GLOBAL CROP CONSERVATION AND USE METRICS

RICE
(*Oryza* L.)

CROP TRUST

Cover photo: Michael Major for ICBA

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Global crop conservation and use metrics

RICE
(*Oryza* L.)

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 rice and its wild relatives, including key metrics on:

- 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; and
- varietal registrations and releases.

The report also includes global statistics on crop production, trade, and availability in food supplies, as well as information about crop networks and partnerships. It is meant to provide an update to some of the information presented in the Global Conservation Strategy for rice (Crop Trust, 2010), but is primarily based on publicly available datasets, rather than a new survey of genetic resource collections and expert consultations.

Introduction and background on rice

The main cultivated species of rice globally, *Oryza sativa* L., originated in Asia, with archaeological and genetic evidence suggesting domestication occurred in the Yangtze River valley of China over 8,000 years ago (Molina *et al.*, 2011). This staple grain has become the primary food source for more than half of the world's population, particularly in Asia, Africa, and Latin America, where it provides a significant portion of daily caloric intake. Rice is cultivated on every continent except Antarctica and thrives in diverse environments from flooded paddies to upland fields (Khush, 1997). Beyond its fundamental role in global food security, rice holds deep cultural significance in many Asian societies, featuring prominently in religious rituals, festivals, and traditional practices. The crop supports the livelihoods of hundreds of millions of smallholder farmers and contributes substantially to the agricultural economies of major producing nations. Rice also serves industrial purposes, its products ranging from rice bran oil and flour to biodegradable packaging materials and alcoholic beverages such as sake.

A separate species, African rice (*Oryza glaberrima* Steud), was independently domesticated approximately 3,000 years ago in West and Central Africa (Wang *et al.*, 2014; Choi *et al.*, 2019). This crop is well-adapted to challenging West African environmental conditions, demonstrating superior tolerance to drought, deep water, fluctuations in water depth, iron toxicity, infertile soils, and various diseases and pests. African rice remains important in West Africa, although its cultivation has declined in some regions following the introduction of *O. sativa*. It is also an important genetic resource for *O. sativa*, and crosses of the two main domesticated species, termed New Rice for Africa (NERICA) varieties, have combined productivity with resistance to various biotic and abiotic stresses (Britwum *et al.*, 2020).

Based on the most recently available production statistics from FAOSTAT, reporting for the year 2023, rice is cultivated in at least 116 countries on over 168 million hectares worldwide, producing 800 million tonnes of grain at a value of over USD 338 billion (FAO, 2025a). The largest producers include China, India, Bangladesh, Indonesia, Viet Nam, Thailand, Myanmar, Philippines, Pakistan, Cambodia, Brazil, and Japan, each producing over ten million tonnes per annum.

There is considerable international trade in rice (over 50 million tonnes per annum), with USA, Brazil, India, Uruguay, and the Russian Federation reporting exporting over 50,000 tonnes each year (FAO, 2025a). Among the 149 countries reporting importing rice, the top recipients include Mexico, Nepal, Venezuela, Vietnam, Costa Rica, Panama, Colombia, Honduras, Nicaragua, and Guatemala, all importing over 100,000 tonnes each year.

The global per capita dietary contribution of rice reported for the year 2022 – as measured in terms of both calories (516.3 kcal/capita/day) and protein (10.6 g/capita/day) – is among the most significant of all cereals (along with wheat and maize). Rice is a major contributor to calories in the food supplies of 172 countries and to protein in 169 countries (Table 1).

Table 1. Global status of rice 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 the 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)	163,298,364	78.75	0.18	0.14
Total production (tonnes)	746,511,992	82.25	0.16	0.10
Gross production value (current thousand USD)	314,539,556	74.25	0.13	0.07
Export quantity (tonnes)	205,196	3.25	0.17	0.68
Export value (current thousand USD)	318,818	4.00	0.13	0.29
Import quantity (tonnes)	291,901	1.75	0.21	0.77
Import value (current thousand USD)	287,437	1.75	0.20	0.60
Contribution to calories in food supplies (kcal/capita/day)	531.50	172.00	0.46	0.29
Contribution to protein in food supplies (g/capita/day)	9.96	169.50	0.45	0.31
Contribution to fat in food supplies (g/capita/day)	1.44	105.75	0.37	0.19
Contribution to food weight in food supplies (g/capita/day)	79.13	171.25	0.45	0.29
Number of public pageviews on Wikipedia over one year	178,674			

Identity and composition of *ex situ* collections

Based on the latest data in global genetic resource databases, germplasm collections of rice and its wild relatives (i.e., genus *Oryza* L.) are present in at least 121 institutions worldwide, collectively maintaining 519,391 accessions (Table 2, Table 3; Supplementary Table 1). This is considerably more than the number of accessions reported for the crop (500,818) 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 in Asia, but also include large collections in the Americas, Australia, and Africa. The International Rice Research Institute (IRRI) and the Africa Rice Center maintain international collections

for the crop; these, along with national collections in India, Japan, USA, Thailand, and Brazil, collectively maintain over 80% of documented accessions. 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), likely underestimate the full degree to which accessions are currently included in the MLS, as several of the rice collections without information on MLS status are in countries that are contracting parties to the Plant Treaty (such as USA, Brazil, and Myanmar) and distribute samples using the Standard Material Transfer Agreement (SMTA).

