GLOBAL CROP CONSERVATION AND USE METRICS

BEETS
(*Beta* L.)

CROP TRUST

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Suggested Citation
Khoury CK, Gora, S and Giovannini, P (2025) Global crop conservation and use metrics: Beets (*Beta* L.). Bonn, Germany: Global Crop Diversity Trust.

Funding Source
The development of this document was funded by the German Federal Ministry of Agriculture, Food and Regional Identity (BMLEH) as part of the project *Mainstreaming Global Crop Conservation Strategies in Plant Treaty Processes* led by the Crop Trust.

Global crop conservation and use metrics

BEETS
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With support from

CROP TRUST

International Treaty on Plant Genetic Resources for Food and Agriculture

Federal Ministry of Agriculture, Food and Regional Identity

Description

This report provides an up-to-date overview of the global status of *ex situ* conservation of genetic resources of beets and their wild relatives, including key metrics on:

- global statistics on crop production, trade, and availability in food supplies;
- the identity and composition of genebank collections;
- the Multilateral System (MLS) status of accessions in these collections;
- storage, regeneration, and safety duplication status;
- documentation, information systems, and research resources;
- germplasm distribution;
- varietal registrations and releases; and
- crop networks and partnerships

Introduction and background on beets

Beets (*Beta vulgaris* L. subsp. *vulgaris*) originated in the Middle East or Eastern Mediterranean, with historical records of food (primarily the leaves) and medicinal uses dating back to the ancient Egyptian, Greek, and Roman periods (Goldman and Janick, 2021). The species comprises four main cultivated forms: table beets grown for their edible roots, Swiss chard cultivated for nutrient-rich leaves, sugar beets as a major commercial source of sugar, and mangel-wurzel used as livestock feed (Goldman and Janick, 2021). Sugar beets were developed from table beets in Germany during the mid-eighteenth century, and industrial sugar production from beets began in Europe in the early nineteenth century. Sugar beets now account for around 30% of global sugar production, having increased in sugar content from less than 10% to around 18% through selection and breeding (Dohm et al., 2013; Felkel *et al.*, 2023). Table beets are nutrient-dense vegetables containing essential minerals and vitamins, including manganese, potassium, iron, folate, vitamin B6, and vitamin C (Chen *et al.*, 2021).

Based on the most recently available production statistics from FAOSTAT, reporting for the year 2023, sugar beets are cultivated in at least 59 countries on over 4.5 million hectares worldwide, producing 281.5 million tonnes at a value of almost USD 15 billion (FAO, 2025a). The largest producers of sugar beets include the Russian Federation, USA, Germany, France, Türkiye, Poland, Ukraine, Egypt, China, UK, Netherlands, and Iran, each producing over 5 million tonnes per annum. Production statistics for table beet and swiss chard are not readily available, with the crops grouped within the general commodity "Vegetables, fresh nes" in FAOSTAT statistics (Khoury *et al.*, 2023).

There is considerable international trade in sugar beet (around 950,000 tonnes exported per annum), with Germany, Slovakia, Belgium, and Latvia each reporting exporting over 100,000 tonnes each year (FAO, 2025a). Among the 45 countries reporting importing sugar beet, the top recipients include Czechia, Switzerland, Lithuania, Germany, Croatia, and France, all importing over 50,000 tonnes each year. These statistics are for unprocessed sugar beet and represent only a small portion of the actual total trade of the crop, as the majority is traded in refined form, which includes the product of both sugar beet and sugarcane. Trade statistics for refined sugar amount to over 26 million tonnes exported per annum, with 144 countries exporting sugar and 196 countries importing the commodity.

Global consumption statistics for sugar beet are imprecise, with FAOSTAT reporting a portion of the contribution of the crop under

its own specific category in food supply statistics, yet with a substantial amount of the actual contribution to food supplies recorded within more general sugar commodities (Khoury *et al.*, 2023). Statistics directly for sugar beet (only) indicate that the crop is a major contributor to food weight in the food supplies of at least 96 countries (Table 1). Production and food supply metrics indicate that sugar beets are widely utilized outside of their regions of origin, implying significant international interdependence with regard to its genetic resources. Global consumption statistics are also imprecise for table beet and swiss chard, with FAOSTAT reporting these vegetables under its "Vegetables, Other" category (Khoury *et al.*, 2023).

Table 1. Global status of beet production, trade, availability in food supplies, and public interest. Production, trade, and food supply statistics from FAOSTAT (2015 to 2018 average). Number of countries refers to the count of countries where the crop is reported as within the top 95 percent of crops in terms of contribution to production, trade, or food supply. The evenness metric quantifies evenness of production, trade, or availability in food supplies across world regions, where 0 equals highly uneven and 1 equals completely even. The international interdependence metric quantifies degree of production, trade, or availability in food supplies outside of the primary region of diversity of the crop, where 0 equals low estimated international interdependence and 1 equals high estimated international interdependence. Wikipedia metric is public pageviews over one year (2019) of the taxon name of the crop. All values from Khoury *et al*. (2023).

Metric	Global value	Number of countries where significant contributor	Evenness of contribution across world regions	Estimated international interdependence
Harvested area (ha)	4,927,094	30.75	0.21	0.67
Total production (tonnes)	280,824,405	43.75	0.21	0.65
Gross production value (current thousand USD)	12,622,808	31.00	0.24	0.68
Export quantity (tonnes)	4,110,506	16.00	0.17	0.19
Export value (current thousand USD)	598,807	9.50	0.19	0.22
Import quantity (tonnes)	4,110,589	32.75	0.15	0.16
Import value (current thousand USD)	668,011	11.75	0.17	0.20
Contribution to calories in food supplies (kcal/capita/day)	0.99	0.50	0.36	1.00
Contribution to protein in food supplies (g/capita/day)	0.05	6.25	0.36	1.00
Contribution to fat in food supplies (g/capita/day)	0.01	0.00	0.63	1.00
Contribution to food weight in food supplies (g/capita/day)	1.45	96.50	0.36	1.00
Number of public pageviews on Wikipedia over one year	94,341			

Identity and composition of *ex situ* collections

Based on the latest data in global genetic resource databases, germplasm collections of beets and their wild relatives (i.e., genus *Beta* L.) are present in at least 103 institutions worldwide, collectively maintaining 13,149 accessions (Table 2, Table 3; Supplementary Table 1). This is slightly more than the number of accessions reported for the crop (12,319) in the major germplasm collections listed in *The Third Report on the State of the World's Plant Genetic Resources for Food and Agriculture* (FAO, 2025b).

