



# GROW

Webinar

**Development of new  
concise, data-driven  
crop reports:  
methodology, results,  
successes and limitations**



[ckhoury@nybg.org](mailto:ckhoury@nybg.org)



[peter.giovannini@croptrust.org](mailto:peter.giovannini@croptrust.org)

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15:00-16:00 CET

**Colin Khoury and Peter Giovannini**



# Global Crop Conservation Strategies (GCCS)

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**An assessment of the status of the current global conservation system + recommendations and priorities for actions**

**Focus:**

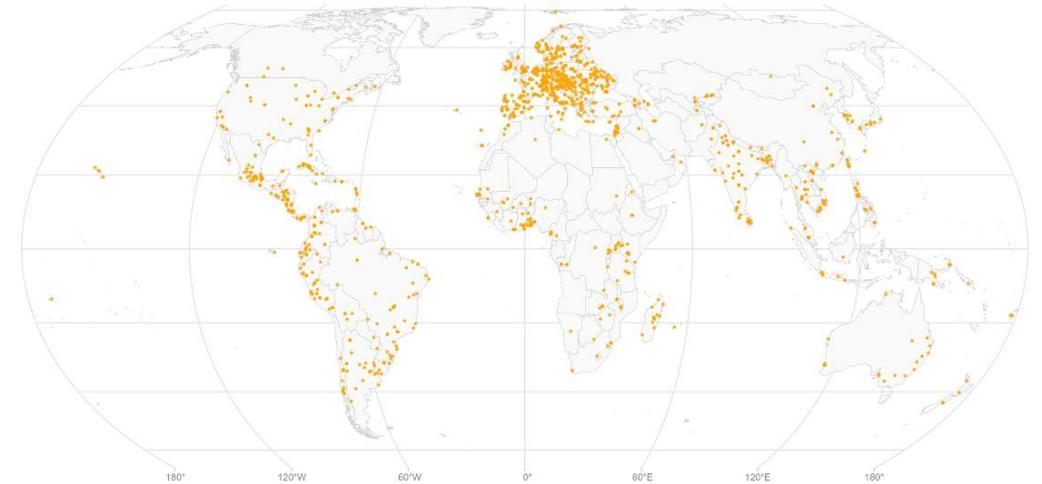
- A crop + its wild relatives
- Initial focus on Annex 1 crops
- *Ex situ* conservation

**Need:**

To identify priority actions to strengthen the conservation of crop genetic resources

To ensure activities and priorities are coordinated between stakeholders and genebanks in different parts of the world

**Problem:** information is dispersed across many sources and not always accessible



Genebank locations  
(Data source: FAO WIEWS\*)



# List of strategies: 2006-2019

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- 2006: Potato, Musa\*
- 2007: Grasspea, Maize, Sorghum, Sweet potato, Wheat, Breadfruit
- 2008: Barley, Chickpea, Lentil, Oats, Strawberry, Coconut\*\*
- 2009: Faba bean
- 2010: Cowpea, Yam, Edible aroids, Rice, Cassava
- 2012: Finger millet, Pearl millet, Cacao\*\*\*
- 2014: Beans
- 2015: Forages
- 2016: Banana/Plantain\*
- 2018: Coffee
- 2019: Tea, Apple

\*Facilitated by Bioversity international and Musanet

\*\*Facilitated by Coconut Genetic Resources Network

\*\*\*Facilitated by Bioversity International and Cacaonet 3



# 2019 (Q4) -2023: Breathing New Life into the Global Crop Conservation Strategies

- Funding: German Federal Ministry of Food and Agriculture through the Federal Agency for Food and Agriculture of the German government
- 1.4 M USD
- 10 new strategies + 5 updates
- Opinion paper: towards mainstreaming Global Crop Conservation strategies

