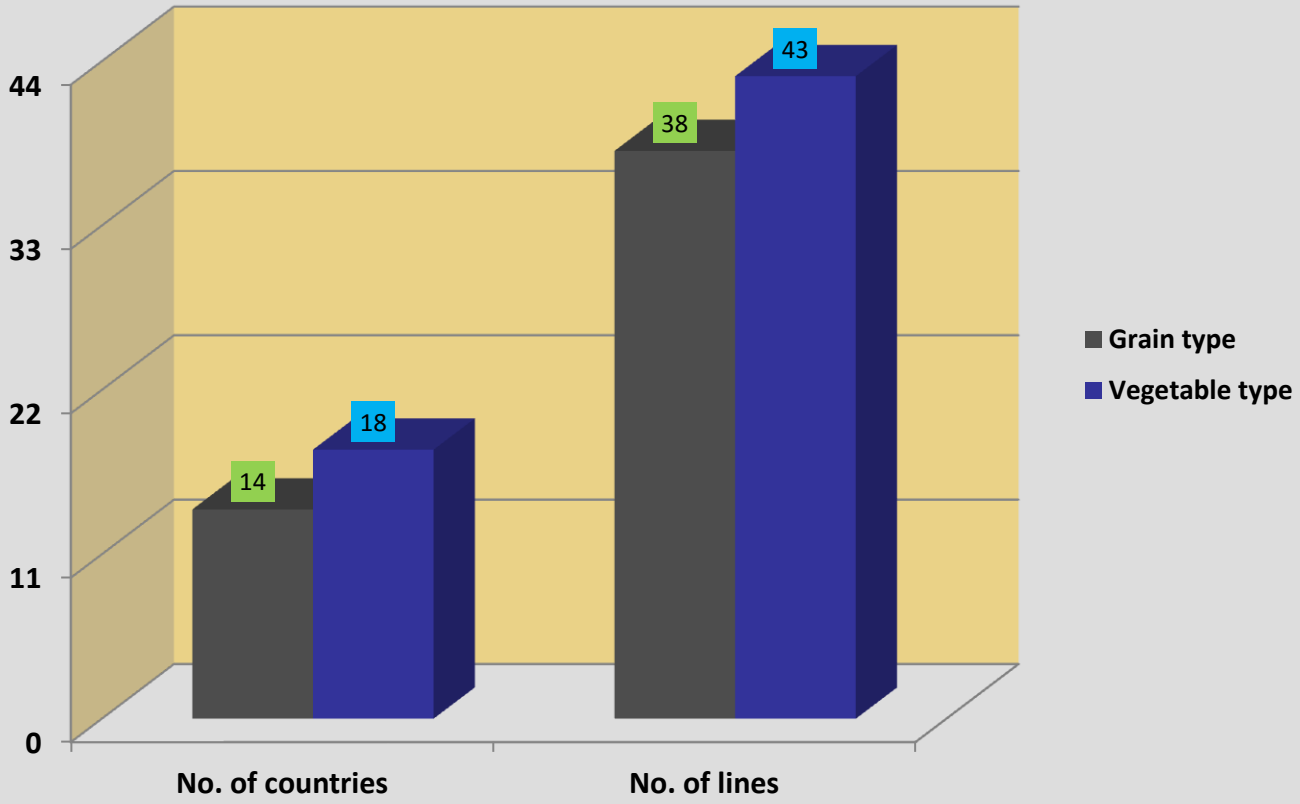
AVRDC-developed grain and vegetable soybean varieties released worldwide since 1978



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Case 2 – tomato – *Solanum lycopersicum*

Centers of origin and genetic diversity

Cultivated tomato is derived from *S. lycopersicum* var. *cerasiforme*; domesticated in Mexico. Wild species are distributed throughout Central and South America.

Due to domestication and transmigration, only 5% of the genetic diversity of wild tomatoes is retained in cultivated tomato!

Solanum sect. *Lycopersicon*: 12 wild species are spread throughout South America:

Species	Distribution	Elevation	AVRDC acc
S. arcanum	Northern Peru	100-2500 m	4
S. cheesmaniae	Galápagos Islands	0-1300 m	17
S. chilense	Southern Peru to northern Chile	0-3000 m	47
S. chmielewskii	South-central Peru to northern Bolivia	1500-3000 m	11
S. corneliomulleri	Southern Peru	1000-3000 m	11
S. galapagense	Galápagos Islands	sea shore	31
S. habrochaites	Southwest Ecuador to south-central Peru	500-3300 m	151
S. huaylasense	Peru	1700-3000 m	0
*S. lycopersicum**	Ecuador and Peru; now widely spread	Variable	6142
S. lycopersicum var. *cerasiforme**	Probably native from Andean region	Variable	125
S. neorickii	Southern Ecuador to south-central Peru	1500-3000 m	12
S. pennellii	Coastal Peru	0-2000 m	65
S. peruvianum	Northern Peru to northern Chile	0-600 m	133
S. pimpinellifolium	Coastal Peru and Ecuador	Under 1000 m	330

***cultivated**

Ex situ conservation of tomato germplasm worldwide

Genebank			Accessions	
Instit. code	Acronym	Country	No.	Percent (%)
TWN001	AVRDC	Taiwan	8259	10
USA003	NE9	USA	6343	8
USA094	DHSNYST	USA	4850	6
PHL130	IPB-UPLB	Philippines	4751	6
USA117	Campbell Inst., Agric. Res.	USA	4572	6
DEU146	IPK	Germany	4063	5
USA176	GSLY	USA	3395	4
RUS001	VIR	Russia	2540	3
JPN003	NIAS	Japan	2428	3
CAN004	PGRC	Canada	2137	3
	Others (148)	Others	39,055	47.4
	Total	World	82,393	100

Tomato collection maintained by AVRDC

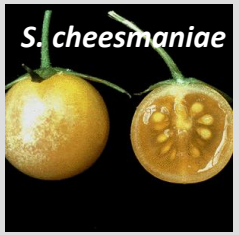
Category	Accs.
Wild species	812
Unidentified accessions	585
S. lycopersicum	6,142
S. lycopersicum var. *cerasiforme*	125
Sub-total	**6,854**
Genetic stocks (IL, RIL, hybrids)	595
Total	**8,261**

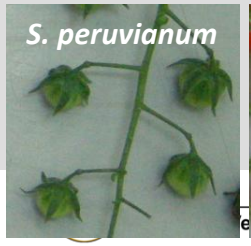
Major contributing countries to cultivated tomato collection:

- US (1197 accs.)
- China (453)
- El Salvador (411)
- Taiwan (394)
- Peru (305)
- Guatemala (231)
- Philippines (217)

AVRDC's collection of wild *Solanum* species

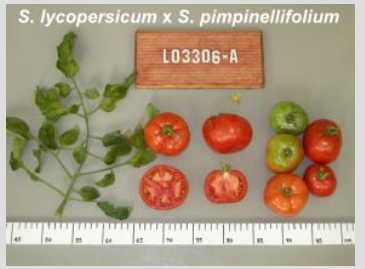
Taxons	No. of accessions
S. arcanum	4
S. cheesmaniae	17
S. chilense	47
S. chmielewskii	11
S. corneliomulleri	11
S. galapagense	31
S. habrochaites	151
S. neorickii	12
S. pennellii	65
S. peruvianum	133
S. pimpinellifolium	330
Total	**812**





Summary of genetic stocks of *Solanum* introgression lines (IL), recombinant inbred lines (RIL) and hybrids

Crosses	# Access.
S. lycopersicum x *S. chilense* (IL)	100
S. lycopersicum x *S. habrochaites* (hybrids)	2
S. Lycopersicum x *S. lycopersicum* var. *cerasiforme* (hybrids)	17
S. Lycopersicum x *S. pennellii* (IL)	79
S. lycopersicum x *S. peruvianum* (hybrids)	5
S. lycopersicum x *S. pimpinellifolium* (hybrids)	123
S. lycopersicum x *S. pimpinellifolium* (RIL)	75
S. lycopersicum (Hawaii 7996) x *S. pimpinellifolium* (WVa700) (RIL) (F8)	188
S. habrochaites x *S. lycopersicum* (hybrids)	2
S. pimpinellifolium x *S. lycopersicum* var. *cerasiforme* (hybr.)	4
Total	**595**



Why do we need intra- and interspecific genetic diversity?