Based on a genebank stakeholder survey process, the 2010 Strategy identified over 500,000 rice and wild relative accessions maintained worldwide (Crop Trust, 20010). Several collections listed in the Strategy are not currently reported in global genetic resource databases, including the Institute of Crop Germplasm Resources (CAAS) China), the China National Rice Research Institute (CNRRI), the Rural Development Administration (RDA) genebank in the Republic of Korea, and the National Agriculture and Forestry Research Institute in Laos, among others. The Strategy considered IRRI, NIAS Japan (now named NARO), and USDA collections to have broad global coverage, while collections in China and India, as well as the smaller collections, were more national in scope. The largest collections of wild rice species were in the Chinese institutes, IRRI, the Indonesian Center for Rice Research (ICRR), the Biotechnology Research and Development Office (BRDO) in Thailand, NBPGR India, and NIAS Japan.

Table 2. Major *ex situ* collections of rice 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 (2024), with supplementary information as noted. Multilateral System (MLS) status from Plant Treaty GLIS (2025) and from Genesys and FAO WIEWS (2024).

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)
PHL001	International Rice Research Institute (IRRI)	132,777	25.6%	25.6%	124,118	127,243	127,876
IND001	National Bureau of Plant Genetic Resources (NBPGR)	112,593	21.7%	47.2%	112,593	1,513	0
JPN183	NARO Genebank (Japan)	39,996	7.7%	54.9%	11,266	15,711	15,712
USA970	Dale Bumpers National Rice Research Center, United States Department of Agriculture, Agricultural Research Services (USDA)	36,280	7.0%	61.9%	36,280	0	0
THA300	Genebank (Thailand)	24,852	4.8%	66.7%	24,579	0	0
BRA008	Embrapa Arroz e Feijão (Brazil)	23,009	4.4%	71.1%	Not listed	20,811	22,949
CIV033	Africa Rice Center	21,035	4.1%	75.2%	19,608	20,753	21,032

USA029	National Small Grains Collection, USDA-ARS	19,126	3.7%	78.9%	19,126	0	0
BRA003	Embrapa Recursos Genéticos e Biotecnologia (Brazil)	15,180	2.9%	81.8%	15,143	0	0
MYS220	Genebank and Seed Centre	12,099	2.3%	84.1%	12,099	0	9,838
BGD002	Bangladesh Rice Research Institute (BRRI)	8,705	1.7%	85.8%	8,638	107	8,578
MMR015	Myanmar SeedBank	7,591	1.5%	87.3%	Not listed	47	0
MDG036	Département de Recherches Rizicoles, FOFIFA	6,932	1.3%	88.6%	Not listed	0	6,930
LKA036	Plant Genetic Resources Centre	5,333	1.0%	89.6%	Not listed	3,281	0
RUS001	N.I. Vavilov All-Russian Research Institute of Plant Industry (VIR)	4,224	0.8%	90.4%	4,224	0	0
VNM049	Plant Resources Center	4,134	0.8%	91.2%	4,116	0	4,134
PHL158	Philippine Rice Research Institute	3,795	0.7%	92.0%	3,795	5,547	3,795
PAK001	Plant Genetic Resources Program	3,323	0.6%	92.6%	2,504	32	2,765
URY003	INIA La Estanzuela	2,827	0.5%	93.2%	2,827	458	0
CUB030	Instituto de Investigaciones de Granos	2,595	0.5%	93.7%	Not listed	0	0
	Other institutions (n = 101)	32,985	6.4%	100%	17,624	7,977	8,227

Oryza L. (Poaceae) is a small genus of around 24 species and a few infraspecific taxa (Crop Trust, 2010; USDA, 2025). The center of species diversity is the area encompassing the islands of Southeast Asia and of the adjacent Pacific region. *O. sativa* was domesticated in East, South, and/or Southeast Asia, reaching Madagascar (through India) and Europe (through Greece and Italy, and subsequently Spain) over 2,000 years ago, and subsequently was spread to other parts of Africa through Mozambique and to other countries of southern Europe, and more recently to the Americas and Australia (Crop Trust, 2010). Four major groups of sativa rice are recognized: Indica, Japonica, Aus-boro, and Basmati. *O. glaberrima* was domesticated from *O. barthii* A. Chev. in West Africa, and is cultivated in comparatively restricted regions of Africa (Crop Trust, 2010).

The species are grouped into several species complexes (Crop Trust, 2010), reflecting their current genepool assignments relative to the main cultivated species (USDA, 2025). This includes seven species in the *O. sativa* complex (AA genome) and primary genepool:
O. barthii
O. glaberrima
Oryza glumipatula Steud.
Oryza longistaminata A. Chev. & Roehr.
Oryza meridionalis Ng
Oryza nivara S. D. Sharma & Shastry (probable progenitor)
Oryza rufipogon Griff. (probable progenitor)

Eleven species in the *O. officinalis* complex (including five diploids with BB, CC and EE genomes, and six tetraploids with BBCC or CCDD genomes) are assigned to the secondary genepool:
Oryza alta Swallen
Oryza australiensis Domin
Oryza eichingeri Peter
Oryza grandiglumis (Döll) Prodoehl
Oryza latifolia Desv.

Table 3. Composition of *ex situ* collections of rice genetic resources. Main *ex situ* collections data from Genesys and FAO WIEWS (2024). Primary and secondary regions (for both Asian and African rice) information from Khoury *et al.* (2023) and subsequent research for this summary. Botanic gardens data from BGCI PlantSearch (2024).

