

Global conservation strategy for crops in the Cucurbitaceae family: summary for ITPGRFA stakeholders

Pumpkin diversity.
Photo: World Vegetable Center

This document is a concise summary of the Global conservation strategy for crops in the Cucurbitaceae family (Ebert et al., 2023) with some key metrics (Table 1) updated in 2024. Its aim is to support decision making by the stakeholders of the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) by providing evidence-based information on this gene pool in an accessible format.

Non-Annex I crops covered by the strategy

Cucurbit crops are not included in Annex 1 of the ITPGRFA. As of 2024, about 9,000 accessions of major cucurbits crops and their CWR were notified as available in the Multilateral System of the ITPGRFA, and more than two thirds of these are held (and distributed) by WorldVeg and CATIE.

Genus *Cucumis*: *Cucumis sativus* L., *C. melo* L.

Genus *Citrullus*: *Citrullus lanatus* (Thunb.) Matsum. & Nakai, *C. amarus* Schrad., *C. colocynthis* (L.) Schrad., *C. mucospermus* (Fursa) Fursa

Genus *Cucurbita*: *Cucurbita argyrosperma* subsp. *argyrosperma* C. Huber, *C. ficifolia* Bouche, *C. maxima* subsp. *maxima* Duchesne, *C. moschata* Duchesne, *C. pepo* L.

Genus *Benincasa*: *Benincasa hispida* (Thunb.) Cogn.

Genus *Lagenaria*: *Lagenaria siceraria* (Molina) Standl.

Genus *Luffa*: *Luffa acutangula* (L.) Roxb., *L. aegyptiaca* Mill.

Genus *Momordica*: *Momordica charantia* L., *M. balsamina* L., *M. cochinchinensis* (Lour.) Spreng, *M. dioica* Roxb. ex Willd.

International organizations conserving collections of crops covered by the strategy

World Vegetable Center (WorldVeg, TWN001) holds one of the largest germplasm collections of *Luffa*, *Momordica*, and *Benincasa*. It also holds large germplasm collections of *Cucurbita* and *Cucumis*.

Centro Agronómico Tropical de Investigación y Enseñanza (CATIE, CRI085) holds one of the largest germplasm collections of *Cucurbita* and a significant collection of *Lagenaria*.

International Center for Agricultural Research in the Dry Areas (ICARDA, LBN002) holds a small number of accessions of cucurbits.

Composition and gaps in *ex situ* collections¹

Globally, genebanks conserve more than 37,000² accessions of *Cucumis* species. About 40% of the *Cucumis* acces-

¹ The estimates of number of accessions for each genus in this section differ slightly from the ones found in Ebert et al. (2023) as they are updated with data available in 2024.

² This figure does not include *Cucumis* accessions conserved at RUS001 as their data are not in Genesys and WIEWS. However, according to survey data collected in 2019 RUS001 holds 6,829 accessions of *Cucumis* species.

sions are held in three genebanks: N.I. Vavilov All-Russian Institute of Plant Genetic Resources (VIR, RUS001); North Central Regional Plant Introduction Station – USDA (USDA, USA020); and the Research Center of Genetic Resources, National Agriculture and Food Research Organization of Japan (NARO, JPN183).

Cucumis melo has the highest number of accessions conserved *ex situ*, followed by *C. sativus*. *Cucumis anguria* and

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Table 1. Key metrics for major cucurbit crops. SD = Safety duplication; PDCI = Passport Data Completeness Index. Genesys and WIEWS dataset (2024) includes accession of the genera *Cucurbita*, *Cucumis*, *Citrullus*, *Lagenaria*, *Luffa*, *Momordica*, and *Benincasa* from 184 genebanks.

Genus	<i>Cucurbita</i>	<i>Cucumis</i>	<i>Citrullus</i>	<i>Lagenaria</i>	<i>Luffa</i>	<i>Momordica</i>	<i>Benincasa</i>	Total
Number of accessions (Genesys and WIEWS 2024)	36,803	37,218	12,873	6,704	4,510	2,798	1,748	102,654
Number of accessions conserved by international organizations (Genesys and WIEWS 2024)	3,834	716	104	520	1,007	256	318	6,755
SD at another genebank out of country or at SGSV (Genesys and WIEWS 2024)	4,360	6,447	1,323	392	916	228	129	13,795
% SD at another genebank outside of the country or at SGSV (Genesys and WIEWS 2024)	7%	8%	4%	3%	13%	7%	5%	13%
Accessions duplicated at SGSV (Genesys and WIEWS 2024)	2,411	4,907	840	319	909	214	129	9,729
SGSV % (Genesys and WIEWS 2024)	7%	13%	7%	5%	20%	8%	7%	9%
SGSV (SGSV seed portal)	3,173	5,402	1,117	477	970	222	133	11,494
SGSV %*	9%	15%	9%	7%	22%	8%	8%	11%
No safety duplication (Genesys and WIEWS 2024)	28,853	27,127	9,351	5,852	3,436	2,538	1,586	78,743
Safety duplication % (Genesys and WIEWS 2024)	22%	27%	27%	13%	24%	9%	9%	23%
Number of accessions with DOI (GLIS 2024)	6,812	4,478	1,320	1,681	1,080	493	341	16,205
Number of accessions notified in the MLS (GLIS 2024)	4,317	1,313	414	1,278	1,013	458	320	9,113
PDCI median score** (Genesys 2024)	5.35	6.25	4.95	4.95	6.20	5.80	6.50	5.55