With support from

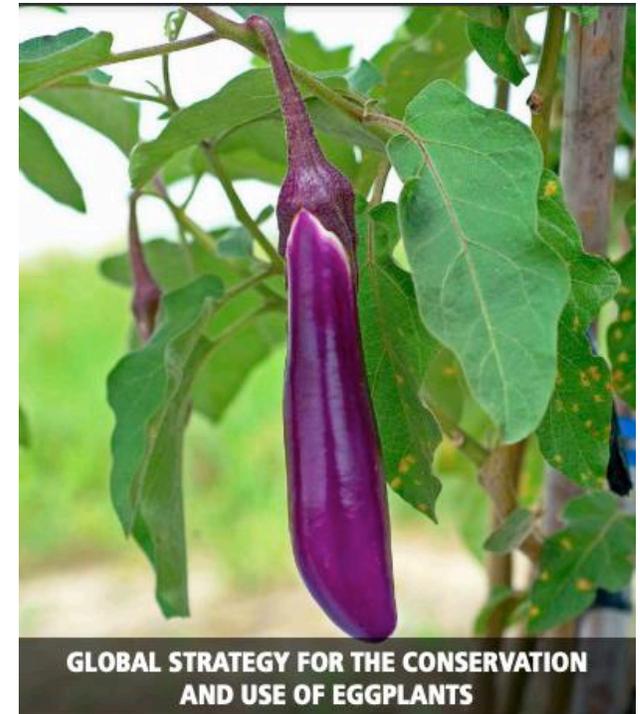


Federal Ministry  
of Food  
and Agriculture

In cooperation with



**The International Treaty**  
ON PLANT GENETIC RESOURCES  
FOR FOOD AND AGRICULTURE



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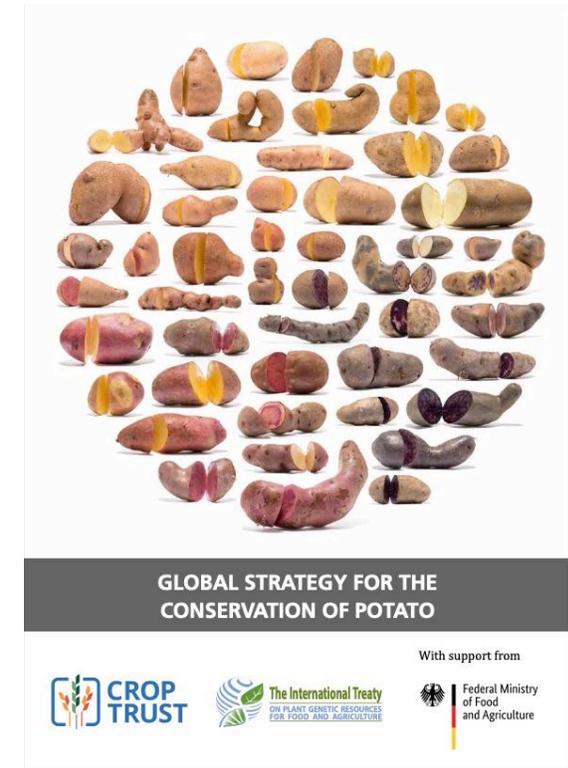




# Example: update of potato conservation strategy

## Table of content

1. Introduction & strategy background
2. Origin, domestication and centers of diversity
3. Taxonomy
4. Potato production and diversity
5. *In situ* conservation of native potato varieties
6. Potato *ex situ* collections
7. Potato germplasm maintenance
8. Management of the collections
9. Data management
10. Collection gaps
11. Potato breeding and usage of the collection
12. Recommended priorities





# Strategy development: Process

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- Finding and hiring lead consultant(s)
- Identification of relevant collections, survey, intro chapters, analysis of data from Genesys and WIEWS
- Survey results, Experts' consultations
- Integrating relevant results from previous studies
- Writing up draft strategy
- Review
- Final manuscript
- Crop Trust review
- Final layout and publishing on-line