The institutions are mainly distributed in Europe as well as in the USA and in Japan, with the largest collections in the USA (over 20% of total accessions worldwide) and Germany (17.9%), as well as Japan, Poland,

Greece, Hungary, Belarus, Ukraine, Bulgaria, Portugal, and Czechia; these collectively maintain over three-quarters of documented accessions worldwide. Reported information on the status of accessions under the Multilateral System of Access and Benefit Sharing (MLS) of the International Treaty on Plant Genetic Resources for Food and Agriculture (Plant Treaty), as recorded in the Global Information System (GLIS) and in pertinent fields in Genesys and FAO WIEWS (Table 2; Table 4), may underestimate the full degree to which accessions are currently included in the MLS, as several of the beets collections without information on MLS status are in countries that are contracting parties to the Plant Treaty (such as USA, Japan, Poland, Greece, and Hungary, among others) and distribute samples of *Beta* genetic resources using the Standard Material Transfer Agreement (SMTA).

The International Board for Plant Genetic Resources (IBPGR)/International Plant Genetic Resources Institute (IPGRI) Register of Base Collections, which included collections that had formed (or had been proposed for) agreements with the international institutions based on long-term conservation of crop genepools on global or regional bases during the 1970s through 1990s (IBPGR/IPGRI, 1993; Thormann *et al*., 2019), listed, for *Beta* crops:

- Federal Agricultural Research Centre (FAL) Institute of Crop Science and Plant Breeding (Germany) – global collection (agreement dated 1977). This genebank no longer exists, and collections were transferred to DEU146.
- Greek Gene Bank (Greece) – regional collection for South Europe and the Mediterranean (agreement dated 1984)
- Nordic Genetic Resources Centre (NordGen) – global collection (agreement dated 1981)
- Warwick Genetic Resources Unit (UK) – global collection (agreement dated 1981)

Based on the number of current accessions (Table 2), it appears that all of these recognized collections continue to maintain diverse Beta germplasm.

Beta L. (Amaranthaceae) contains around eight species, native to Europe, the Mediterranean including North Africa, and West and South Asia (USDA, 2025; WFO, 2025). A published genepool concept is available for cultivated beet (*Beta vulgaris* L. subsp. *vulgaris*) (USDA, 2025).

The primary genepool contains:
Beta macrocarpa Guss.
Beta patula Aiton
Beta vulgaris L. subsp. *adanensis* (Pamukç. ex Aellen) Ford-Lloyd & J. T. Williams
Beta vulgaris L. subsp. *maritima* (L.) Arcang.

The secondary genepool contains:
Beta ×*intermedia* Bunge
Beta corolliflora Zosimovic ex Buttler
Beta lomatogona Fisch. & C. A. Mey.
Beta macrorhiza Steven
Beta nana Boiss. & Heldr.
Beta trigyna Waldst. & Kit.

Several species in related genera have been assigned to the tertiary genepool. These include:
Aphanisma blitoides Nutt. ex Moq.
Hablitzia tamnoides M. Bieb.
Oreobliton thesioides Durieu & Moq.
Patellifolia patellaris (Moq.) A. J. Scott et al.
Patellifolia procumbens (C. Sm.) A. J. Scott et al.
Patellifolia webbiana (Moq.) A. J. Scott

Data compilation for this report on beets genetic resources included all taxa in *Beta*; the related genera *Patellifolia* A. J. Scott et al., *Aphanisma* Nutt. ex Moq., *Hablitzia* M. Bieb., and *Oreobliton* Durieu are not covered. Along with the crop, around nine species as well as hybrids and accessions only recognized to the genus level are present in germplasm collections (Supplementary Table 2). These include

The global genetic resources databases do not offer insights on diversity gaps, but published research has indicated specific priority species and geographic regions for further collecting for conservation. In a global *ex situ* conservation gap analysis of the wild relatives of major crops, Castañeda-Álvarez *et al.* (2016), assessing 14 sugar beet wild relatives, listed 12 taxa (85.7%) as of high priority for further collecting.

Table 2. Major *ex situ* collections of beet genetic resources. Top 20 institutions listed in descending order by total number of accessions. Number of accessions and storage condition information from Genesys and FAO WIEWS (2025), with supplementary information as noted. Multilateral System (MLS) status from Plant Treaty GLIS (2025) and from Genesys and FAO WIEWS (2025).