*This percentage is calculated using at the denominator the total accessions figures based on Genesys and WIEWS 2024 data, and at the numerator the accessions recorded in SGSV seed portal

**PDCI score can range between 0 and 10

C. metuliferus have relatively low numbers of accessions conserved *ex situ*. Germplasm of African origin for *C. melo* and *C. sativus* is underrepresented in *ex situ* collections. Furthermore, there are no records of accessions for *C. picrocarpus*, the closest crop wild relative (CWR) of *C. melo*.

Over 36,000³ accessions of *Cucurbita* species are held in 158 institutes worldwide. VIR in Russia, Embrapa Hortaliças in Brazil (BRA012), the Centro Agronómico Tropical de Investigación y Enseñanza in Costa Rica (CATIE, CRI001), and the Institute of Crop Science, Chinese Academy of Agricultural Sciences in China (ICS-CAAS, CHN001), hold the largest *Cucurbita* collections.

Cucurbita moschata has the highest number of accessions conserved *ex situ*, followed by *C. pepo* and *C. maxima*. For *Cucurbita argyrosperma* subsp. *argyrosperma*, further collecting of landraces in Central America is considered a priority. For *C. moschata*, germplasm from Colombia is under-represented *ex situ*. *Cucurbita* CWRs are conserved

in only a few institutes and *C. cordata*, *C. pedatifolia*, *C. radicans*, and *C. x scabridifolia* are high priority for further collecting, followed by *C. digitata*, *C. foetidissima*, and *C. palmata*.

Close to 13,000⁴ accessions of *Citrullus* species are conserved *ex situ*: VIR; Plant Genetic Resources Conservation Unit - Southern Regional Plant Introduction Station - University of Georgia (USA016); Embrapa Semi-Árido (BRA017); and NARO (JPN183), Japan hold the largest collections. North Africa, West Africa, Central and East Africa, and South America are considered priorities for additional collecting. With regards to CWRs, there are fewer than ten accessions of *C. ecirrhosus* and *C. rehmii* and only 37 accessions of *C. naudinianus* in *ex situ* collections.

For *Momordica* spp., *Lagenaria* spp., *Luffa* spp., and *Benincasa hispida*, the main priority of targeted collecting is considered to be landraces in Bangladesh, Myanmar, and Vietnam.

³ This figure does not include *Cucurbita* accessions conserved at RUS001 and CHN001 as their data are not in Genesys and WIEWS. However, according to survey data collected in 2019, RUS001 and CHN001 hold 2,992 and 1,420 accessions of *Cucurbita* species, respectively.

⁴ This figure does not include *Citrullus* at RUS001 as their data are not in Genesys and WIEWS. However, according to survey data collected in 2019 RUS001 holds 3,154 accessions of *Citrullus* species.

Survey results

Conservation conditions and processes

Among survey⁵ respondents, 19 (73%) reported long-term storage at temperatures conforming to the FAO genebank standards (FAO, 2014). Ninety percent of the genebanks that conserve material in long-term storage reported using aluminum foil bags as packing material. The majority of surveyed genebanks reported having written procedures in place to describe key genebank and germplasm management processes. Regeneration is the best documented practice, with 88% of genebanks having written regeneration protocols. The least well documented processes are related to germplasm health assessment (42%).

Safety duplication

Two-thirds of the surveyed genebanks have safety-duplicated at least part of their cucurbit collections, but in several cases collections are not backed up outside the host country. Data from Genesys and WIEWS (Table 1) suggest that only about a quarter of the accessions of major cucurbits crops have at least one safety duplicate, and only 13% are duplicated outside of the depositors' country (including duplicates stored at Svalbard).

Documentation and information systems

Eighty-four percent of the genebanks that participated in the survey reported using an electronic information system for managing their collection. A further 12% of genebanks are using such an information system only in part, and 4% of genebanks have no electronic system. Six genebanks have adopted GRIN-Global as an information management system, and others are planning to make the switch shortly. About 50% of the genebanks that

responded to the survey make information about their Cucurbitaceae collection fully accessible online and share accession-level information on international databases.