Metric	Number	Percentage
Total number of accessions in genebank collections	519,391	
Number of institutions holding genebank collections	121	
Number of distinct taxonomic names in genebank collections	37	
Number of accessions of crop wild relatives (CWR) in genebank collections	10,096	1.9%
Number of accessions of weedy materials in genebank collections	1,008	0.2%
Number of accessions of landraces in genebank collections	159,790	30.8%
Number of accessions of breeding materials in genebank collections	129,963	25.0%
Number of accessions of improved varieties in genebank collections	28,267	5.4%
Number of accessions of other materials in genebank collections	31	0.01%
Number of accessions not marked with an improvement type in genebank collections	190,236	36.6%
Number of countries where germplasm has been collected for genebank collections	135	
Number of accessions in genebank collections from the primary region(s) of diversity	125,397	24.1%
Number of accessions in genebank collections from the primary and secondary region(s) of diversity	137,474	26.5%
Number of taxa in botanic garden collections	23	
Number of botanic gardens holding collections of crop or its wild relatives	85	

Oryza malampuzhaensis Krishnasw. & Chandrasekh.
Oryza minuta J. Presl
Oryza officinalis Wall. ex G. Watt
Oryza punctata Kotschy ex Steud.
Oryza rhizomatis D. A. Vaughan
Oryza schweinfurthiana Prodoehl

The remaining species are more distantly related to the cultivated species, with genomes FF, GG, HHJJ and HHKK. This tertiary genepool may also include species in the small related genera *Potamophila* R. Br. and *Zizania* L. (USDA, 2025):
Oryza brachyantha A. Chev. & Roehr.
Oryza coarctata Roxb.
Oryza longiglumis Jansen
Oryza meyeriana (Zoll. & Moritzi) Baill. and infraspecific taxa
Oryza neocaledonica Morat
Oryza ridleyi Hook. f.
Oryza schlechteri Pilg.
Potamophila parviflora R. Br.
Zizania latifolia (Griseb.) Turcz. ex Stapf
Zizania palustris L.

Data compilation for this report included all species in *Oryza*. Thirty seven taxonomic names are present in germplasm collections, including the cultivated species (and infraspecific types), wild relatives, nine hybrid variations, and accessions only recognized to the genus level (Supplementary Table 2). Along with the cultivated species, these include large collections of *O. nivara, O. rufipogon, O. barthii, O. officinalis, O. longistaminata,* and *O. punctata*, as well as sativa hybrids, all with over 250 accessions conserved worldwide. Landraces make up the largest proportion of collections (30.8%), followed by breeding materials (25%), improved varieties (5.4%), and wild relatives (1.9%) (Table 3); these percentages are estimates based on available data, noting that 36.6% of accessions do not have biological status data.

Oryza germplasm has been collected from at least 135 countries, with approximately 24.1% of accessions originating from the primary region of diversity of cultivated rice (including both Asian and African rice, thus East, South, and Southeast Asia, as well as Central and West Africa) and 26.5% from primary and secondary (i.e. East and Southern

Africa, and tropical South America) regions; these statistics are also estimates, as 18.2% of rice landrace accessions and 14.9% 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 85 botanic gardens collectively conserve 23 *Oryza* taxa; of these, one (*O. neocaledonica*) is conserved only in botanic gardens and not found in genebank collections.

The 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. Gaps for wild *Oryza* were noted in the 2010 Strategy, particularly for those species outside of South and East Asia (Crop Trust, 2010). In a global *ex situ* conservation gap analysis of the wild relatives of major crops, Castañeda-Álvarez *et al.* (2016), assessing 20 rice wild relatives, listed eight (*O. alta, O. glumipatula, O. grandiglumis, O. latifolia, O. malampuzhaensis, O. meridionalis, O. ridleyi,* and *O. schweinfurthiana*) as of high priority for further collecting, and seven (*O. australiensis, O. brachyantha, O. eichingeri, O. longistaminata, O. minuta, O. officinalis,* and *O. punctata*) as medium priority. Some progress has been made recently in filling these gaps, including via the Adapting Agriculture to Climate Change: Collecting, Protecting and Preparing Crop Wild Relatives project (Crop Trust, 2025), which with activities from 2011 to 2021, resulted in the collecting of 318 seed samples of around 16 rice wild relative taxa from 12 countries (including 20 samples of *O. alta*, 23 of *O. glumipatula*, 12 of *O. grandiglumis*, and 77 of *O. latifolia*, among others) as well as the development of new varieties with introgressions from wild germplasm (Eastwood *et al.*, 2022). This said, Lin *et al.* (2024) assessed 22 wild *Oryza* using a similar gap analysis methodology, and still determined 12 (54.5%) to be of high priority for further collecting and a further nine to be medium priority. Geographic hotspots requiring further collecting were determined to be concentrated in Southeast and South Asia, Northern Australia, West Africa, and in the American tropics.

Regarding landraces, the 2010 Strategy stated that gaps in passport data and the lack of availability of an integrated information system made full identification of landrace (and wild relative) gaps challenging. In the current global genetic resources databases, 18.2% of landrace accessions do not contain information even of the country where the accession was collected. Ramirez-Villegas *et al.* (2022) identified geographic gaps for rice landrace groups in East, South, and Southeast Asia, as well as in West Africa.