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… to create better vegetables

Building on crop diversity to deliver better vegetable cultivars and produce for farmers and consumers:

- **Higher yields through multiple resistance to pests and diseases;**
- **More stable yields under biotic and abiotic stresses;**
- **Improved high-value features (*e.g.* size, color, taste);**
- **Better nutritional quality (*e.g.* vitamin A and iron)**

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… to improve tolerance to environmental stress

High yielding tomato variety

Wild tomato - source of drought tolerance

Plant breeding and genetic resources

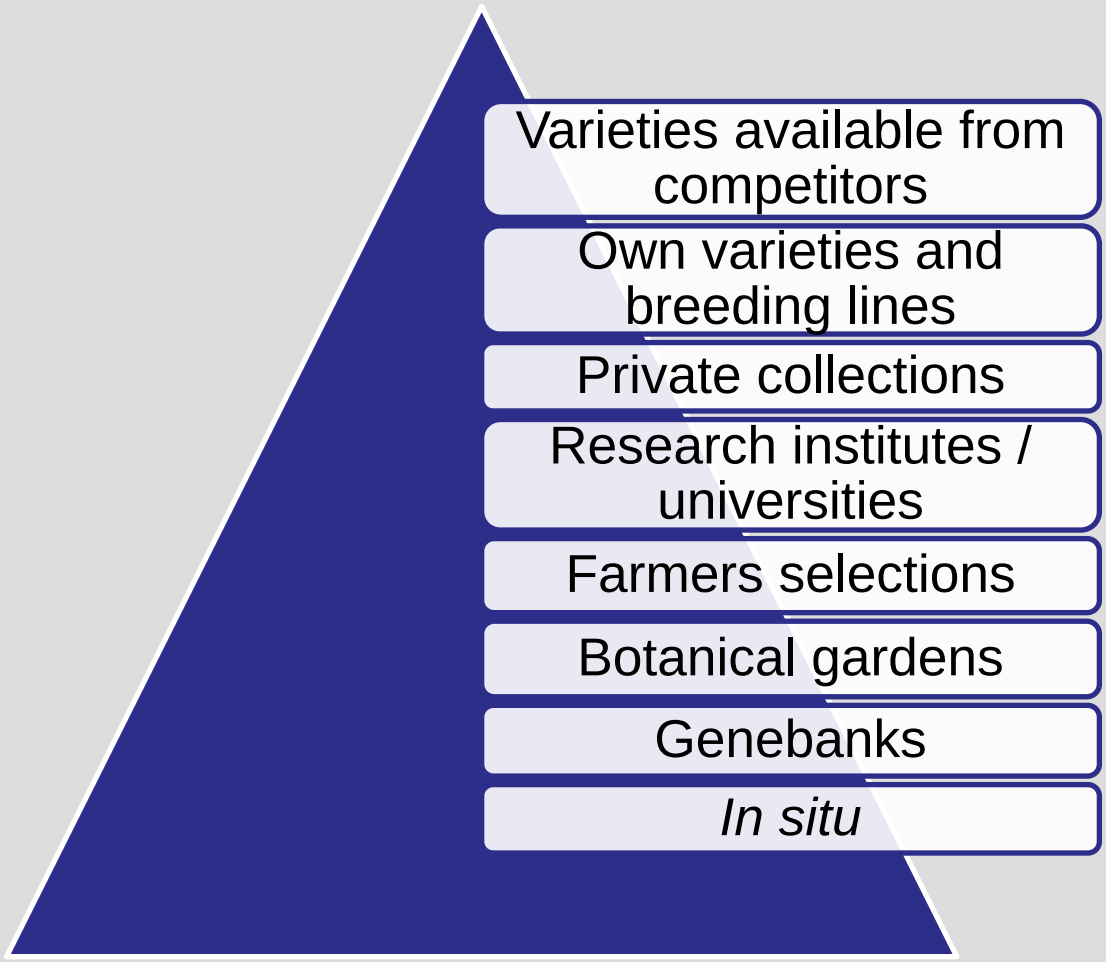
Access to and use of plant genetic resources is vitally important for effective plant variety development and improvement;

Without access to and without maintenance of PGR:

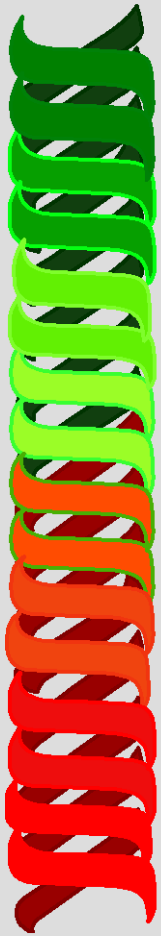
- no availability of PGR

- no plant breeding

Availability of genetic resources for breeding



Conservation approaches and methods



In situ

- nature reserves
- managed areas
- introduction to reserves
- on-farm management (farmer exchanges) (new introductions)
- on-farm conservation (community genebanks)
- field genebanks
- seed genebanks (short-term; long-term)
- in vitro genebanks (slow growth; cryopreservation)
- pollen banks
- DNA libraries

Ex situ

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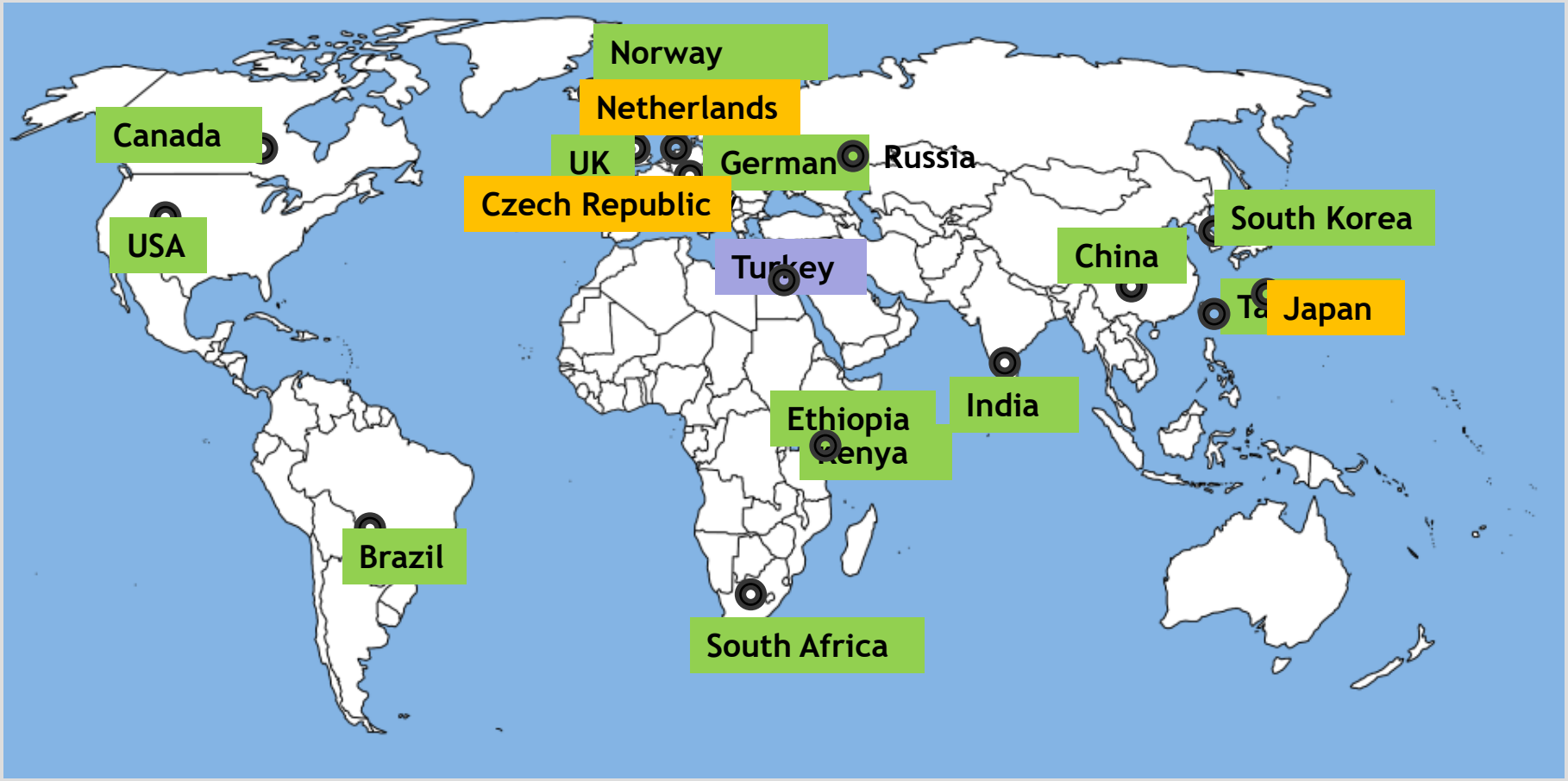
Diversity in vegetables for almost any conceivable purpose found in genebanks:

- **Adapting to climate change**
  - **E.g. early-morning flowering**
- **Improving tolerance to biotic stresses**
  - **New diseases, pests, weeds**
- **Improving tolerance to abiotic stresses**
  - **Polluted, degraded or saline soils**
  - **Cold, heat, drought, flood**
- **Improving food quality**
  - **Taste / perceived quality**
  - **Nutritional value / health benefits**
- **Improving yield**
- **Future unknowns …**

Ex-situ conservation of (vegetable) germplasm by public genebanks around the world



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Major (vegetable) genebanks

Number of accessions, genera, and species

Taiwan, AVRDC: 1995: 43,205 / 63 /209;
2015: 61,435 / 172 / 439

USA, NPGS: 508,994 / 2128 / 11,815

China, ICGR-CAAS: 391,919

India, NBPGR: 366,333 / 723 / 1495

Russia, VIR: 322,238 / 256 / 2025

Korea, RDA: 272,181 / 15,937 hort. crops

Japan, NIAS: 243,463 / 341 / 1409

Germany, IPK: 148,128 / 801/ 3049

Brazil, CENARGEN: 107,246 / 212 / 670

Canada, PGRC: 106,280 / 257 / 1166

Ethiopia, IBC: 67,554 / 151 / 324

Turkey, AARI: 54,523 / 545/ 2692

Kenya, KARI-NGBK: 48,777 / 855 / 2350

Hungary, ABI: 45,321 / 294 / 915

Nordic countries, NGB: 28,007 / 129/ 319

Netherlands, CGN: 24,076 / 36 / 311

Ecuador, INIAP: 17,830/272/662

Czech Republic, RICP: 15,421 / 30 / 175

South Africa, Veg. & Orn. Plant Inst.