Institution Code	Institution name	Number of accessions	Percent of total	Cumulative percent	Number of accessions in long term storage (-18-20 C)	Number of accessions included in MLS (from Plant Treaty GLIS)	Number of accessions included in MLS (from genebank collections databases)
USA022	Western Regional Plant Introduction Station, USDA-ARS, Washington State University	2,694	20.5%	20.5%	Not listed*	0	0
DEU146	Genebank, Leibniz Institute of Plant Genetics and Crop Plant Research	2,359	17.9%	38.4%	2,265	2,353	2,359
JPN183	NARO Genebank	939	7.1%	45.6%	41	0	0
POL003	Plant Breeding and Acclimatization Institute	784	6.0%	51.5%	782	0	691
GRC005	Greek Genebank, Institute of Plant Breeding and Genetic Resources	740	5.6%	57.2%	Not listed	0	0
HUN003	Centre for Plant Diversity	448	3.4%	60.6%	112	0	25
BLR011	Republican Unitary Enterprise 'Research and Practical Centre of the National Academy of Sciences of Belarus for Arable Farming'	371	2.8%	63.4%	327	0	0
UKR014	Institute of Sugarbeet	357	2.7%	66.1%	18	0	0
USA974	Seed Savers Exchange	292	2.2%	68.3%	Not listed	0	0
BGR001	Institute for Plant Genetic Resources 'K.Malkov'	282	2.1%	70.5%	6	0	0
UKR063	Branch of the Institute of Sugarbeet	259	2.0%	72.4%	226	0	0
PRT102	Banco de Germoplasma - Universidade da Madeira	217	1.6%	74.1%	Not listed	0	217
CZE122	Gene bank	212	1.6%	75.7%	211	26	212
GBR165	Science and Advice for Scottish Agriculture, Scottish Government	201	1.5%	77.2%	201	0	0

Institution Code	Institution name	Number of accessions	Percent of total	Cumulative percent	Number of accessions in long term storage (-18-20 C)	Number of accessions included in MLS (from Plant Treaty GLIS)	Number of accessions included in MLS (from genebank collections databases)
ESP027	Gobierno de Aragón. Centro de Investigación y Tecnología Agroalimentaria. Banco de Germoplasma de Hortícolas	193	1.5%	78.7%	180	0	11
SWE054	Nordic Genetic Resource Center	174	1.3%	80.0%	174	169	174
BLR018	Republican Unitary Enterprise 'Research station of sugar beet of the National Academy of Sciences of Belarus'	152	1.2%	81.2%	53	0	0
MNG030	Institute of Plant and Agricultural Science	141	1.1%	82.2%	Not listed	0	0
UZB006	Uzbek Research Institute of Plant Industry	127	1.0%	83.2%	Not listed	0	0
UKR008	Ustymivka Experimental Station of Plant Production	123	0.9%	84.2%	10	0	0
	Other institutions (n = 83)	2,084	15.9%	100.0%	879	160	997

* but known to conserve accessions in long-term storage conditions

Table 3. Composition of *ex situ* collections of beet genetic resources. Main *ex situ* collections data from Genesys and FAO WIEWS (2025). Primary and secondary regions information from Khoury *et al*. (2023) and subsequent research for this summary. Botanic gardens data from BGCI PlantSearch (2025).

Metric	Number	Percentage
Total number of accessions in genebank collections	13,149	
Number of institutions holding genebank collections	103	
Number of distinct taxonomic names in genebank collections	16	
Number of accessions of crop wild relatives (CWR) in genebank collections	2,845	21.6%
Number of accessions of weedy materials in genebank collections	228	1.7%
Number of accessions of landraces in genebank collections	1,780	13.5%
Number of accessions of breeding materials in genebank collections	3,084	23.4%
Number of accessions of improved varieties in genebank collections	2,966	22.6%
Number of accessions of other materials in genebank collections	1,139	8.7%
Number of accessions not marked with an improvement type in genebank collections	1,107	8.4%
Number of countries where germplasm has been collected for genebank collections	76	
Number of accessions in genebank collections from the primary region(s) of diversity	4,743	36.1%
Number of taxa in botanic garden collections	9	
Number of botanic gardens holding collections of crop or its wild relatives	110	

large collections of the crop and wild relatives in the primary and secondary genepools, as well as accessions only determined to the genus level.

Breeding materials make up the largest proportion of collections (23.4%), followed by improved varieties (22.6%), wild relatives (21.6%), and landraces (13.5%) (Table 3); these percentages are estimates based on available data, noting that 8.4% of accessions do not have biological status data and another 8.7% are marked as "other" materials. *Beta* germplasm has been collected from at least 76 countries, with approximately 36.1% of accessions originating from the primary region of diversity of the crops (i.e. Europe and the Mediterranean); these statistics are also estimates, as 2.3% of *Beta* landrace accessions and 5.3% of wild relative accessions do not contain information even of the country where the accession was collected. Information on botanic garden collections from BGCI PlantSearch indicate that 110 botanic gardens collectively conserve nine *Beta* taxa. All of these taxa are also conserved in genebank collections.

The global genetic resources databases do not offer insights on diversity gaps, but published research has indicated specific priority species and geographic regions for further collecting for conservation. In a global *ex situ* conservation gap analysis of the wild relatives of major crops, Castañeda-Álvarez *et al.* (2016), assessing 14 sugar beet wild relatives, listed 12 taxa (85.7%) as of high priority for further collecting.

Multilateral System status of accessions in *ex situ* collections

The genus *Beta* is listed in Annex I of the International Treaty on Plant Genetic Resources for Food and Agriculture (Plant Treaty) and is thus included in its Multilateral System of Access and Benefit Sharing (MLS). Of the 13,149 accessions conserved globally, approximately 1.1% are held in international institutions (including at the World Vegetable Center), and are included in the MLS of the Plant Treaty, with the remainder maintained in national and other collections (Table 4).

As of 2025, 2,708 accessions are formally included in the MLS according to the Plant Treaty's GLIS database, and 3,037 accessions have been assigned Digital Object Identifiers (DOIs). Per the relevant fields in the global genetic resources databases, 4,686 accessions (35.6% of world total) are listed as included in the MLS; this is likely an underestimate, noting that 57.8% of accessions do not have MLS status data. The discrepancies between the GLIS data and the global genetic resources data indicates that several institutions have not registered or recently updated their registrations in the GLIS portal.

Table 4. Representation of beet accessions in international and national institutions, number of accessions with DOIs, and representation of accessions in the Multilateral System of Access and Benefit Sharing of the International Treaty on Plant Genetic Resources for Food and Agriculture. Main *ex situ* collections data from Genesys and FAO WIEWS (2025). DOI and MLS data from Plant Treaty GLIS (2025).