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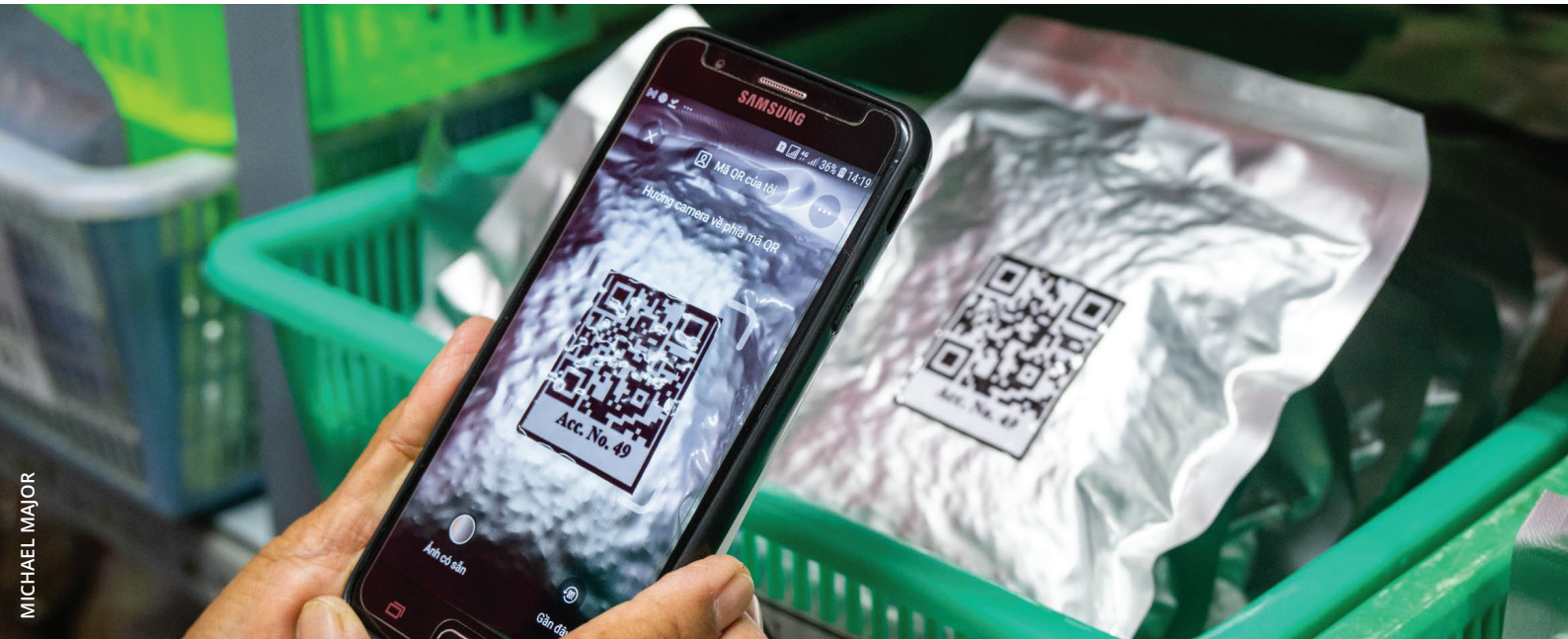
Multilateral System status of accessions in *ex situ* collections

The genus *Oryza* 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 519,391 accessions conserved globally, approximately 29.7% are held in international institutions (i.e., IRRI and the Africa Rice Center), and are included in the MLS under Article 15 of the Plant Treaty, with the remainder maintained in national and other collections (Table 4).

As of 2025, 203,914 accessions are formally included in the MLS according to the Plant Treaty's GLIS database, and 210,161 accessions have been assigned Digital Object Identifiers (DOIs). Per the relevant fields in the global genetic resources databases, 231,836 accessions (44.6% of world total) are listed as included in the MLS; this is likely an underestimate, noting that 44.3% 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 rice 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 (2024). DOI and MLS data from Plant Treaty GLIS (2025).

Metric	Number	Percentage
Number of accessions in genebank collections in international institutions	154,093	29.7%
Number of accessions in genebank collections in national or other institutions	365,298	70.3%
Number of accessions in genebank collections in Annex I	519,391	100%
Number of accessions with DOI (Plant Treaty GLIS 2025)	210,161	
Number of accessions included in the Multilateral System (MLS) (Plant Treaty GLIS 2025)	203,914	
Number of accessions included in the Multilateral System (MLS) (genebank collections databases)	231,836	44.6%
Number of accessions included in the Multilateral System (MLS) that are in international collections (genebank collections databases)	148,986	28.7%
Number of accessions not included in the Multilateral System (MLS) (genebank collections databases)	57,418	11.1%
Number of accessions without information regarding inclusion in the Multilateral System (MLS) (genebank collections databases)	230,137	44.3%



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Storage conditions, regeneration status, and safety duplication

As expected for an orthodox seed crop, almost the entirety (at least 97.1%) of rice accessions are conserved as seed, with 83% of these accessions listed as conserved under long-term cold-storage conditions (Table 5). Information on storage in general is missing for 2.8% of all accessions, and information on seed storage type (i.e., long, medium, or short term) is missing for 2.3% of seed accessions.

Current regeneration status and needs cannot be directly derived from the global germplasm databases. The 2010 Strategy listed regeneration as a first priority, particularly in institutions in Indonesia, DPR Korea, Lao PDR, Madagascar, Nepal, Pakistan, Philippines, Russian Federation, and Vietnam, noting that wild germplasm was a particular challenge. Partnerships were recommended to ensure appropriate environmental conditions for regeneration (Crop Trust, 2010). 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 44,217 rice accessions regenerated during this time by reporting institutions, with 32,671 accessions identified as needing regeneration and 9,370 of these lacking funds to conduct the regeneration.