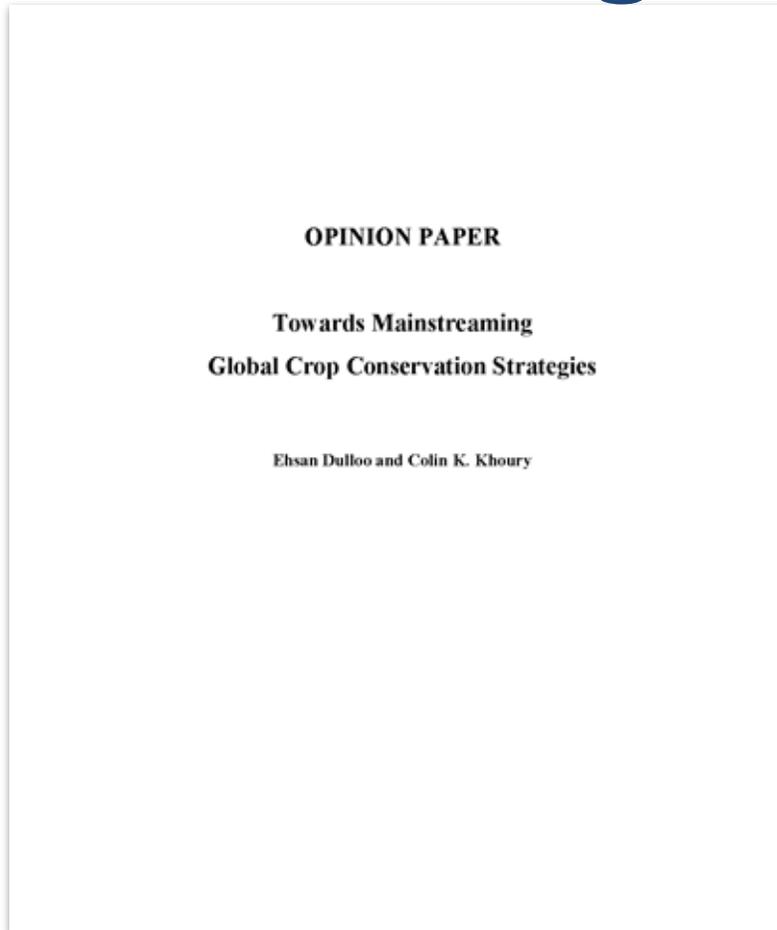
# Global Crop Conservation Strategies: values and challenges

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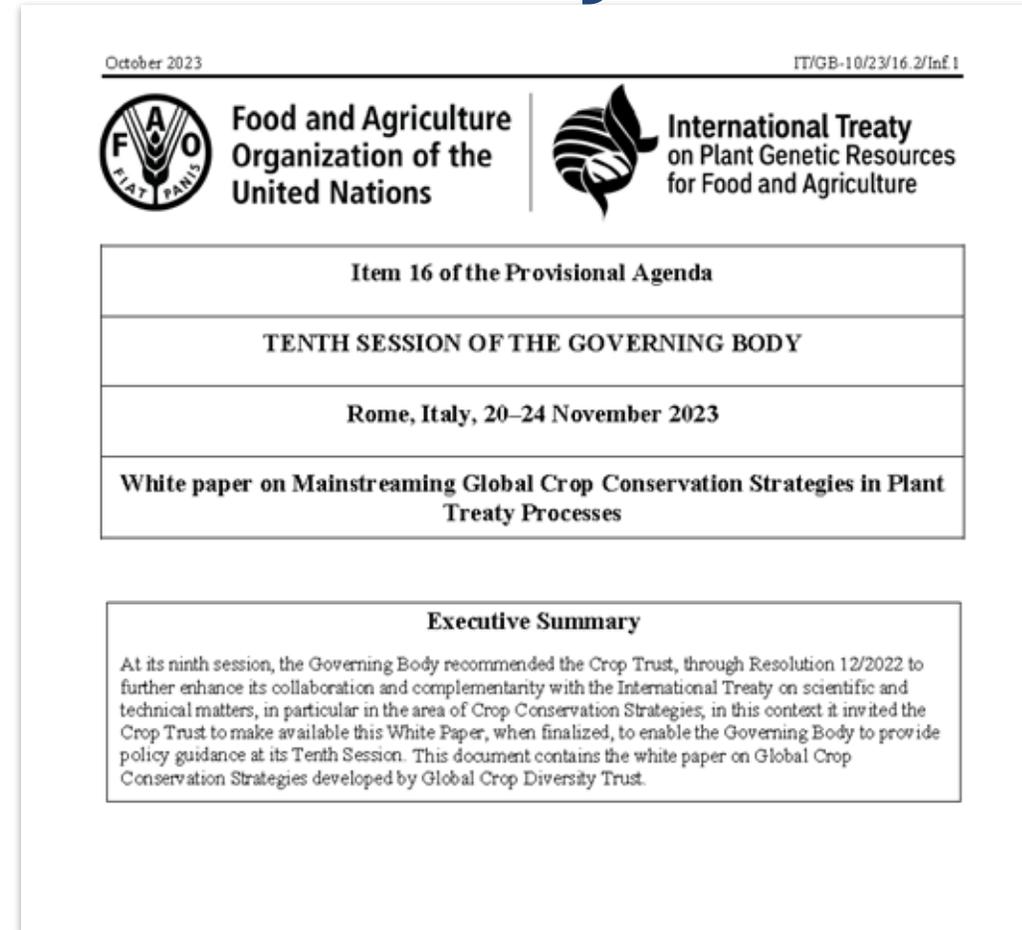
- Unique sources of global information from combination of online databases, curator surveys, and stakeholder meetings
- But less than ideal uptake and implementation
- GCCS are long (>100 pages, often!) and aren't standardized (different formats and emphases)
- GCCS production takes a long time (typically at least 1 yr per Strategy)
- GCCS are expensive (~\$100,000 per Strategy) – estimated