Metric	Number	Percentage
Number of accessions in genebank collections in international institutions	154	1.2%
Number of accessions in genebank collections in national or other institutions	12,995	98.8%
Number of accessions in genebank collections in Annex I	13,149	100%
Number of accessions with DOI (Plant Treaty GLIS 2025)	3,037	
Number of accessions included in the Multilateral System (MLS) (Plant Treaty GLIS 2025)	2,708	
Number of accessions included in the Multilateral System (MLS) (genebank collections databases)	4,686	35.6%
Number of accessions included in the Multilateral System (MLS) that are in international collections (genebank collections databases)	143	1.1%
Number of accessions not included in the Multilateral System (MLS) (genebank collections databases)	857	6.5%
Number of accessions without information regarding inclusion in the Multilateral System (MLS) (genebank collections databases)	7,606	57.8%

Storage conditions, regeneration status, and safety duplication

As expected for an orthodox seed crop, the great majority (at least 87.9%) of *Beta* accessions are conserved as seed, with 47.5% of these accessions listed as conserved under long-term cold-storage conditions (Table 5). Information on storage in general is missing for 11% of all accessions, and information on seed storage type (i.e., long, medium, or short term) is missing for 28% of seed accessions.

Current regeneration status and needs cannot be directly derived from the global germplasm databases. FAO WIEWS reporting for the *Third State of the World's Plant Genetic Resources for Food and Agriculture* (FAO, 2025b) for the years 2014 to 2019, documented 457 Beta accessions regenerated during this time by reporting institutions, with 383 accessions identified as needing regeneration and 324 of these lacking funds to conduct the regeneration.

Analysis of the location of safety duplication sites of *Beta* germplasm, as listed in Genesys, indicates that 3.5% are safety duplicated in an active collection (i.e., apart from potentially being duplicated at the Svalbard Global Seed Vault [SGSV]) outside of the country of the main collection (Table 5). The actual extent of safety duplication of *Beta* accessions worldwide, when also considering safety duplication within the same country, may be higher than this estimate, given that some national genebanks, such as the USA, typically provide safety backup of their collections in a different location within the country. Information from the SGSV database from 2025 indicates that approximately 17% of total accessions worldwide are duplicated in Svalbard.

Table 5. Storage conditions of beet *ex situ* collections, regeneration status, and safety duplication status. Main *ex situ* collections data from Genesys and FAO WIEWS (2025). Regeneration status information from FAO WIEWS (2025); data from 2014 to 2019. Safety duplication out of the country data based only on Genesys (2025) data. Svalbard Global Seed Vault data from SGSV portal (2025).

Metric	Number	Percentage
Number of accessions held in seed storage in genebank collections	11,556	87.9%
Number of accessions held in short-term seed storage in genebank collections	185	1.6%
Number of accessions held in medium-term seed storage in genebank collections	2,648	22.9%
Number of accessions held in long-term seed storage in genebank collections	5,485	47.5%
Number of accessions held in seed storage of undefined type in genebank collections	3,238	28.0%
Number of accessions held in field storage in genebank collections	354	2.7%
Number of accessions held in *in vitro* storage in genebank collections	0	0.0%
Number of accessions held in cryo storage in genebank collections	23	0.2%
Number of accessions held as DNA in genebank collections	3	0.0%
Number of accessions held in other storage in genebank collections	0	0.0%
Number of accessions not marked with a storage type in genebank collections	1,442	11.0%
Number of accessions in genebank collections regenerated 2014–2019	457	25.8%
Number of accessions in genebank collections in need of regeneration 2014–2019	3,832	21.6%
Number of accessions in genebank collections in need of regeneration without budget for regeneration 2014–2019	324	18.3%
Number of accessions safety duplicated out of the country in genebank collections	374	3.5%
Number of accessions in genebank collections safety duplicated in Svalbard	2,231	17.0%

Documentation, information systems, and research resources

A descriptor list for beet was published by the international agricultural research community in 1994 and is available online (IPGRI, 1994). The World Vegetable Center published a descriptor list in 2015 (WorldVeg, 2015).

The estimated completeness of passport information for *Beta* accessions listed in Genesys is 6.1 on a scale of 0 (no data) to 10 (complete data), which indicates that a sizable amount of data is available, but also that there are gaps that it would be valuable to fill. Four metrics of the current degree of digital sequence information (DSI) for beets (from the National Center for Biotechnology Information USA database), two metrics of published literature on the crop (Google Scholar and PubMed Central), and one metric of the degree of research resources such as herbarium specimens (from the Global Biodiversity Information Facility - GBIF), are listed in Table 6. Beets, along with tomatoes, onions and garlic, and lettuce, stand out compared to many other vegetables in terms of the degree of DSI resources, published literature, and research resources in GBIF (Khoury *et al.*, 2023).

Table 6. Documentation, information systems, and research resources for beets. Passport data completeness index (PDCI) from Genesys (2025), based on the methods outlined in van Hintum *et al*. (2011). Global Biodiversity Information Facility data from GBIF (2025). All other metrics data from Khoury *et al*. (2023).

Metric	Number
Passport data completeness index (range 0-10) as a median value across accessions in genebank collections	6.1
Number of genes as recorded in NCBI's Entrez database as of 2022	51,336
Number of genomes as recorded in NCBI's Entrez database as of 2022	1
Number of nucleotides as recorded in NCBI's Entrez database as of 2022	737,542
Number of proteins as recorded in NCBI's Entrez database as of 2022	185,142
Number of publications listed in Google Scholar with taxon name in title published between 2009 and 2019	2,380
Number of publications listed in PubMed Central with taxon name in text as of 2022	40,003
Number of research materials as recorded in GBIF (2025)	708,249

Germplasm distributions and varietal registrations and releases

Germplasm distributions and varietal development statistics for beets are listed in Table 7. Germplasm distribution data from FAO WIEWS and the Plant Treaty Data Store reflect different reporting scopes: FAO WIEWS primarily reports distributions from national genebanks, while the Plant Treaty Data Store includes all transfers made under the SMTA, encompassing distributions made by genebanks as well as by breeding programs and other organizational types (Khoury *et al.*, 2025). Distributions as reported in the FAO WIEWS dataset were made from institutions in 14 countries, with the largest numbers of samples distributed from institutions in Germany, China, Sweden, Italy, and Spain, and were primarily to stakeholders in other countries and to within-country national agricultural research centers (Khoury *et al.*, 2025). In the Plant Treaty dataset, the providers of the most samples were located in Germany, Sweden, Switzerland, Czechia, and China, and the recipients of the most samples were located in Germany, Japan, Tunisia, Denmark, China, Iran, the Netherlands, and the Russian Federation.