UK, Warwick Crop Center, Veg. GB

Svalbard Global Seed Vault

Source: 2nd SoW PGRFA; AVRDC-GRSU

We now need: Not a Green Revolution, but a **Revolution with Greens!**

The world's largest public sector collection of vegetable germplasm: AVRDC Genetic Resources and Seed Unit Genebank

Steps in germplasm and genebank management

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Collection / acquisition of germplasm

(Done in collaboration with NARES, other genebanks, donations)

Short-term storage

Registration
(Registration & Temp. Accession Nos.)

Passport Information

Regeneration and Characterization

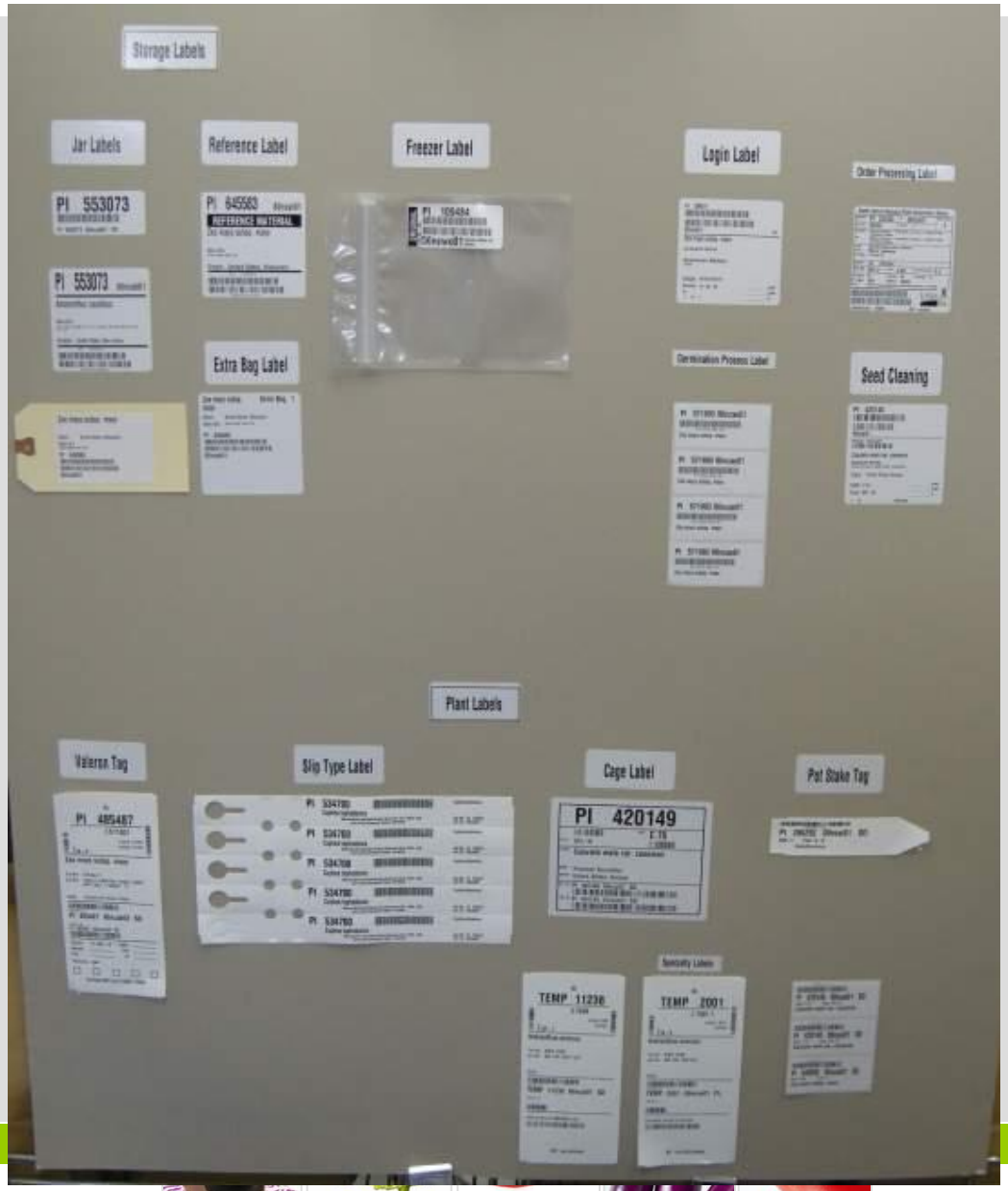
Preservation
(LT)

Utilization
(MT)

Genebank operations:

Registration, cleaning, drying, germination test, SMC, packaging, storage

Use of barcode labels in different stages

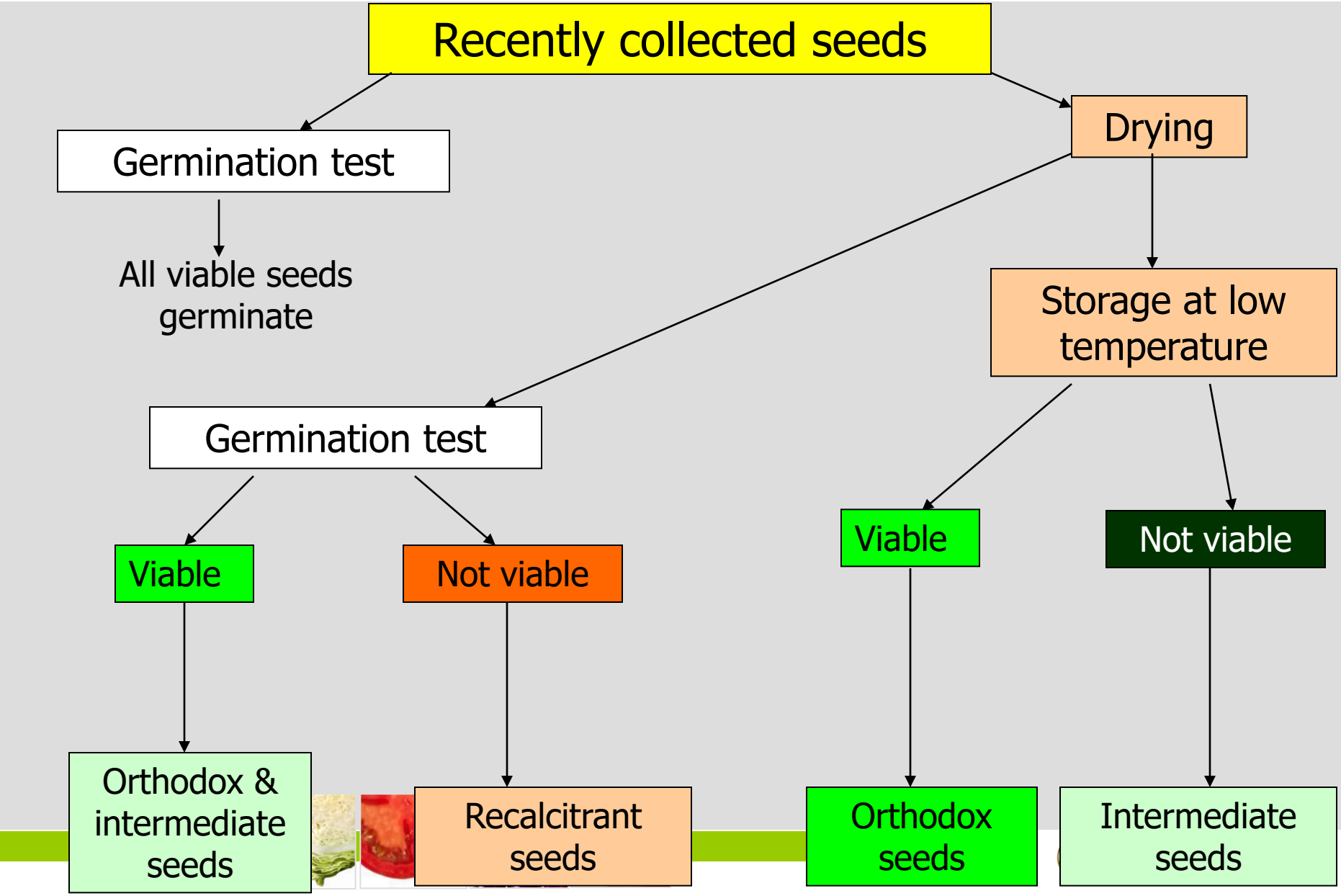


Behaviour of vegetable seeds in storage

Majority of vegetable crops are produced from orthodox seeds:

- Preservation: seeds can be dried to a low seed moisture content (4-7%) and stored in a cool and dry place for many years (decades)
- Some vegetatively propagated crops (shallot, garlic, leafy sweet potato) need to be preserved in field genebanks

Determination of Seed Storage Behaviour



Seed Classification

	Orthodox seeds	Intermediate seeds	Recalcitrant seeds from temperate zones	Recalcitrant seeds from tropical climates
Seed moisture content for storage (%)	Very low (2-5%)	Low (7-10%) (equilibrium with HR of 30-50%)	High >30-50% at maturity (12-30% after drying)	High >30-50% at maturity (12-30% after drying)
Storage temperature	Very low -18 ^{o}C	Medium to high ~ 20 ^{o}C	Low > 0 ^{o}C	High ~ 25 ^{o}C

Viability monitoring during cold storage

REGENERATION
(WEDNESDAY AFTERNOON, 5 AUGUST)

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Predicted longevity of sel. species and monitoring frequency