# GCCS: suggestions for innovation and mainstreaming with Plant Treaty



Dulloo E and Khoury CK (2023) Towards Mainstreaming Global Crop Conservation Strategies. Global Crop Diversity Trust. Bonn, Germany. doi: 10.5281/zenodo.7610356.  
[https://www.croptrust.org/fileadmin/uploads/croptrust/Documents/Technical\\_reports/Other/Global\\_Crop\\_Conservation\\_Strategies\\_opinion\\_paper.pdf](https://www.croptrust.org/fileadmin/uploads/croptrust/Documents/Technical_reports/Other/Global_Crop_Conservation_Strategies_opinion_paper.pdf)



Dulloo E and Khoury CK (2023) *White paper on Mainstreaming Global Crop Conservation Strategies in Plant Treaty Processes*. Global Crop Diversity Trust. Bonn, Germany. <https://www.fao.org/3/cc8285en/cc8285en.pdf>



# GCCS opinion paper and White paper – Main considerations and recommendations

- **Scope** – covers mainly ex situ but increasingly also in situ and use – adding extra components trade-offs: complexity, time, and costs.
- **Format** – Recommended exploring more concise, standardized, and dynamic format. Also exploring more integration with global databases.
- **Timing** – to be relevant, update every 5-10 years; if concise versions could be made, they could be produced more frequently (every 1-3 years).
- **Crops** – future GCCS should prioritize both major crops and opportunity crops.
- **Leadership** – needs sustainable core leadership. Recommends Crop Trust + international advisory group.
- **Funding** – long term secured funding best; if not, explores options for project-based funding.
- **Implementation** - Discusses low implementation; advises more direct assignment of responsibility; recommends exploring crop specific networks or consortia as leads on implementation. Funding for implementation is paramount.

# GCCS Opinion paper – on concise GCCS metrics

“A digest of the strategy could also include **key standardized metrics** which could be used to monitor the status of conservation and other aspects for the target crop(s). The production of stand-alone summaries of the priorities and recommendations of the GCCS would likely be extremely valuable to increasing readership and potential impact.” p. 19

“At the extreme end of the spectrum of potential methods for efficient reporting of GCCS outputs, it may be worth investigating the degree to which pertinent global information systems such as **Genesys PGR, FAO’s WIEWS**, and the **Plant Treaty’s Data Store** or other components of the Global Information System for PGRFA (**GLIS**), may be able to automatically produce part or all of the needed information.” p. 20



**AMARANTH**  
(*Amaranthus L.*)

**BEETS**  
(*Beta L.*)

**TROPICAL AND  
SUBTROPICAL  
FORAGES**

**LETTUCE**  
(*Lactuca L.*)

**PIGEONPEA**  
(*Cajanus Adans.*)

**TURKEY BERRY**  
(*Solanum torvum Sw.*)

**JUTE**  
(*Corchorus L.*)

**OKRA**  
(*Abelmoschus Medi*)

**SESAME**  
(*Sesamum L.*)

**BEANS**  
(*Phaseolus L.*)

**TOMATOES**  
(*Solanum lycopersic*)

**ONIONS, GARLIC  
AND LEEKS**  
(*Allium L.*)

# Concise, data-driven GCCS reports - composition

Development of standardized metrics, based on available online data, for:

- Global statistics on crop production, trade, and availability in food supplies (as appropriate)
- Identity and composition of genebank collections
- 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
- Crop networks and partnerships

With support from



The development of these reports 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 and in cooperation with the Secretariat of the International Treaty on Plant Genetic Resources for Food and Agriculture.