Information on varietal registrations and releases indicate that beets are among the vegetable crops with the largest numbers of varieties in development, although it is not feasible to distinguish between vegetable and sugar beet varieties in the data (Khoury *et al.*, 2023).

Table 7. Beet germplasm distributions and varietal registrations and releases. FAO WIEWS distributions data is annual average over years 2014 to 2019. Plant Treaty Data Store distributions data is annual average over years 2015 to 2021. Evenness metric quantifies evenness of germplasm distributions across world regions, where 0 equals highly uneven and 1 equals completely even. International Union for the Protection of New Varieties of Plants (UPOV) PLUTO data is annual average over years 2014 to 2019. FAO WIEWS varietal releases data is annual average over years 2015 to 2019. All metrics data from Khoury *et al*. (2023), with Plant Treaty Data Store additions for more recent years (2019 to 2021).

Metric	Number
Average annual number of accessions distributed worldwide as recorded in FAO WIEWS	754.5
Average annual number of samples distributed worldwide as recorded in FAO WIEWS	1,238.4
Average annual number of samples distributed worldwide as recorded in the Plant Treaty Data Store	1,075.0
Number of countries receiving germplasm as recorded in the Plant Treaty Data Store	11.3
Evenness of distributions across world regions as recorded in the Plant Treaty Data Store	0.9
Average annual number of varietal registrations worldwide as recorded in UPOV's PLUTO	957.0
Average annual number of varietal releases worldwide as recorded in FAO WIEWS	96.2

Networks and partnerships

- The International Beta Genetic Resources Network was active in the 1990s and does not appear to be active at this time.
- Currently active networks include:
  - The European Cooperative Programme for Plant Genetic Resources (ECPGR) Beta Working Group
  - The USDA ARS Sugarbeet Crop Germplasm Committee (also here)

Conclusions

Beets are important sugar and vegetable crops in several world regions. Their genetic resources are bolstered by the activities taking place in collections in several national and subnational agricultural research organizations, particularly in the USA, Germany, Japan, Poland, Greece, and a few other countries; there are no major international collections for the crop. Available data indicates that these collections, in combination, are diverse and extensive, although they do not represent the full range of crop varieties as well as species and populations of wild relatives that could be conserved *ex situ* and made available for use. The genus is included in the MLS of the Plant Treaty, although further efforts are needed to include all accessions in the MLS (approximately 35.6% are currently included). There are considerable amounts of associated research resources, and there has been significant activity in germplasm distributions and varietal development for the crops. Further efforts are required to: identify/determine taxa within current *ex situ* accessions; regenerate accessions in need; fully secure these accessions in long-term seed storage conditions and, especially, safety backup all unique accessions, including at the SGSV; and to provide more complete accession-level passport information as well as generate further characterization and evaluation datasets.

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Methods and materials

Primary data sources for the metrics reported in this summary include: Genesys; World Information and Early Warning System on Plant Genetic Resources for Food and Agriculture of the Food and Agriculture Organization of the United Nations (FAO WIEWS); Botanic Gardens Conservation International PlantSearch database (BGCI PlantSearch); Global Information System of the International Treaty on Plant Genetic Resources for Food and Agriculture (Plant Treaty GLIS); Data Store of the International Treaty on Plant Genetic Resources for Food and Agriculture (Plant Treaty Data Store); Svalbard Global Seed Vault portal (SGSV portal); International Union for the Protection of New Varieties of Plants (UPOV) PLUTO database; FAOSTAT; National Center for Biotechnology Information's Entrez database (NCBI Entrez); Google Scholar; PubMed Central; Wikipedia; and the Global Biodiversity Information Facility (GBIF). Some of these data were acquired from literature/databases including Khoury et al. (2023) and Khoury et al. (2025). Data processing, metric calculation, and table generation were conducted in R, with code available on this GitLab repository. Extended methods are available here.

Acknowledgements

The development of this document was funded by the German Federal Ministry of Agriculture, Food and Regional Identity (BMLEH) as part of the project *Mainstreaming Global Crop Conservation Strategies in Plant Treaty Processes* led by the Crop Trust. The Crop Trust cooperated with the Secretariat of the the International Treaty on Plant Genetic Resources for Food and Agriculture in the development of this document.

References

Castañeda-Álvarez NP, Khoury CK, Achicanoy HA, Bernau V, Dempewolf H, Eastwood RJ, Guarino L, Harker RH, Jarvis A, Maxted N, Mueller JV, Ramírez-Villegas J, Sosa CC, Struik PC, Vincent H, and Toll J (2016) Global conservation priorities for crop wild relatives. *Nature Plants* 2(4): 16022. https://doi.org/10.1038/nplants.2016.22

Chen L, Zhu Y, Hu Z, Wu S, and Jin C (2021) Beetroot as a functional food with huge health benefits: Antioxidant, antitumor, physical function, and chronic metabolomics activity. *Food Science & Nutrition* 9(11): 6406–6420. https://doi.org/10.1002/fsn3.2577