Regarding safety duplication, the 2010 Strategy listed proportions of collections safety duplicated per institute for some of the surveyed institutes. The data indicated that degree of duplication varied widely among collections, and that many collections were inadequately duplicated. The Strategy prioritized further safety backup of unique accessions both in other institutions outside of the country (and preferably in another continent) as well as in the SGSV. The total number of rice accessions in SGSV at the time of the Strategy was 135,978, deposited by eight institutes; this has increased to 185,604 in 2024.

Analysis of the location of safety duplication sites of rice germplasm, as listed in Genesys, indicates that over three-quarters (77.2%) of accessions listed 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 rice accessions worldwide, when also considering safety duplication within the same country, may be higher than this estimate, given that a number of national genebanks (such as the USA and Russian Federation) typically provide safety backup of their collections in a different location within the country. Information from the SGSV database from 2024 indicated that approximately 35.7% of total accessions worldwide were duplicated in Svalbard.

Table 5. Storage conditions of rice *ex situ* collections, regeneration status, and safety duplication status. Main *ex situ* collections data from Genesys and FAO WIEWS (2024). Regeneration status information from FAO WIEWS (2024); data from 2014 to 2019. Safety duplication out of the country data based only on Genesys (2024) data. Svalbard Global Seed Vault data from SGSV portal (2024).

Metric	Number	Percentage
Number of accessions held in seed storage in genebank collections	504,309	97.1%
Number of accessions held in short-term seed storage in genebank collections	0	0%
Number of accessions held in medium-term seed storage in genebank collections	74,041	14.7%
Number of accessions held in long-term seed storage in genebank collections	418,540	83.0%
Number of accessions held in seed storage of undefined type in genebank collections	11,728	2.3%
Number of accessions held in field storage in genebank collections	735	0.1%
Number of accessions held in *in vitro* storage in genebank collections	0	0%
Number of accessions held in cryo storage in genebank collections	1	0%
Number of accessions held as DNA in genebank collections	21	0%
Number of accessions held in other storage in genebank collections	1	0%
Number of accessions not marked with a storage type in genebank collections	14,350	2.8%
Number of accessions in genebank collections regenerated 2014–2019	44,217	50.4%
Number of accessions in genebank collections in need of regeneration 2014–2019	32,671	37.2%
Number of accessions in genebank collections in need of regeneration without budget for regeneration 2014–2019	9,370	10.7%
Number of accessions safety duplicated out of the country in genebank collections	140,475	77.2%
Number of accessions in genebank collections safety duplicated in Svalbard	185,604	35.7%

Documentation, information systems, and research resources

A descriptor list for rice was first published by the International Board for Plant Genetic Resources (IBPGR) and IRRI in 1982, with a revised version published in 2007 (Bioversity International, IRRI, and The Africa Rice Center, 2007). A prioritized list of characterization and evaluation descriptors was published in 2009 (Bioversity International and IRRI, 2009).

The estimated completeness of passport information for rice accessions listed in Genesys was 7.0 on a scale of 0 (no data) to 10 (complete data), which indicates that much data is available, but also that there are gaps that it would be valuable to fill. Thirty rice characterization and evaluation datasets are available via Genesys, covering a total of 188,546 accessions. Four metrics of the current degree of digital sequence information (DSI) for rice (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. Rice, along with wheat, maize, and barley, stands out compared to many other cereals in terms of the amount of DSI resources, published literature, and research resources in GBIF (Khoury *et al.*, 2023).

The 2010 Strategy identified several priorities for rice documentation and information systems (Crop Trust, 2010). This included the development and establishment of better germplasm management systems for insti-

tutes (including mentioning the potential of GRIN Global), as well as the need for an integrated online information system enabling analyses and understanding across rice genetic resource collections. The Strategy also prioritized further completion of passport and other data relevant to the conservation and use of rice accessions. Information management for crop genetic resources has evolved substantially since the 2010 Strategy. GRIN Global has been developed and deployed (Crop Trust, USDA, and Bioversity International, 2025). The current Genesys and FAO WIEWS databases offer some essential taxonomic, institutional, and passport data, and Genesys now holds some characterization data for the crop, but a dedicated online information system including accession-level characterization and evaluation data for rice germplasm collections remains a gap.

Table 6. Documentation, information systems, and research resources for rice. Passport data completeness index (PDCI) from Genesys (2024), 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	7.0
Number of genes as recorded in NCBI's Entrez database as of 2022	135,146
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	2,930,901
Number of proteins as recorded in NCBI's Entrez database as of 2022	2,049,650
Number of publications listed in Google Scholar with taxon name in title published between 2009 and 2019	15,400
Number of publications listed in PubMed Central with taxon name in text as of 2022	53,975
Number of research materials as recorded in GBIF (2025)	646,833

Germplasm distributions and varietal registrations and releases

Germplasm distributions and varietal development statistics for rice 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 types of organizations (Khoury *et al.*, 2025). Rice is among the most distributed cereal crops in both these datasets (Khoury *et al*., 2023) (Table 7). Information on varietal registrations and releases indicates that rice is also among the cereals with the largest numbers of varieties in development.

Table 7. Rice 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 2018. 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	22,471.3
Average annual number of samples distributed worldwide as recorded in FAO WIEWS	47,449.5
Average annual number of samples distributed worldwide as recorded in the Plant Treaty Data Store	32,827.3
Number of countries receiving germplasm as recorded in the Plant Treaty Data Store	61.7
Evenness of distributions across world regions as recorded in the Plant Treaty Data Store	0.7
Average annual number of varietal registrations worldwide as recorded in UPOV's PLUTO	140.2
Average annual number of varietal releases worldwide as recorded in FAO WIEWS	109.4

Networks and partnerships

- IRRI and the Africa Rice Center continue to play critical global roles in rice germplasm conservation and varietal development, maintaining active partnerships with national agricultural research organizations, other international centers, and several academic and industry institutions.
- Some rice-focused networks are currently active, for example the USDA ARS Rice Crop Germplasm Committee and here.
- The major rice networks identified in the 2010 Strategy appear to no longer be active. Very little information is currently available online that might indicate the persistence and level of activity of rice networks over the past two decades.