# Concise, data-driven GCCS reports – data sources

## Data sources:

- **Genesys** Plant Genetic Resources portal - for *ex situ* collections holdings, composition, and conditions; Multilateral System (MLS) status; safety duplication status; and characterization and evaluation datasets (continually updated) (downloaded from online portal).
- **FAO WIEWS** - World Information and Early Warning System on Plant Genetic Resources for Food and Agriculture of the Food and Agriculture Organization of the United Nations - for *ex situ* collections holdings, composition, and conditions; Multilateral System (MLS) status; and safety duplication status (continuously updated); and germplasm distributions (2014-2019) and varietal releases (2015-2019) from GPAII/SOWIII reporting (partly downloaded from online portal/data retrieved via request).
- **Plant Treaty GLIS** - Global Information System of the International Treaty on Plant Genetic Resources for Food and Agriculture - for Multilateral System (MLS) status (continually updated) (data retrieved via request).
- **Plant Treaty Data Store** - Data Store of the International Treaty on Plant Genetic Resources for Food and Agriculture - for germplasm distributions (continuously updated; data compiled for years 2015 to 2021 (data retrieved via request).
- **SGSV portal** - Svalbard Global Seed Vault portal - for safety duplication status (continually updated) (downloaded from online portal).

# Concise, data-driven GCCS reports – data sources

## Data sources:

- **BGCI PlantSearch** - Botanic Gardens Conservation International PlantSearch database - for *ex situ* collections holdings and composition (continually updated) (data retrieved via request).
- **GBIF** - Global Biodiversity Information Facility - for research resources (continually updated) (data retrieved by application programming interface [API]).
- **FAOSTAT** - for global production, trade, and food supplies statistics (continually updated; data compiled for years 2015 to 2018 (from Khoury *et al.* 2023; source data downloaded from online portal).
- **UPOV** - International Union for the Protection of New Varieties of Plants PLUTO database - for varietal registrations (continually updated; data compiled for years 2014 to 2018) (from Khoury *et al.* 2023; source data available with subscription but access given for PTFTW study).
- **Wikipedia** public page views - for public interest metric (continually updated; data for year 2019) (from Khoury *et al.* 2023; source data retrieved by API).
- **NCBI Entrez** - National Center for Biotechnology Information's Entrez database - for research resources (continually updated) (from Khoury *et al.* 2023; source data retrieved by API).
- **Google Scholar** - for research resources (continually updated; data compiled for years 2009 to 2019) (from Khoury *et al.* 2023; source results visible online per crop but not downloadable – required much work to compile).
- **PubMed Central** - for research resources (continually updated and reporting publications to date) (from Khoury *et al.* 2023; source data retrieved by API).

# Concise, data-driven GCCS reports – data processing

## Data processing:

- **Taxonomic standardization –**
  - Used existing code/API to align with World Flora Online and Grin Global Taxonomy – further review by hand. Significant time/effort.
- **Collections standardization/de-duplication –**
  - Created code to select between Genesys and WIEWS data per institute (if in both), based on recency of updates and completeness of datasets.
- **Data supplementation/annotation/standardization –**
  - Assigned institutional types (CGIAR, international, national, etc.) based on the FAO WIEWS Organizations database, using the institute code and manual revision.
  - Assigned Annex 1 status of crop.
  - Primary and secondary regions of diversity were listed as per Khoury *et al.* (2023) with additions based on crop-specific literature review and subject matter expert inputs.
  - Data columns were aligned as relevant with the Multi-Crop Passport Descriptor (MCPD) standards.
  - Country codes were standardized using 3-letter ISO 3166-1 country codes.

# Concise, data-driven GCCS reports – metrics

Resulting metrics: 100 metrics!