Dohm JC, Minoche AE, Holtgräwe D, Capella-Gutiérrez S, Zakrzewski F, Tafer H, *et al.* (2014) The genome of the recently domesticated crop plant sugar beet (*Beta vulgaris*). *Nature* 505(7484): 546–549. https://doi.org/10.1038/nature12817

FAO (2009) *The International Treaty on Plant Genetic Resources for Food and Agriculture*. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy. https://openknowledge.fao.org/server/api/core/bitstreams/a9d0de2a-8e98-4f75-98a8-673078841030/content

FAO (2025a) FAOSTAT. https://www.fao.org/faostat/en/#data (accessed September 2025)

FAO (2025b) *The Third Report on The State of the World's Plant Genetic Resources for Food and Agriculture*. FAO: Rome. https://doi.org/10.4060/cd4711en

Felkel S, Dohm JC, and Himmelbauer H (2023) Genomic variation in the genus *Beta* based on 656 sequenced beet genomes. *Sci Rep*. 13(1): 8654. https://doi.org/10.1038/s41598-023-35691-7

Goldman IL and Janick J (2021) Evolution of Root Morphology in Table Beet: Historical and Iconographic. *Front Plant Sci*. 12: 689926. https://doi.org/10.3389/fpls.2021.689926

International Plant Genetic Resources Institute (IPGRI) (1994) Descriptors for Beta (*Beta* spp.). International Plant Genetic Resources Institute 46 pp. https://hdl.handle.net/10568/72819

Khoury CK, Sotelo S, Amariles D, and Hawtin G (2023) *The Plants That Feed the World: baseline data and metrics to inform strategies for the conservation and use of plant genetic resources for food and agriculture*. International Treaty on Plant Genetic Resources for Food and Agriculture Rome: Food and Agricultural Organization of the United Nations. doi: 10.4060/cc6876en. https://www.fao.org/documents/card/en/c/cc6876en

Khoury CK, Sotelo S, Hawtin G, Halewood M, Lopez Noriega I, and Lusty C (2025) Germplasm exchange: Thematic Study for *The Third Report on the State of the World's Plant Genetic Resources for Food and Agriculture*. Rome: Food and Agricultural Organization of the United Nations. doi: 10.4060/cd4850en. https://doi.org/10.4060/cd4850en

USDA (2025) Global Global Taxonomy. https://npgsweb.ars-grin.gov/gringlobal/taxon/taxonomysearch (accessed September 2025)

Van Hintum T, Menting F, and Van Strien E (2011) Quality indicators for passport data in *ex situ* genebanks. *Plant Genetic Resources* 9(3): 478–485. https://doi.org/10.1017/S1479262111000682

World Flora Online (WFO) (2025) *Beta* L. https://www.worldfloraonline.org/taxon/wfo-4000004539 (accessed October 2025)

World Vegetable Center (WorldVeg) (2015) World Vegetable Center Genebank morphological descriptors. https://worldveg.tind.io/record/75880/?v=pdf (accessed November 2025)

Supplementary Information

Supplementary Table 1: Full list of *ex situ* collections of beet genetic resources, in descending order by total number of accessions. Number of accessions and storage condition information from Genesys and FAO WIEWS (2025), with supplementary information as noted. Multilateral System (MLS) status from Plant Treaty GLIS (2025) and from Genesys and FAO WIEWS (2025).

Institution Code	Institution name	Number of accessions	Percent of total	Cumulative percent	Number of accessions in long term storage (-18-20°C)	Number of accessions included in MLS (from Plant Treaty GLIS)	Number of accessions included in MLS (from genebank collections databases)
USA022	Western Regional Plant Introduction Station, USDA-ARS, Washington State University	2,694	20.5%	20.5%	Not listed	0	0
DEU146	Genebank, Leibniz Institute of Plant Genetics and Crop Plant Research	2,359	17.9%	38.4%	2,265	2,353	2,359
JPN183	NARO Genebank	939	7.1%	45.6%	41	0	0
POL003	Plant Breeding and Acclimatization Institute	784	6.0%	51.5%	782	0	691
GRC005	Greek Genebank, Institute of Plant Breeding and Genetic Resources	740	5.6%	57.2%	Not listed	0	0
HUN003	Centre for Plant Diversity	448	3.4%	60.6%	112	0	25
BLR011	Republican Unitary Enterprise 'Research and Practical Centre of the National Academy of Sciences of Belarus for Arable Farming'	371	2.8%	63.4%	327	0	0
UKR014	Institute of Sugarbeet	357	2.7%	66.1%	18	0	0
USA974	Seed Savers Exchange	292	2.2%	68.3%	Not listed	0	0
BGR001	Institute for Plant Genetic Resources 'K.Malkov'	282	2.1%	70.5%	6	0	0
UKR063	Branch of the Institute of Sugarbeet	259	2.0%	72.4%	226	0	0
PRT102	Banco de Germoplasma - Universidade da Madeira	217	1.6%	74.1%	Not listed	0	217
CZE122	Gene bank	212	1.6%	75.7%	211	26	212
GBR165	Science and Advice for Scottish Agriculture, Scottish Government	201	1.5%	77.2%	201	0	0
ESP027	Gobierno de Aragón. Centro de Investigación y Tecnología Agroalimentaria. Banco de Germoplasma de Hortícolas	193	1.5%	78.7%	180	0	11
SWE054	Nordic Genetic Resource Center	174	1.3%	80.0%	174	169	174