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Conclusions

Rice continues to be among the most important crops worldwide and it is likely that it will maintain this importance in future food systems. Rice genetic resources are bolstered by the activities taking place at IRRI, the Africa Rice Center, and in several major collections in national agricultural research organizations. Although difficult to discern clearly from available data, there appears to have been significant progress made i n safety duplication, collection gap filling, and in information systems over the past two decades, there are considerable associated research resources, and there has been significant activity in germplasm distributions and varietal development for the crop. These data also indicate that further efforts are needed to fill some remaining gaps in existing collections through collecting of wild relatives and landraces, to more fully include rice germplasm collections under the MLS of the Plant Treaty, to make the information accompanying accessions more complete and/or more accessible in online databases, and to address regeneration and safety duplication backlogs.

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 GitHub repository. Extended methods are available here.

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Supplementary information

Supplementary Table 1: Full list of *ex situ* collections of rice genetic resources, in descending order by total number of accessions. Number of accessions and storage condition information from Genesys and FAO WIEWS (2024), with supplementary information as noted. Multilateral System (MLS) status from Plant Treaty GLIS (2025) and from Genesys and FAO WIEWS (2024).

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)
PHL001	International Rice Research Institute	132,777	25.6%	25.6%	124,118	127,243	127,876
IND001	National Bureau of Plant Genetic Resources	112,593	21.7%	47.2%	112,593	1,513	0
JPN183	NARO Genebank	39,996	7.7%	54.9%	11,266	15,711	15,712
USA970	Dale Bumpers National Rice Research Center, United States Department of Agriculture, Agricultural Research Services	36,280	7.0%	61.9%	36,280	0	0
THA300	Genebank	24,852	4.8%	66.7%	24,579	0	0
BRA008	Embrapa Arroz e Feijão	23,009	4.4%	71.1%	Not listed	20,811	22,949
CIV033	Africa Rice Center	21,035	4.0%	75.2%	19,608	20,753	21,032
USA029	National Small Grains Collection, USDA-ARS	19,126	3.7%	78.9%	19,126	0	0
BRA003	Embrapa Recursos Genéticos e Biotecnologia	15,180	2.9%	81.8%	15,143	0	0
MYS220	Genebank and Seed Centre	12,099	2.3%	84.1%	12,099	0	9,838
BGD002	Bangladesh Rice Research Institute (BRRI)	8,705	1.7%	85.8%	8,638	107	8,578
MMR015	Myanmar SeedBank	7,591	1.5%	87.3%	Not listed	47	0
MDG036	Département de Recherches Rizicoles, FOFIFA	6,932	1.3%	88.6%	Not listed	0	6,930
LKA036	Plant Genetic Resources Centre	5,333	1.0%	89.6%	Not listed	3,281	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)
RUS001	N.I. Vavilov All-Russian Research Institute of Plant Industry	4,224	0.8%	90.4%	4,224	0	0
VNM049	Plant Resources Center	4,134	0.8%	91.2%	4,116	0	4,134
PHL158	Philippine Rice Research Institute	3,795	0.7%	92.0%	3,795	5,547	3,795
PAK001	Plant Genetic Resources Program	3,323	0.6%	92.6%	2,504	32	2,765
URY003	INIA La Estanzuela	2,827	0.5%	93.1%	2,827	458	0
CUB030	Instituto de Investigaciones de Granos	2,595	0.5%	93.6%	Not listed	0	0
VNM329	Cuu Long Delta Rice Research Institute	2,265	0.4%	94.1%	2,265	0	2,265
UZB006	Uzbek Research Institute of Plant Industry	1,995	0.4%	94.5%	Not listed	0	0
CHL028	Banco Base de Semillas INIA Intihuasi	1,905	0.4%	94.8%	1,905	0	0
NPL069	National Agriculture Genetic Resources Centre-Genebank	1,852	0.4%	95.2%	1,852	0	0
AUS165	Australian Grains Genebank, Agriculture Victoria	1,730	0.3%	95.5%	1,543	1,633	0
KEN212	Genetic Resources Research Institute	1,275	0.2%	95.8%	1,275	884	1,275
PRT001	Banco Português de Germoplasma Vegetal	1,212	0.2%	96.0%	594	0	1,212
CRI089	Corporación Nacional Arrocera	1,203	0.2%	96.2%	206	0	0
IDN179	Indonesian Center for Agricultural Biotechnology and Genetic Resources Research and Development	1,144	0.2%	96.5%	1,143	1,246	313
BGD028	Bangladesh Institute of Nuclear Agriculture (BINA)	1,067	0.2%	96.7%	Not listed	0	0
MLI002	Institut d'Economie Rurale	982	0.2%	96.9%	583	1,112	259
PHL670	Institute of Crop Science	970	0.2%	97.0%	Not listed	0	0
BGR001	Institute for Plant Genetic Resources 'K.Malkov'	928	0.2%	97.2%	539	0	0
TZA016	National Plant Genetic Resources Centre	922	0.2%	97.4%	922	0	0
GHA091	Plant Genetic Resources Research Institute	861	0.2%	97.6%	10	897	860
BTN026	National Biodiversity Center	822	0.2%	97.7%	822	58	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)