Distribution and obstacles to use

All genebanks that participated in the survey reported distributing germplasm and keeping records of distributions made. Domestic distribution was more common than international distribution. Within the country, genebanks distributed a median of 47 accessions annually. Outside the country, genebanks distributed a median of 20 accessions annually. The WorldVeg genebank (Taiwan, TWN001) and USDA genebanks (Griffin, GA, USA016; Ames, IA, USA020) together account for 87% of international distributions. Eighty percent of genebanks require a Material Transfer Agreement (MTA) for the distribution of germplasm, while 16% distribute germplasm without requiring an MTA. The remaining 4% reported being unsure of their terms and conditions for distribution. About a quarter of genebanks indicated that the Cucurbitaceae germplasm held in their collections is not available in sufficient quantity and health for distribution, and 15% of genebanks reported problems with disease in their collections, which may restrict germplasm distribution.

Regeneration

Regeneration backlogs are common and affect not only national genebanks, but also regional and international ones. Nearly 25% of accessions in the surveyed genebanks require urgent regeneration. Because Cucurbitaceae crops are outcrossing, regeneration is especially challenging, requiring special approaches to restrict pollen flow. Regeneration backlogs might be addressed through collaborations among genebanks, with those having spare capacity and suitable environmental conditions for regeneration assisting those with backlogs; collaborations with private seed companies may also be beneficial. Further studies of

⁵ The survey was conducted in 2019, with 26 genebanks completing it.



seed longevity to enhance long-term viability in storage could reduce conservation costs by decreasing regeneration frequency. Best-practice regeneration protocols for Cucurbitaceae crops should be shared and harmonized.

Networks

[European Cooperative Programme for Crop Genetic Resources \(ECPGR\) Cucurbit Working Group](#), under the framework of the ECPGR Vegetable Network.

Recommendations

1) Collecting threatened and missing genetic diversity

- *Citrullus*: North Africa, West Africa, Central and East Africa, and South America should be targeted for additional collecting. *C. ecirrhosus*, *C. rehmi*, and *C. naudinianus* are priorities for collecting among *Citrullus* CWRs.
- *Cucurbita argyrosperma* subsp. *argyrosperma*: collecting of landraces in Central America is a priority. For *C. moschata*, additional germplasm from Colombia should be collected.
- *Cucumis*: *Cucumis melo* and *C. sativus* collecting additional germplasm of African origin is a priority. Also *C. picrocarpus* should be collected.
- *Benincasa hispida*, *Lagenaria* spp., *Luffa* spp. and *Momordica* spp.: The priority is to collect landraces in Bangladesh, Myanmar and Vietnam.

Collecting should be prioritized from extreme environments and in areas with high pest and disease pressure to increase the likelihood of capturing useful traits.

2) Global registry of *ex situ* Cucurbitaceae diversity

Develop a global registry of cucurbits collections conserved *ex situ*. This would include sharing and verification of passport data, integration of available images, and characterization and evaluation data. The information in the global registry should be used to define a virtual global core collection.

3) Safeguarding Cucurbitaceae collections and improving use

- Improve knowledge of optimal long-term storage conditions: for all cucurbits genera the long-term con-

ditions necessary to maintain germplasm for at least 25 years require further study.

- Safety duplication: Develop and implement a regional approach to safeguard unique landraces and CWRs held in national genebanks. Under a black-box agreement, the WorldVeg regional genebank in Tanzania, the SADC Plant Genetic Resources Network in Southern Africa, the USDA NPGS for the Americas, members of AEGIS for Europe, and WorldVeg for Asia and Oceania could act as safety duplication sites for national genebanks. Additionally, a second safety duplicate should be deposited at SGSV.
- Address regeneration backlogs through collaboration among genebanks and with private industry.
- Create a universal standardized descriptor list for each Cucurbitaceae crop: there are published descriptor lists for each of the major Cucurbitaceae crops, standardized descriptor lists will facilitate efforts to compare germplasm.
- Address phytosanitary constraints to distribution:
 - Centers that have a clear mandate for international exchange (such as SADC-PGRC, USDA NPGS, AEGIS, and WorldVeg) might serve as designated third-party providers of germplasm certification services.
 - Develop chemical or temperature seed treatments for disease-free germplasm.

Bibliography

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Acknowledgement

The development of this document was funded by the German Federal Ministry of Food and Agriculture (BMEL) as part of the project “Mainstreaming the Global Crop Conservation Strategies in Plant Treaty Processes”.