Institution Code	Institution name	Number of accessions	Percent of total	Cumulative percent	Number of accessions in long term storage (-18-20°C)	Number of accessions included in MLS (from Plant Treaty GLIS)	Number of accessions included in MLS (from genebank collections databases)
BLR018	Republican Unitary Enterprise 'Research station of sugar beet of the National Academy of Sciences of Belarus'	152	1.2%	81.2%	53	0	0
MNG030	Institute of Plant and Agricultural Science	141	1.1%	82.2%	Not listed	0	0
UZB006	Uzbek Research Institute of Plant Industry	127	1.0%	83.2%	Not listed	0	0
UKR008	Ustymivka Experimental Station of Plant Production	123	0.9%	84.2%	10	0	0
GBR006	Warwick Genetic Resources Unit	122	0.9%	85.1%	Not listed	0	122
UKR021	Institute of Vegetable and Melon Growing	122	0.9%	86.0%	74	0	0
TUR001	Plant Genetic Resources Department	120	0.9%	86.9%	120	0	0
AZE015	Genetic Resources Institute	115	0.9%	87.8%	1	0	0
SVK001	National Agricultural and Food Centre (NPPC), Research Institute of Plant Production (RIPP)	115	0.9%	88.7%	Not listed	0	115
ARE003	International Center for Biosaline Agriculture	108	0.8%	89.5%	Not listed	94	108
LVA009	Latvian State Forest Research Institute 'Silava'	107	0.8%	90.3%	107	0	107
BEL004	Government Plant Breeding Station	104	0.8%	91.1%	Not listed	0	104
ESP026	Generalidad Valenciana. Universidad Politécnica de Valencia. Escuela Técnica Superior de Ingenieros Agrónomos. Banco de Germoplasma	96	0.7%	91.8%	88	0	4
GBR004	Millennium Seed Bank - Royal Botanic Gardens Kew	92	0.7%	92.5%		0	0
CHE001	Agroscope Changins	83	0.6%	93.2%	75	0	83
PRT001	Banco Português de Germoplasma Vegetal	79	0.6%	93.8%	71	0	0
MAR088	Centre Régional de la Recherche Agronomique de Settat	77	0.6%	94.3%	4	0	77
ROM007	Suceava Genebank	64	0.5%	94.8%	Not listed	4	4
IND001	National Bureau of Plant Genetic Resources	51	0.4%	95.2%	51	0	0
ARM059	Agrobiotechnology Scientific Center	47	0.4%	95.6%	29	0	20

Institution Code	Institution name	Number of accessions	Percent of total	Cumulative percent	Number of accessions in long term storage (-18-20°C)	Number of accessions included in MLS (from Plant Treaty GLIS)	Number of accessions included in MLS (from genebank collections databases)
CYP004	National (CYPARI) Genebank, Agricultural Research Institute, Ministry of Agriculture, Rural Development and Environment	44	0.3%	95.9%	5	0	43
ISR002	Israel Gene Bank for Agricultural Crops, Agricultural Research Organisation, Volcani Center	40	0.3%	96.2%	17	0	0
NLD037	Centre for Genetic Resources, the Netherlands	38	0.3%	96.5%	38	0	0
BEL094	ILVO - Instituut voor Landbouw- en Visserijonderzoek (Institute for Agricultural and Fisheries Research)	36	0.3%	96.8%	Not listed	0	36
TWN001	World Vegetable Center	34	0.3%	97.0%	32	23	25
ALB026	Plant Genetic Resources Center	30	0.2%	97.3%	30	0	28
ARG1350	Banco Activo de Germoplasma de La Consulta	28	0.2%	97.5%	Not listed	0	0
CHL028	Banco Base de Semillas INIA Intihuasi	25	0.2%	97.7%	25	0	0
ITA396	CREA-Centro di Ricerca Cerealicoltura e Colture Industriali - Sede di Rovigo	23	0.2%	97.8%	Not listed	15	15
UKR007	Institute of Agriculture & Cattle-breeding of the Western Region	20	0.1%	98.0%	Not listed	0	0
SDN002	Agricultural Plant Genetic Resources Conservation and Research Centre	17	0.1%	98.1%	17	0	17
ARM005	Institute of Botany	15	0.1%	98.2%	Not listed	0	12
LTU001	Lithuanian Institute of Agriculture	15	0.1%	98.3%	15	0	15
KEN212	Genetic Resources Research Institute	14	0.1%	98.5%	Not listed	0	0
TUN029	Banque Nationale de Gènes de Tunisie	14	0.1%	98.6%	14	0	2
SAU015	Plant Genetic Resources Bank	13	0.1%	98.7%	Not listed	0	13
ETH013	International Livestock Research Institute	10	0.1%	98.7%	Not listed	10	10
GBR017	Henry Doubleday Research Association	10	0.1%	98.8%	Not listed	0	0
ROM055	Research and Development Station for Vegetables - Bacau	10	0.1%	98.9%	Not listed	0	0

Institution Code	Institution name	Number of accessions	Percent of total	Cumulative percent	Number of accessions in long term storage (-18-20°C)	Number of accessions included in MLS (from Plant Treaty GLIS)	Number of accessions included in MLS (from genebank collections databases)
KGZ040	Bank-Laboratory of Plant Genetic Resources of the KR	9	0.1%	99.0%	9	0	0
CAN004	Plant Gene Resources of Canada, Saskatoon Research and Development Centre	8	0.1%	99.0%	8	0	8
USA995	National Center for Genetic Resources Preservation	8	0.1%	99.1%	Not listed	0	0
MLT003	Plant Protection Directorate, Veterinary and Phytosanitary Regulation Department	7	0.0%	99.1%	Not listed	0	0
AUS167	Australian Pastures Genebank	6	0.0%	99.2%	6	6	6
ESP004	Centro Nacional de Recursos Fitogenéticos	6	0.0%	99.2%	6	0	0
LKA036	Plant Genetic Resources Centre	6	0.0%	99.3%	Not listed	0	0
AUT047	HBLFA Gartenbau Schönbrunn	5	0.0%	99.3%	5	0	5
BRA003	Embrapa Recursos Genéticos e Biotecnologia	5	0.0%	99.3%	Not listed	0	0
JOR105	National Agricultural Research Center	5	0.0%	99.4%	Not listed	5	0
PAK001	Plant Genetic Resources Program	5	0.0%	99.4%	Not listed	0	3
SVN019	Crops and Seed Production Department, Agricultural Institute of Slovenia	5	0.0%	99.5%	Not listed	0	0
CHL177	Banco Activo INIA La Platina	4	0.0%	99.5%	Not listed	0	0
ITA368	Banca del germoplasma autoctono vegetale regionale	4	0.0%	99.5%	4	0	0
LBY006	National Bank for Plant Genetic Resources	4	0.0%	99.6%	Not listed	0	0
UKR054	Panfily Experimental Station	4	0.0%	99.6%	Not listed	0	0
GUY021	National Agricultural Research and Extension Institute	3	0.0%	99.6%	Not listed	0	0
HRV053	Center for Seed and Seedlings	3	0.0%	99.6%	3	0	1
ITA363	Dipartimento di Chimica, Biologia e Biotecnologie, Universitá degli Studi Perugia	3	0.0%	99.7%	3	0	0
LTU006	Lithuanian Institute of Horticulture	3	0.0%	99.7%	2	0	3
MKD001	Faculty of Agriculture, University Ss. Cyril and Methodius	3	0.0%	99.7%	Not listed	0	0