- **I. Production, trade, and food supply**
  - Ha, tonnes, \$, kcal/capita/day, g/capita/day
  - Number of countries where crop is significant
  - Evenness of contribution of crop across world regions
  - Estimated international interdependence
- **II. Identity and composition of *ex situ* collections**
  - Number of institutions holding genebank collections
  - Number of distinct taxonomic names in genebank collections
  - Number of accessions of different crop improvement categories (CWR, weedy materials, landraces, etc.)
  - Number of countries where germplasm has been collected for genebank collections
  - Number of accessions in genebank collections from the primary (/secondary) region(s) of diversity
  - Number of taxa in botanic garden collections
  - Number of botanic gardens holding collections of crop or its wild relatives
  - **Metrics also provided per institute - # of accessions, # in long term storage, # in MLS**

# Concise, data-driven GCCS reports – metrics

Resulting metrics: 100 metrics!

- **III. Multilateral System status of accessions in *ex situ* collections**
  - Number of accessions in genebank collections in international institutions
  - Number of accessions in genebank collections in national or other institutions
  - Number of accessions in genebank collections in Annex I
  - Number of accessions with DOI (Plant Treaty GLIS 2025)
  - Number of accessions included in the Multilateral System (MLS) (Plant Treaty GLIS 2025)
  - Number of accessions included in the Multilateral System (MLS) (genebank collections databases)
  - Number of accessions not included in the Multilateral System (MLS) (genebank collections databases)
  - Number of accessions included in the Multilateral System (MLS) that are in international collections (genebank collections databases)
  - Number of accessions without information regarding inclusion in the Multilateral System (MLS) (genebank collections databases)

# Concise, data-driven GCCS reports – metrics

Resulting metrics: 100 metrics!

- **IV. Storage conditions, regeneration status, safety duplication**
  - Storage conditions
    - Number of accessions held in seed storage in genebank collections
      - Number of accessions held in (short-term/medium-term/long-term) seed storage in genebank collections
    - Number of accessions held in (field/*in vitro*/cryo/DNA/other) storage in genebank collections
  - Regeneration status
    - Number of accessions in genebank collections regenerated 2014–2019
    - Number of accessions in genebank collections in need of regeneration 2014–2019
    - Number of accessions in genebank collections in need of regeneration without budget for regeneration 2014–2019
  - Safety duplication status
    - Number of accessions safety duplicated out of the country in genebank collections
    - Number of accessions in genebank collections safety duplicated in Svalbard