UKR011	Experimental Station of Rice	772	0.1%	97.9%	337	0	0
MAR088	Centre Régional de la Recherche Agronomique de Settat	750	0.1%	98.0%	Not listed	0	0
LAO018	National Agriculture and Forestry Research Institute	735	0.1%	98.2%	Not listed	440	0
ITA383	CREA-Centro di Ricerca Cerealicoltura e Colture Industriali - Sede di Vercelli	707	0.1%	98.3%	Not listed	54	60
ROM002	National Agricultural Research and Development Institute - Fundulea	669	0.1%	98.4%	Not listed	0	0
MYS005	MARDI Seberang Perai	632	0.1%	98.5%	Not listed	729	0
ZMB048	National Plant Genetic Resources Centre	399	0.1%	98.6%	399	541	327
COL017	Corporación Colombiana de Investigación Agropecuaria, AGROSAVIA	373	0.1%	98.7%	349	0	0
BGD215	Advanced Seed Research & Biotech Centre	339	0.1%	98.8%	Not listed	0	0
UGA132	Plant Genetic Resource Centre	327	0.1%	98.8%	288	0	2
UGA528	Uganda National Genebank	327	0.1%	98.9%	Not listed	0	0
IDN414	Aceh Rice Research Institute	308	0.1%	98.9%	308	0	0
CUB005	Instituto Nacional de Ciencias Agrícolas	294	0.1%	99.0%	Not listed	0	0
MKD001	Faculty of Agriculture, University Ss. Cyril and Methodius	276	0.0%	99.0%	96	0	0
GBR004	Millennium Seed Bank - Royal Botanic Gardens Kew	267	0.0%	99.1%	Not listed	0	252
MWI041	Malawi Plant Genetic Resources Centre	257	0.0%	99.1%	256	0	89
MLI019	Laboratoire d'Hydrobiologie de Mopti	256	0.0%	99.2%	256	0	0
HUN003	Centre for Plant Diversity	253	0.0%	99.2%	56	0	9
NGA010	National Centre for Genetic Resources and Biotechnology	209	0.0%	99.3%	Not listed	210	0
MYS219	Agrobiodiversity and Environment Research Centre	207	0.0%	99.3%	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)
ZMB030	SADC Plant Genetic Resources Centre	203	0.0%	99.4%	203	0	0
BEN025	Institut National des Recherches Agricoles du Bénin	193	0.0%	99.4%	Not listed	0	0
SEN075	Unité de Recherche en Culture In-vitro	181	0.0%	99.4%	Not listed	0	181
CHL171	Banco de Semillas SAG Magallanes	178	0.0%	99.5%	178	0	0
ETH085	Ethiopian Biodiversity Institute	143	0.0%	99.5%	Not listed	0	133
IDN415	Borneo Institute	141	0.0%	99.5%	Not listed	0	0
NER001	Institut national de la recherche agronomique du Niger	139	0.0%	99.6%	139	94	139
TUR001	Plant Genetic Resources Department	126	0.0%	99.6%	126	0	0
TUR034	Field Crop Central Research Institute	111	0.0%	99.6%	111	0	0
BEN098	Groupe de Recherche, Innovation agricole, Gestion de la Biodiversité et Action pour un Développement durable et Équitable à la Base	107	0.0%	99.6%	Not listed	0	0
CRI009	Centro de Investigación en Granos y Semillas, Universidad de Costa Rica	105	0.0%	99.6%	Not listed	0	0
NGA021	Ahmadu Bello University	105	0.0%	99.7%	Not listed	0	0
ALB026	Plant Genetic Resources Center	102	0.0%	99.7%	102	0	102
CHL099	Banco Base INIA Quilamapu	102	0.0%	99.7%	Not listed	0	0
GUY021	National Agricultural Research and Extension Institute	99	0.0%	99.7%	Not listed	0	1
MLI015	Centre Régional de Recherche Agricole Mopti/Délégation Progamme Mil	98	0.0%	99.7%	98	0	98
MEX208	INIFAP, Centro Nacional de Recursos Genéticos (CNRG)	97	0.0%	99.8%	97	0	0
MLI070	Unité des Ressources Génétiques	92	0.0%	99.8%	92	0	92
NIC014	Centro Nacional de Investigación Agropecuaria (INTA-CNIA)	83	0.0%	99.8%	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)
ECU023	Departamento Nacional de Recursos Fitogenéticos	82	0.0%	99.8%	82	0	82
ZWE049	Genetic Resources and Biotechnology Institute-Department of Research and Specialist Services	81	0.0%	99.8%	Not listed	57	0
CRI007	Escuela de Ciencias Agrarias, Universidad Nacional	77	0.0%	99.8%	Not listed	0	0
CRI077	Instituto Nacional de Innovación y Transferencia de Tecnología Agropecuaria	77	0.0%	99.9%	77	0	34
ESP004	Centro Nacional de Recursos Fitogenéticos	67	0.0%	99.9%	48	0	67
PNG041	Momase Regional Centre, Bubia	63	0.0%	99.9%	Not listed	0	63
PAN172	Subcentro de Investigación Agropecuaria de San Félix	56	0.0%	99.9%	Not listed	0	0
ARE003	International Center for Biosaline Agriculture	55	0.0%	99.9%	Not listed	0	55
PHL200	Department of Agriculture - Region 2	53	0.0%	99.9%	Not listed	0	0
MLI017	Station de Recherche sur la Biologie des Essences Autochtones	51	0.0%	99.9%	51	0	38
USA995	National Center for Genetic Resources Preservation	51	0.0%	99.9%	51	0	0
MLI014	Station d'Elevage et de Recherche Zootechnique de Toronke	40	0.0%	99.9%	40	0	40
EGY087	National Gene Bank	34	0.0%	99.9%	Not listed	2	34
GIN009	Centre de Recherche Agronomique de Foulaya	34	0.0%	99.9%	Not listed	0	34
ZAF062	RSA National Plant Genetic Resources Centre	34	0.0%	100.0%	34	0	0
CAN004	Plant Gene Resources of Canada, Saskatoon Research and Development Centre	29	0.0%	100.0%	29	0	29
CMR205	Ecogerm Farmers	20	0.0%	100.0%	Not listed	0	0
ETH013	International Livestock Research Institute	17	0.0%	100.0%	Not listed	17	17
TJK027	National Center for Genetic Resources	17	0.0%	100.0%	15	0	17