Institution Code	Institution name	Number of accessions	Percent of total	Cumulative percent	Number of accessions in long term storage (-18-20°C)	Number of accessions included in MLS (from Plant Treaty GLIS)	Number of accessions included in MLS (from genebank collections databases)
TJK027	National Center for Genetic Resources	3	0.0%	99.7%	3	0	3
ARG1408	Instituto de Investigación y Desarrollo Hortícola Semillero	2	0.0%	99.7%	Not listed	0	0
BEL002	Gembloux agro-biotech, Université de Liège, département des Sciences agronomiques, Phytotechnie tropicale et Horticulture	2	0.0%	99.7%	Not listed	0	2
BIH039	Institute of Genetic Resources, University of Banja Luka	2	0.0%	99.8%	2	0	0
CUB014	Instituto de Investigaciones Fundamentales en Agricultura Tropical	2	0.0%	99.8%	Not listed	0	0
GEO001	I.Lomouri Institute of Crop Science	2	0.0%	99.8%	Not listed	0	0
GRC100	CIHEAM Mediterranean Agronomic Institute of Chania	2	0.0%	99.8%	2	0	0
HRV041	Faculty of Agriculture, University of Zagreb	2	0.0%	99.8%	Not listed	0	0
LBN020	Lebanese Agricultural Research Institute	2	0.0%	99.8%	2	2	2
MDG048	Laboratoire des semences et ressources phytogénétiques, FOFIFA	2	0.0%	99.9%	Not listed	0	0
MEX263	SNICS, Depositario Nacional de Referencia de Semillas (DNRS)	2	0.0%	99.9%	Not listed	0	0
TUR034	Field Crop Central Research Institute	2	0.0%	99.9%	2	0	0
ARM058	Plant Genebank	1	0.0%	99.9%	1	0	0
AUT001	Austrian Agency for Health and Food Safety	1	0.0%	99.9%	1	0	1
AZE014	Azerbaijan State Agrarian University	1	0.0%	99.9%	Not listed	0	0
ECU023	Departamento Nacional de Recursos Fitogenéticos	1	0.0%	99.9%	1	0	1
ESP133	Región de Murcia. Instituto Murciano de Investigación y Desarrollo Agrario y Alimentario. Fruticultura	1	0.0%	99.9%	1	0	0
ESP149	Gobierno de Aragón. Centro de Investigación y Tecnología Agroalimentaria. Recursos Forestales	1	0.0%	99.9%	1	0	0
ESP172	Cabildo Insular de Tenerife. Centro de Conservación de la Biodiversidad Agrícola de Tenerife	1	0.0%	99.9%	Not listed	0	0

Institution Code	Institution name	Number of accessions	Percent of total	Cumulative percent	Number of accessions in long term storage (-18-20°C)	Number of accessions included in MLS (from Plant Treaty GLIS)	Number of accessions included in MLS (from genebank collections databases)
EST019	Estonian Crop Research Institute	1	0.0%	99.9%	1	0	1
GRC047	Vegetable Department, Institute of Plant Breeding and Genetic Resources	1	0.0%	100.0%	Not listed	0	0
GRC102	Hellenic Mediterranean University	1	0.0%	100.0%	Not listed	0	0
LBN002	International Centre for Agricultural Research in Dry Areas	1	0.0%	100.0%	Not listed	0	0
NZL001	Margot Forde Genebank, AgResearch Ltd	1	0.0%	100.0%	Not listed	0	0
QAT004	Biotechnology Center, Ministry of Environment	1	0.0%	100.0%	1	1	1
ZAF062	RSA National Plant Genetic Resources Centre	1	0.0%	100.0%	1	0	0
ZMB030	SADC Plant Genetic Resources Centre	1	0.0%	100.0%	1	0	0

Supplementary Table 2: Full list of taxonomic names in *ex situ* genetic resource collections, in descending order by number of accessions conserved. Germplasm data from Genesys and FAO WIEWS (2025).

Taxon	Number of accessions (from genebank collections databases)
Beta vulgaris L.	11,314
Beta L.	887
Beta patula Aiton	190
Beta macrocarpa Guss.	152
Beta lomatogona Fisch. & C. A. Mey.	120
Beta corolliflora Zosimovic ex Buttler	112
Beta intermedia Bunge ex Boiss.	88
Beta trigyna Waldst. & Kit.	79
Beta macrorhiza Steven	57
Beta nana Boiss. & Heldr.	57
Beta vulgaris subsp. *adanensis* (Pamukç.) Ford-Lloyd & J. T. Williams	42
Beta hybr.	29
Beta maritima x *vulgaris*	16
Beta rubra Delile	4
Beta vulgaris subsp. *maritima* x *vulgaris* subsp. *vulgaris*	1
Beta vulgaris var. *trojana* (Pamukç. ex Aellen) Ford-Lloyd & J. T. Williams	1

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