Genus	Species	Predicted longevity (years)	Monitoring frequency (years)*
Lactuca	*sativa*	74.5	18.6
Allium	*cepa*	111	27.8
Glycine	*max*	112.5	28.1
Brassica	*napus*	131.5	32.9
Cucurbita	*pepo*	245	61.3
Cucumis	*melo*	266	66.5
Phaseolus	*vulgaris*	373	93.3
Pisum	*sativum*	446.5	111.6
Vigna	*unguiculata*	304	76.0
Vigna	*radiata*	1252	313

*Frequency: 4 intervals based on longevity

Source: 2nd Draft FAO Genebank Standards

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Regeneration/characterization at AVRDC

Total of 118 net cages erected to accommodate about 1500 accessions

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Characterization

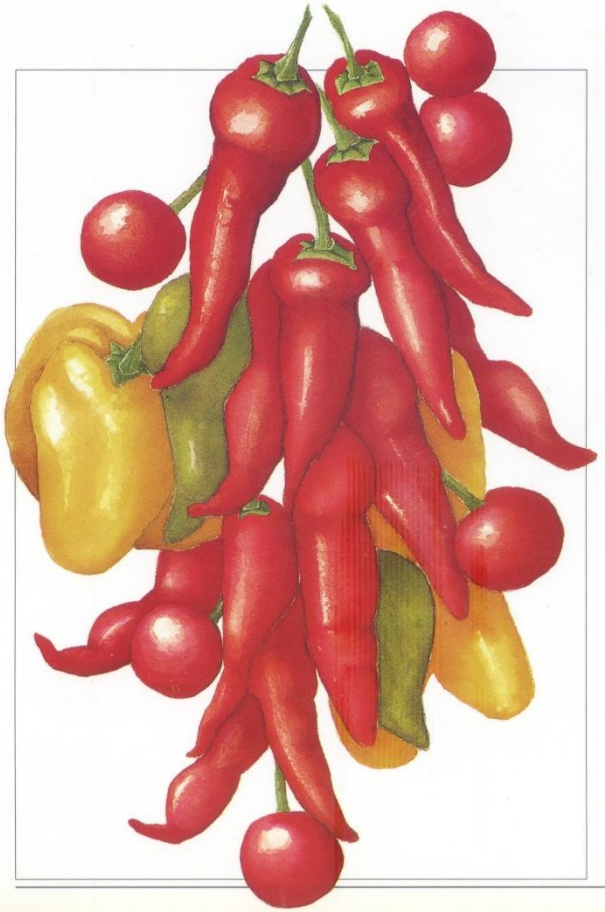
- **Traits that are**
  - **Highly heritable and show low GxE interactions**
    - ➔ **assessment possible in one location, one year, with no replication, controls or treatment contrasts**
  - **Easy to record**
    - ➔ **Without expensive specialist equipment or expertise**
- **Why should genebanks characterize?**
  - **Without data about an accession, no rational basis to select it for use**
  - **Need data on every accession in the collection**
  - **Feasible to characterize entire collection**

Descriptor lists

Descriptors for

Capsicum

(*Capsicum* spp.)



Produced in association with

IPGRI

CONTENTS

Morphological characterization

Leaf pubescence Azuki bean

Plant height Azuki bean, at flowering

Pod length Yard-long bean

Seed color Yard-long bean

Characterization of new Sun hemp collection

sunhemp descriptors.pdf

***Crotalaria* sp. acc. TZ 85**

Source: NPGRC, Tanzania

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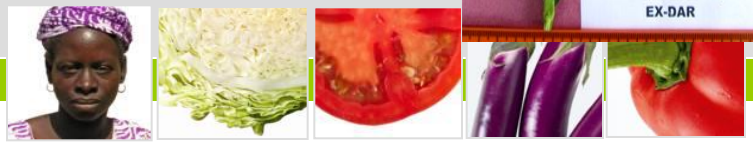
Characterization of indigenous vegetables using morphological traits; *Amaranthus, Brassica* and *Corchorus* (top left to right) and, *Solanum* (bottom). Arrow indicates seedless fruits

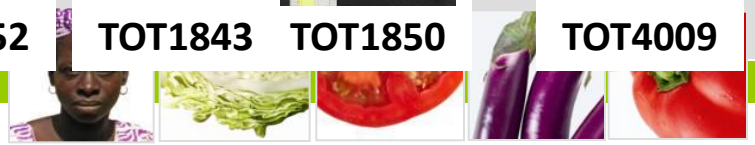


TOT4256 TOT4370-1 TOT7308 TOT6236 TOT4531 TOT4491 TOT4362

TOT4244 TOT4409 TOT4549 TOT3991 TOT6983 TOT7098 TOT1756 TOT2533

TOT5852 TOT1843 TOT1850 TOT4009

Photo documentation



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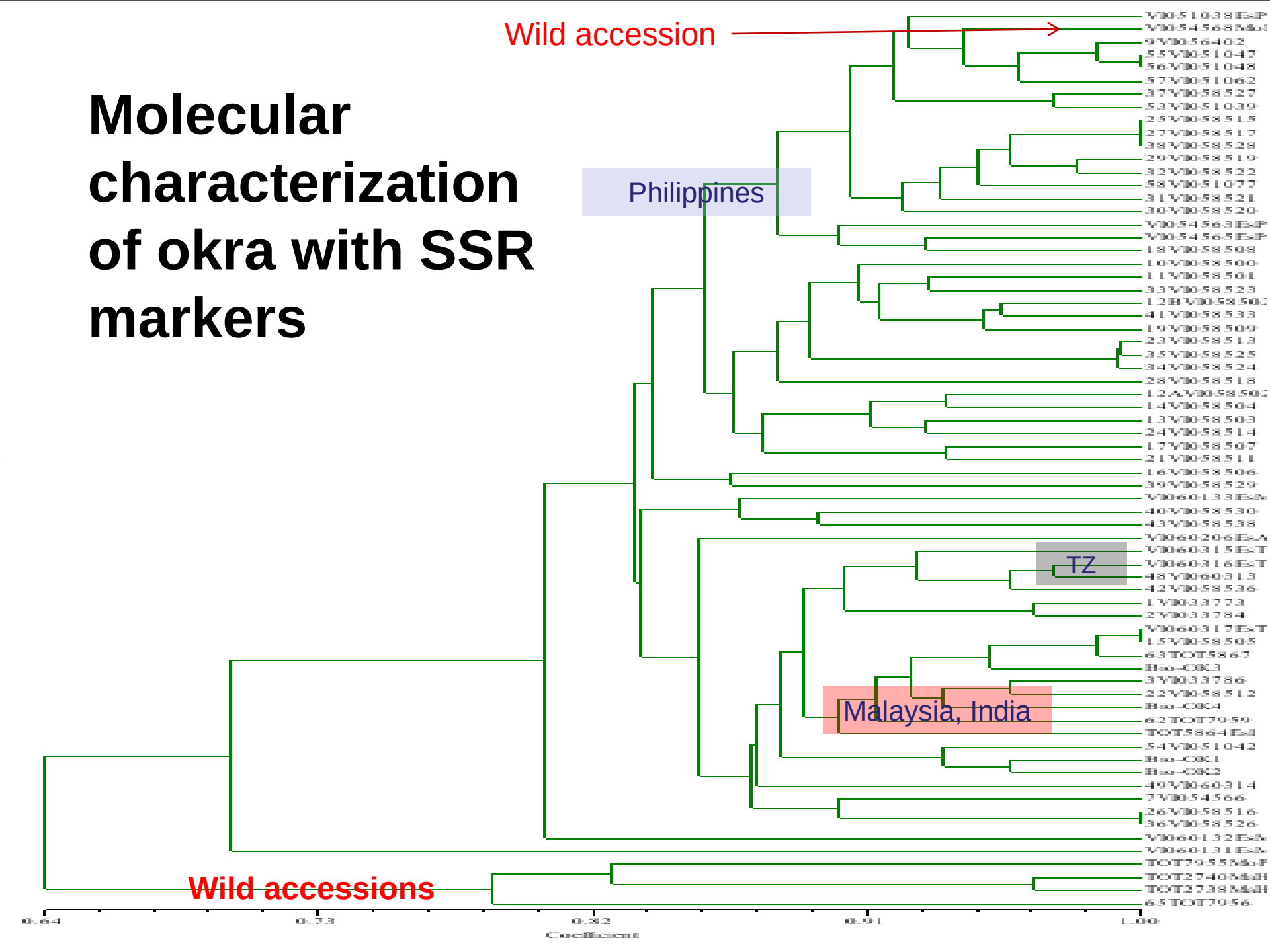
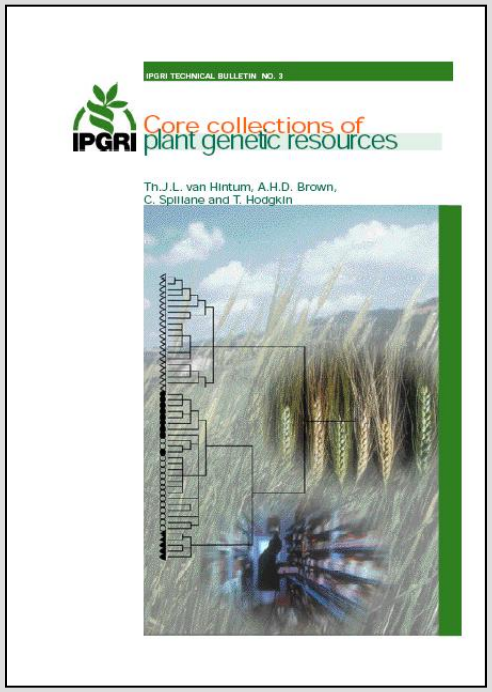
Molecular characterization of okra with SSR markers