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)
MEX006	UACh, Banco Nacional de Germoplasma Vegetal (BANGEV)	13	0.0%	100.0%	13	0	0
SDN002	Agricultural Plant Genetic Resources Conservation and Research Centre	13	0.0%	100.0%	13	0	10
ITA436	Istituto di Bioscienze e Biorisorse, Consiglio Nazionale delle Ricerche	12	0.0%	100.0%	Not listed	0	0
ISR002	Israel Gene Bank for Agricultural Crops, Agricultural Research Organisation, Volcani Center	11	0.0%	100.0%	Not listed	0	0
GRC001	Cereal Department, Institute of Plant Breeding and Genetic Resources	10	0.0%	100.0%	Not listed	0	0
KGZ040	Bank-Laboratory of Plant Genetic Resources of the KR	10	0.0%	100.0%	10	0	10
NGA136	Biodiversity Education and Resource Centre	10	0.0%	100.0%	Not listed	0	0
TGO031	Centre de Recherche Agronomique du Littoral	9	0.0%	100.0%	Not listed	0	9
GBR016	Genetic Resources Unit, Institute of Biological, Environmental & Rural Sciences, Aberystwyth University	7	0.0%	100.0%	Not listed	0	0
CUB014	Instituto de Investigaciones Fundamentales en Agricultura Tropical	6	0.0%	100.0%	Not listed	0	0
NZL001	Margot Forde Genebank, AgResearch Ltd	6	0.0%	100.0%	Not listed	0	0
TTO010	Central Experiment Station, Research Division, Ministry of Agriculture, Land and Fisheries	6	0.0%	100.0%	Not listed	0	0
AZE015	Genetic Resources Institute	5	0.0%	100.0%	Not listed	0	5
NIC098	Centro Nacional Experimental de Arroz	5	0.0%	100.0%	Not listed	0	0
UGA130	Plant Genetic Resources Programme, National Agricultural Research Organization	5	0.0%	100.0%	Not listed	0	0
HND029	Dirección de Ciencia y Tecnología Agropecuaria	4	0.0%	100.0%	Not listed	0	4

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)
MYS003	Malaysian Agricultural Research and Development Institute	4	0.0%	100.0%	Not listed	0	0
CRI001	Centro Agronómico Tropical de Investigación y Enseñanza	3	0.0%	100.0%	3	3	3
CRI085	CATIE - Banco de Germoplasma (Colecciones Semillas Ortodoxas)	3	0.0%	100.0%	3	0	3
AUT001	Austrian Agency for Health and Food Safety	2	0.0%	100.0%	2	0	2
ROM007	Suceava Genebank	2	0.0%	100.0%	Not listed	0	0
AUT025	Referat Pflanzengesundheit und Spezialkulturen	1	0.0%	100.0%	1	0	1
GTM001	Instituto de Ciencia y Tecnología Agrícolas	1	0.0%	100.0%	Not listed	0	0
JOR105	National Agricultural Research Center	1	0.0%	100.0%	Not listed	0	1
SLV050	CENTA - Banco de Germoplasma	1	0.0%	100.0%	1	0	0
SWZ015	National Plant Genetic Resources Centre	1	0.0%	100.0%	1	0	0
USA151	National Arboretum-Germplasm Unit, USDA/ARS	1	0.0%	100.0%	Not listed	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 (2024).

Taxon	Number of accessions (from genebank collections databases)
Oryza sativa L.	494,108
Oryza glaberrima Steud.	7,807
Oryza sativa subsp. *japonica* Kato	5,411
Oryza nivara S. D. Sharma & Shastry	2,525
Oryza L.	2,216
Oryza rufipogon Griff.	1,758
Oryza sativa subsp. *indica* Kato	1,481
Oryza rufipogon x *sativa*	707
Oryza sativa x *glaberrima*	471
Oryza barthii A. Chev.	456
Oryza officinalis Wall. ex G. Watt	433
Oryza longistaminata A. Chev. & Roehr.	418
Oryza punctata Kotschy ex Steud.	268
Oryza latifolia Desv.	202
Oryza glumipatula Steud.	189
Oryza meridionalis Ng	124
Oryza australiensis Domin	111
Oryza sativa x *glumipatula*	81
Oryza minuta J. Presl	80
Oryza eichingeri Peter	77
Oryza grandiglumis (Döll) Prodoehl	73
Oryza ridleyi Hook. f.	67
Oryza alta Swallen	66
Oryza sativa f. spontanea Roshev.	54
Oryza brachyantha A. Chev. & Roehr.	38
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