Core Collections

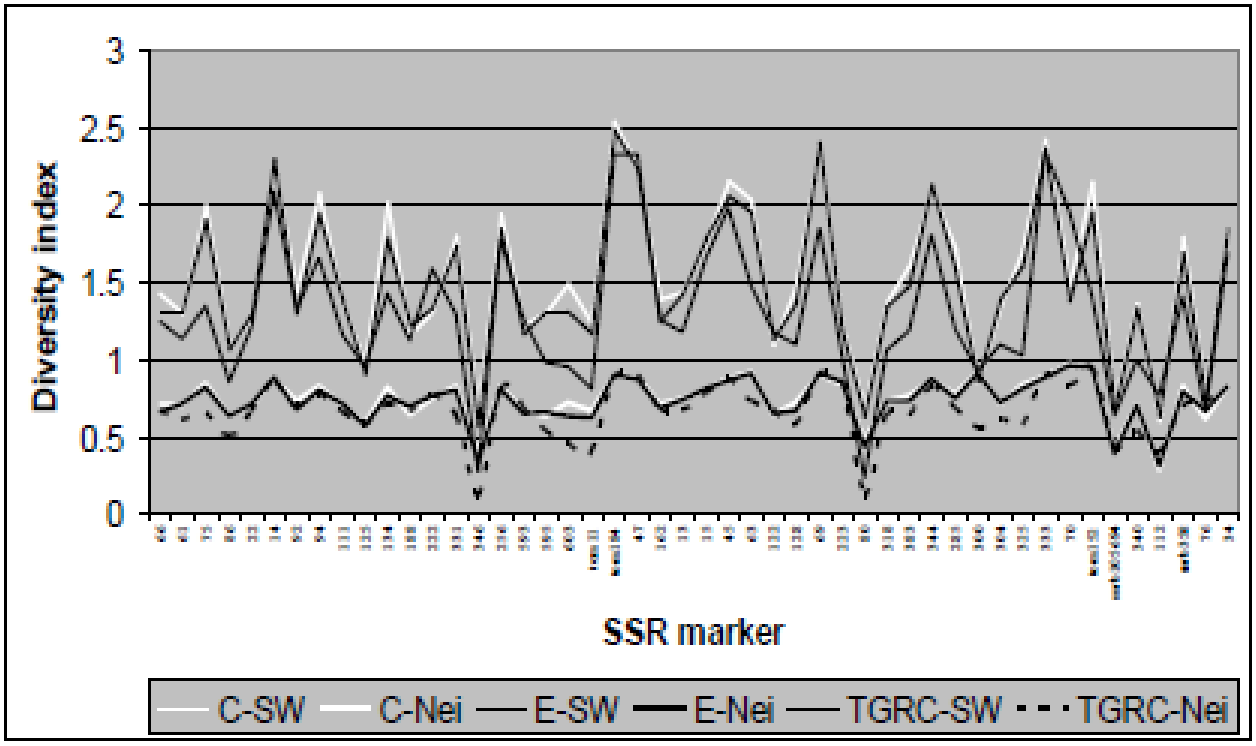


A core collection is a limited set of accessions representing, with a minimum of repetitiveness, the genetic diversity of a crop species and its wild relatives (Frankel 1984). A core of about 10% of the total collection is likely to contain at least 70% of the variation.

Mini core collections (ICRISAT) comprise approx. 10% of the core or 1% of the entire collection; meant to enhance utilization of germplasm further.

Solanum pimpinellifolium core collection

75 core accessions identified representing 22.7% of AVRDC's entire collection. A well balanced core with a good representation of the different populations (31 from Pop I, 22 from Pop II, and 22 from the Admixture group) and geographic origins (40 from Peru, 17 from Ecuador, 14 from Mexico and 4 from other countries).



Distribution of Shannon Weaver & Nei diversity indices among 48 SSR markers in the entire collection (E-SW; E-Nei) & the core collection (C-SW; C-Nei)

Rao et al. (2012) Using SSR markers to map genetic diversity and population structure of *Solanum pimpinellifolium* for development of a core collection. Plant Genetic Resources: Characterization & Utilization (2012) 10(1): 38-48.

Mining the genetic treasure of the AVRDC genebank – development and release of Tengeru97 and Tanya

- Developed by AVRDC breeders and released in Tanzania in 1997; Tanya was the first locally adapted processing variety suitable for year-round production.

- In 6 years - from 1997 to 2003 -, the tomato production area grew from 16,600 to 19,000 ha
- In 2003, the most important tomato varieties grown were Tanya (45%) and Tengeru97 (24%), followed by Marglobe (11%) and Money Maker (7%)
- 69% of the farmers adopted the new varieties in 2003.

- With average variable cost of production being 17% lower, and a yield increase of 36%, the overall net income was 39% higher with the new varieties.

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African eggplant DB3 and AB2

- Selected from accessions of *Solanum aethiopicum*, DB3 and AB2 are sweet tasting; out-yielding most traditional bitter-tasting varieties
- Can be harvested every week for 7 months
- Premium priced, giving a potential income of approx. US$ 2,500 per ha annually
- Local seed companies have started scaling up seed production

Amaranthus Green Gina and White Elma

- Selected from accessions of *Amaranthus cruentus*, *A. hybridis and A. dubius*
- Fast growing with soft, sweet leaves, much shorter cooking time – maximizing nutritional values and saving fuel wood
- Start appearing in supermarkets and on the menus of small local hotels in Nairobi and other cities
- Demand is so high that national seed companies are taking interest in producing and selling the seeds

There are further options for the use of conserved genetic materials…

1. Nutritional content of vegetables can be enhanced:
   - higher nutrient content
   - improved bioavailability of the nutrients

Orange-colored Golden tomato lines CLN2366 A and -B
- contain 10 to 12-times more ß-carotene
- one golden tomato can provide a person's full day vitamin-A requirement

Bitter gourd: High value

Beneficial medicinal characteristics can be exploited

Bitter gourd
(Momordica charantia)

- Bitterness is attributed to non-toxic alkaloid momordicin, a potential compound to treat type 2 diabetes and tumors.

- In traditional medicine used to treat diabetes, tumors (leukemia, skin); said to be effective cure for scabies, itching, psoriasis, ringworm and fungal infections; used to treat arthritis, rheumatism, asthma, and alcohol dependency.

Flowers
Medicine
Cosmetics

Bark
Dyes
Medicine

Gum
Medicine
Glue

Root
Medicine
Condiment

Leaves
Nutrition
Medicine

Stem
Fuel wood
Pulp
Paper

Pods
Nutrition
Medicine

Seeds
Water
purification
Medicine
Oil

Drumstick tree (*Moringa oleifera*)

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Market Potential

Current Use of Moringa

- Moringa oil as base for shampoos
- Food supplement – fortification
- Specialty creams (cosmetics)
- Specialty "Energy" drinks

Documentation - Linking Germplasm Conservation with Utilization

Germplasm Conservation

Evaluation
virus resistance (CMV, CVMV, PMMV, PVY, ToMV, TMV, gemini viruses, WTG,ZYMV, CGMMV)
DM,PM, BW (Pss186, Pss4, Pss190)
cotton aphid
cotton leaf hopper
bruchids

Characterization
Morphological
Seed Proteins, RAPD, SSR

Evaluation
protein
sugar
total soluble solids
dry matter
fiber
color value
capsaicin
Vitamin A/β carotene
Vitamin C/ascorbic acid
alkalinity/pH
acidity/% citric acid
lipid
total phenol
total anti-oxidant activity
carotenoids

Germplasm Utilization

Data made available in AVGRIS

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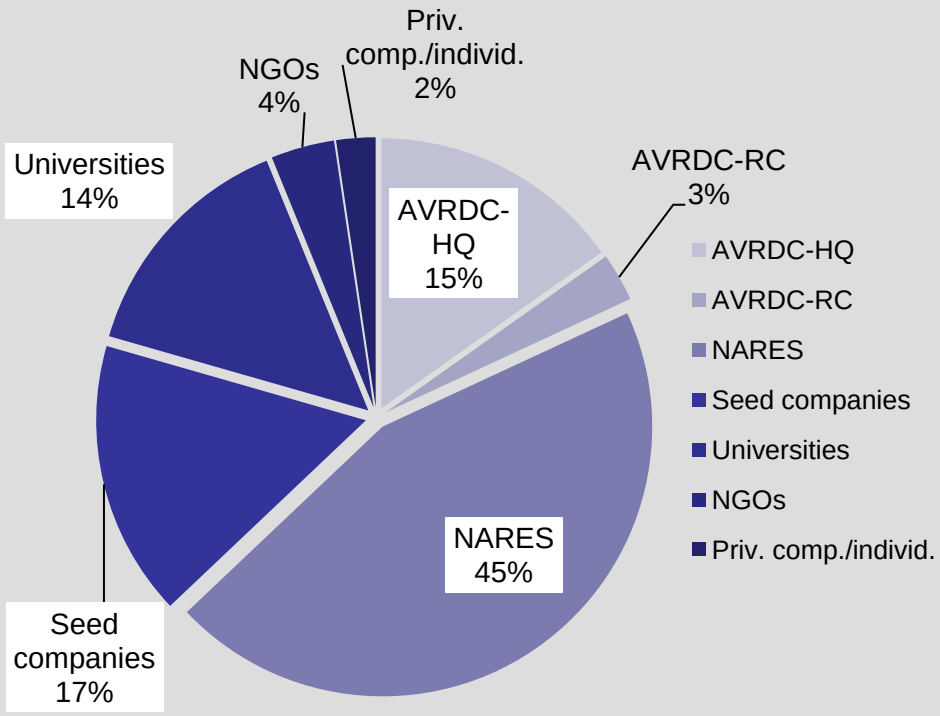
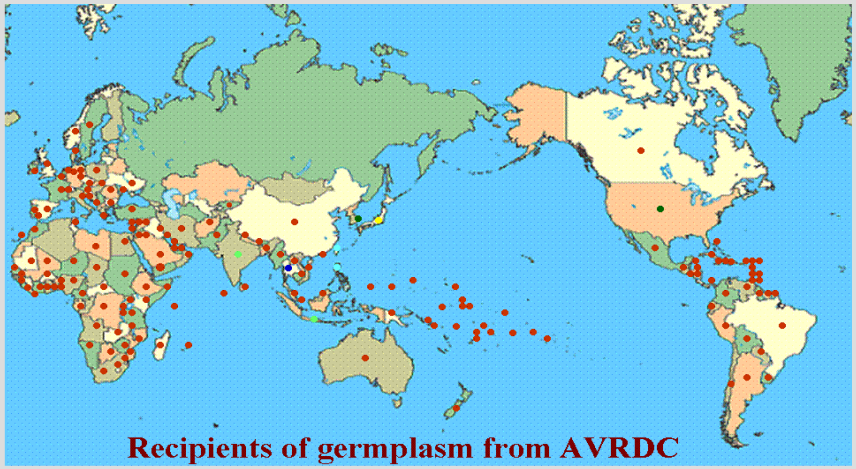
Seed distribution in 2014

The contribution of AVRDC's genebank to the use of vegetable diversity worldwide in 2014 (6727 unique samples)





6000 to 8000 genebank accessions and breeding lines dispatched annually worldwide

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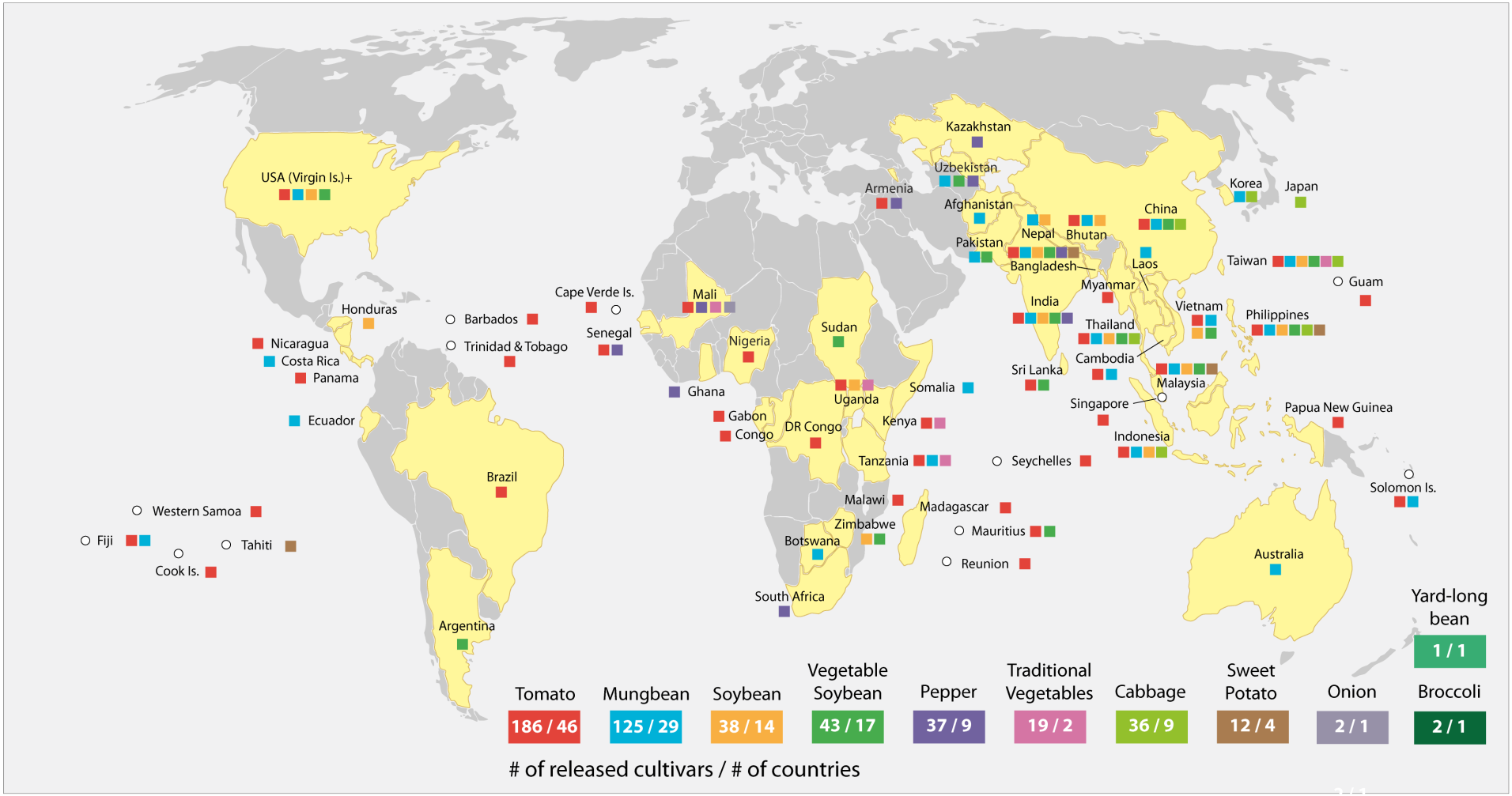
AVRDC-derived varieties released since 1978



501 improved vegetable cultivars

benefit farmers around the world

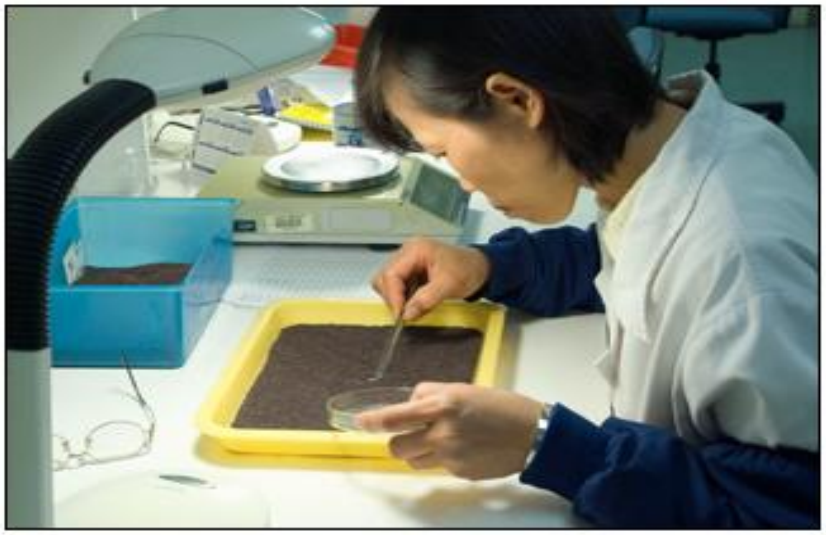
September 2013

http://www.avrdc.org - Under "Seed", scroll down and select "AVRDC genebank" to have access to → AVGRIS

AVGRIS

AVRDC Vegetable Genetic Resources Information System

Home | Search | Data Category | Contact Us | Terms of Use | About AVGRIS



WELCOME TO AVGRIS

The AVRDC Vegetable Genetic Resources Information System (AVGRIS) is an information system that manages the data of all vegetable germplasm conserved at GRSU, AVRDC. It is designed to manage the GRSU operations more efficiently. It links all operations associated with germplasm conservation and management from registration, characterization, evaluation, seed inventory and seed distribution to end-users.

This web version of AVGRIS has been developed by GRSU staff. It provides the user direct access to germplasm data through the internet.

Use of the system is FREE but please first read the TERMS OF USE

The system aims to:

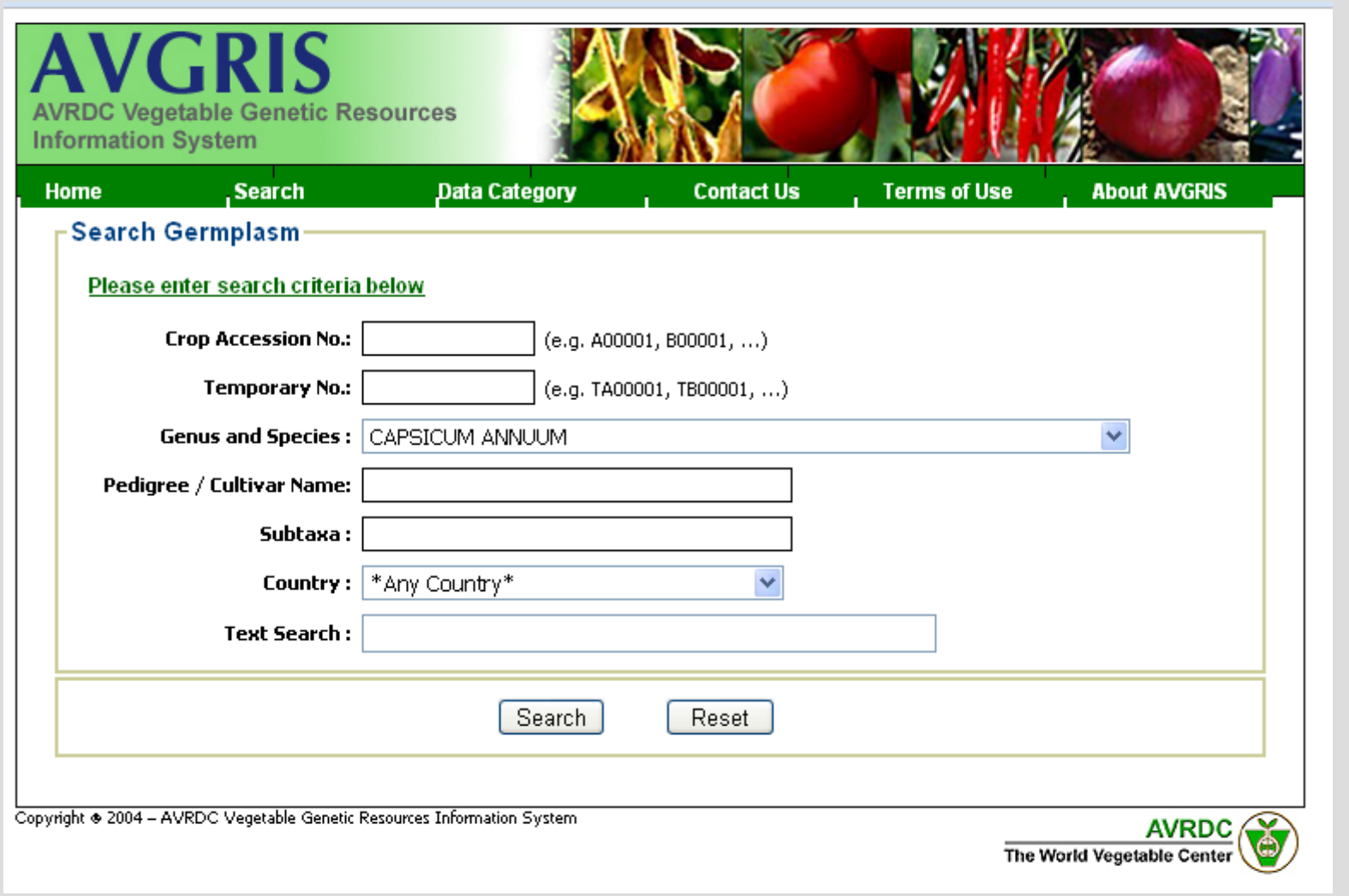
- Assist the GRSU staff in day-to-day activities.
- Facilitate recording, storage and maintenance of germplasm data.
- Provide direct access to information pertaining to accessions in the genebank, and
- Allows requests for the desired seeds

The data that are accessible are:

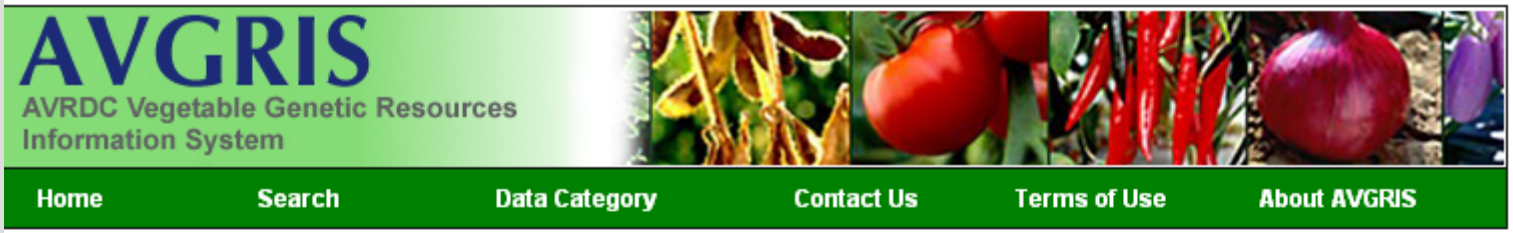
- Passport
- Characterization, and
- Evaluation

http://203.64.245.173/

Search Germplasm – Passport Data



Search Germplasm – Passport Data



SEARCH GERMPLASM RESULTS:

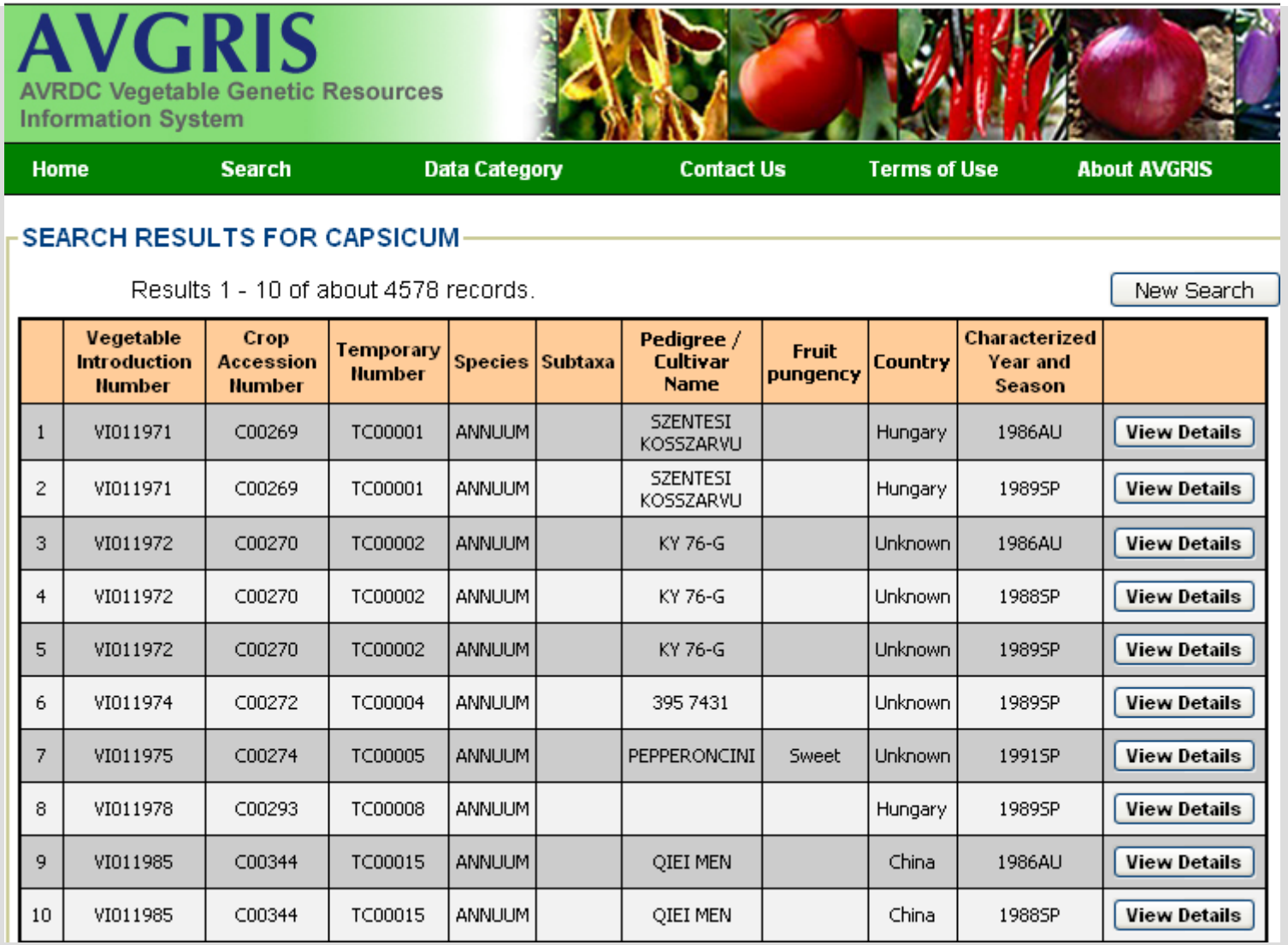
Results 1 - 10 of about 5368 records.

New Search

	Crop Accession Number	Temporary Number	Vegetable Introduction Number	Family	Genus	Species	Subtaxa	Pedigree / Cultivar Name	Country of Collection	
1	C00269	TC00001	VI011971	SOLANACEAE	CAPSICUM	ANNUUM		SZENTESI KOSSZARVU	Hungary	View Details
2	C00270	TC00002	VI011972	SOLANACEAE	CAPSICUM	ANNUUM		KY 76-G	Unknown	View Details
3	C00272	TC00004	VI011974	SOLANACEAE	CAPSICUM	ANNUUM		395 7431	Unknown	View Details
4	C00274	TC00005	VI011975	SOLANACEAE	CAPSICUM	ANNUUM		PEPPERONCINI	Unknown	View Details
5	C00293	TC00008	VI011978	SOLANACEAE	CAPSICUM	ANNUUM			Hungary	View Details
6	C00308	TC00010	VI011980	SOLANACEAE	CAPSICUM	ANNUUM		BUDAIEDES	Unknown	View Details
7	C00324	TC00012	VI011982	SOLANACEAE	CAPSICUM	ANNUUM		GYPSY (F1)	Hungary	View Details
8	C00342	TC00013	VI011983	SOLANACEAE	CAPSICUM	ANNUUM		CANAPE (F1)	Hungary	View Details
9	C00344	TC00015	VI011985	SOLANACEAE	CAPSICUM	ANNUUM		QIEI MEN	China	View Details
10	C00352	TC00016	VI011986	SOLANACEAE	CAPSICUM	ANNUUM		PM 217	Mexico	View Details

Search Germplasm – Characterization Data

Search Germplasm – Characterization Data



	Vegetable Introduction Number	Crop Accession Number	Temporary Number	Species	Subtaxa	Pedigree / Cultivar Name	Fruit pungency	Country	Characterized Year and Season	
1	VI011971	C00269	TC00001	ANNUUM		SZENTESI KOSSZARVU		Hungary	1986AU	View Details
2	VI011971	C00269	TC00001	ANNUUM		SZENTESI KOSSZARVU		Hungary	1989SP	View Details
3	VI011972	C00270	TC00002	ANNUUM		KY 76-G		Unknown	1986AU	View Details
4	VI011972	C00270	TC00002	ANNUUM		KY 76-G		Unknown	1988SP	View Details
5	VI011972	C00270	TC00002	ANNUUM		KY 76-G		Unknown	1989SP	View Details
6	VI011974	C00272	TC00004	ANNUUM		395 7431		Unknown	1989SP	View Details
7	VI011975	C00274	TC00005	ANNUUM		PEPPERONCINI	Sweet	Unknown	1991SP	View Details
8	VI011978	C00293	TC00008	ANNUUM				Hungary	1989SP	View Details
9	VI011985	C00344	TC00015	ANNUUM		QIEI MEN		China	1986AU	View Details
10	VI011985	C00344	TC00015	ANNUUM		QIEI MEN		China	1988SP	View Details

AVGRIS

AVRDC Vegetable Genetic Resources Information System

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Characterization Data - Capsicum

Back

Crop accession number	C00104
Duplicate number	2
Temporary number	
Variant	
Species	ANNUUM
Subtaxa	
Pedigree / Cultivar Name	MC 4
Country	Malaysia
Characterized year and season	1986SP
Remarks	

DESCRIPTOR NAME	VALUE
	SeedlingData
Hypocotyl color	
Hypocotyl color intensity	
Cotyledonous leaf length (mm)	
Cotyledonous leaf width (mm)	
Cotyledonous leaf shape	
Cotyledonous leaf color	

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Safety duplication of AVRDC germplasm

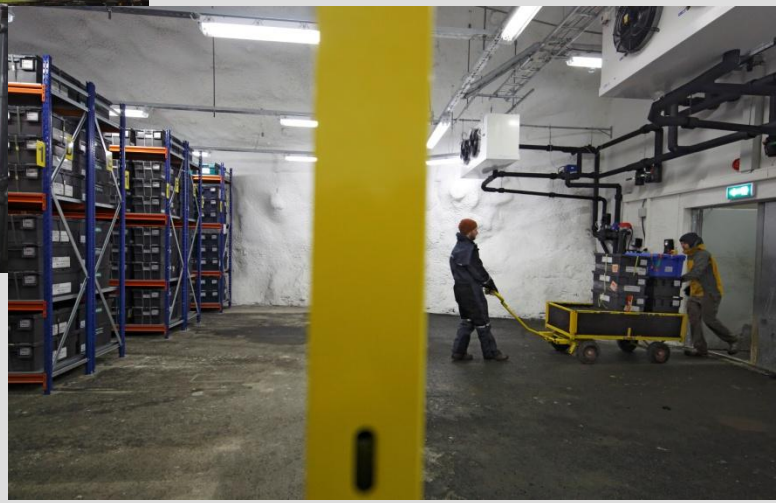
Duplication Site	Crops	# of acc.
National Plant Genetic Resources Center (NPGRC), Taichung, Taiwan (1993 to present)	Mungbean, soybean, pepper, tomato, etc.	26,954
National Plant Genetic Resources Laboratory, Philippines (08/1982)	Mungbean, tomato	9,407
Nat. Vegetable Res. Station Wellesbourne, UK (1982-1986)	Brassica	372
Nat. Inst. Agrobiol. Sciences (NIAS), Japan (1981-1985)	Brassica	357
NIAS, Japan (1984-1986)	Southeast Asian soybeans	2,389
Nat. Germplasm Resources Lab., Beltsville, USA (1984-1986)	Southeast Asian soybeans	2,389
Svalbard Global Seed Vault, Norway (02/2008 + 09/2009 + 11/2010 + 10/2012)	All major AVRDC collections included	12,769
National Agrobiodiversity Center, RDA, Korea (05/2009 + 12/2010 + 11/2012)	All major AVRDC collections included	12,819 (21.5%)

Svalbard Global Seed Vault, Norway

Destination of some of the Center's germplasm in 02/2008 + 09/2009 + 11/2010 + 10/2012

12,769 accessions

"Noah's Ark" on Svalbard



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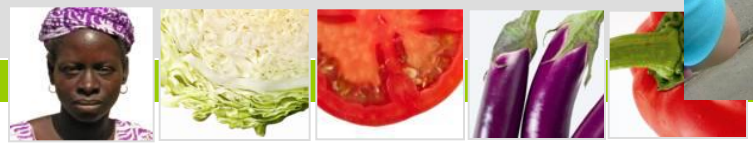
Shipment to RDA genebank in Suwon, Korea (15/05/09)

Officer of BAPHIQ in-specting seed shipment

Boxes ready for shipment on FedEx truck



Processing of seed requests

Seed Request

Other AVRDC units

- Availability of requested seeds
- Shipment list
- Seed treatment protocols
- Technoguides
- Signed MTA(s)
- Payment received
- IP (if necessary)

If not genebank material

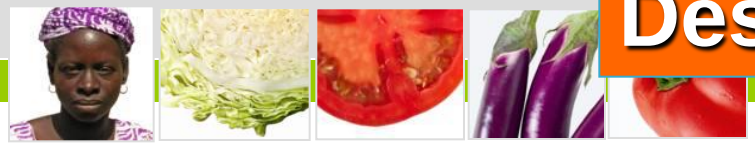
GRSU

- Availability of requested seeds
- Shipment list
- Seed treatment protocols
- Technoguides
- Signed MTA(s)
- Payment received
- IP (if necessary)

Taiwan Bureau of Animal and Plant Health Inspection and Quarantine

Phytosanitary Certificate

Destination



Pest Risk Analysis

PEST RISK ANALYSIS

ON IMPORTING

MUSTARD SEEDS

(*Brassica Juncea*)

FROM ITALY

18-page document

AVRDC Genebank
The source for tomorrow's vegetables

Field collection of germplasm

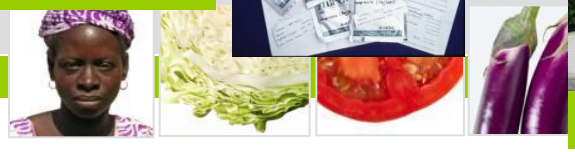
Developed genetic material

Seed processing and packing

Worldwide seed distribution

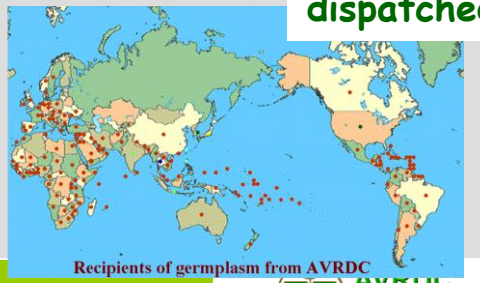
AVRDC Genebank - Conservation and Distribution center

Samples obtained from national programs / other donors



GRSU research team

5 to 7,000 genebank acc. / breeding lines dispatched per year



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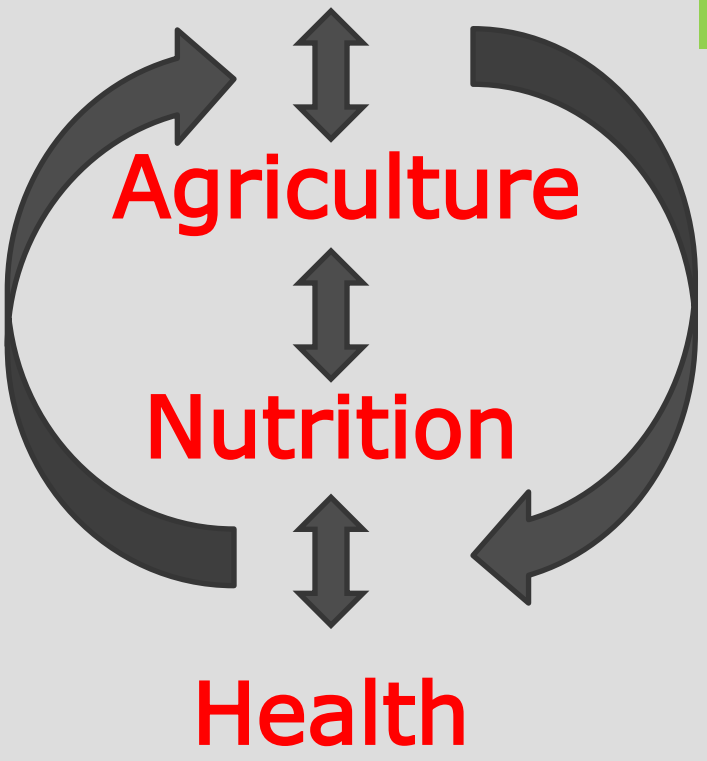
Increased diversity in vegetable production & consumption has multiple benefits

Nutrition & Health benefits

- Improved strength & endurance
- Improved learning capacity of children
- Enhanced maternal health
- Higher productivity
- …



Agricultural & social benefits

- More resilient agric. systems
- More jobs
- Better income
- Gender equity
- Food security
- Dietary diversity
- Improved livelihoods
- …

The GRSU Team