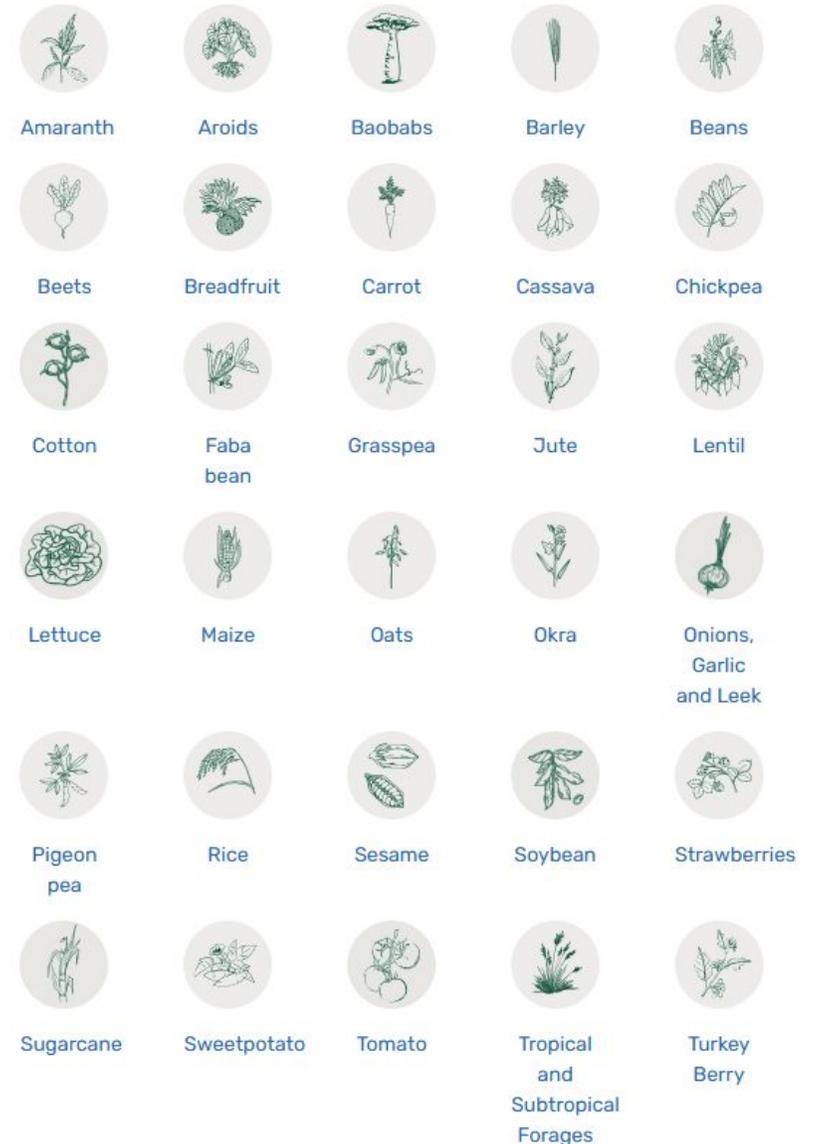
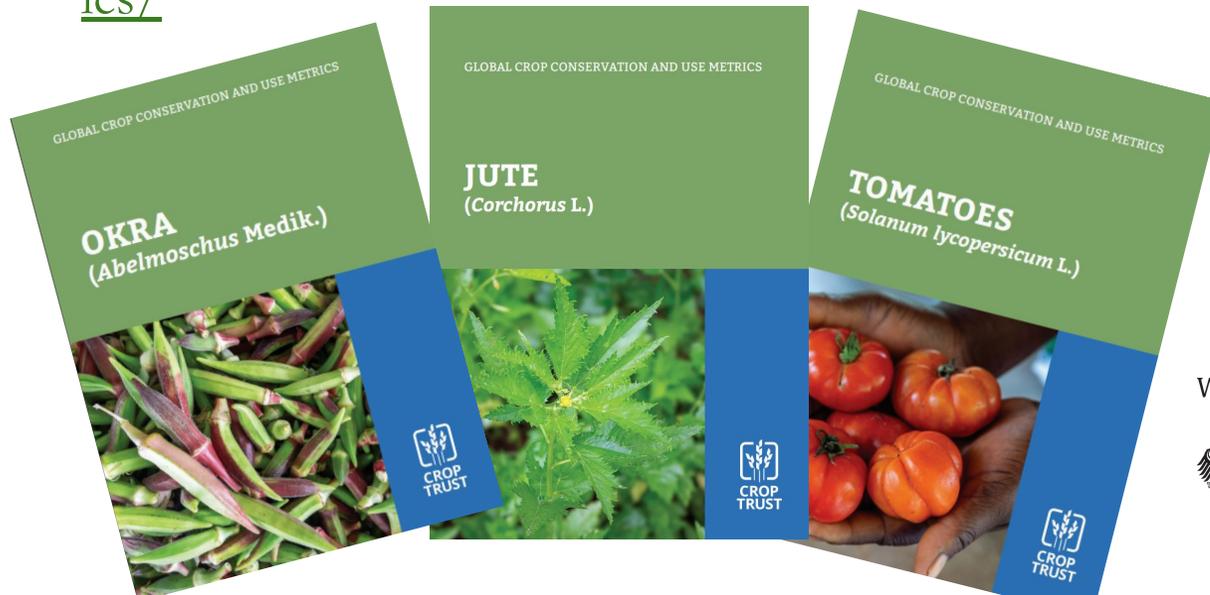
# Concise, data-driven GCCS reports – metrics

Resulting metrics: 100 metrics!

- **V. Documentation, information systems, and research resources**
  - Passport data completeness index (PDCI) (Van Hintum *et al.* 2011)
  - NCBI - Number of (genes/genomes/nucleotides/proteins) resources
  - Number of publications listed in Google Scholar
  - Number of publications listed in PubMed Central
  - Number of research materials as recorded in GBIF
- **VI. Germplasm distributions and varietal registrations and releases**
  - Average annual number of (accessions/samples) distributed worldwide as recorded in FAO WIEWS
  - Average annual number of samples distributed worldwide as recorded in the Plant Treaty Data Store
  - Number of countries receiving germplasm as recorded in the Plant Treaty Data Store
  - Evenness of distributions across world regions as recorded in the Plant Treaty Data Store
  - Average annual number of varietal registrations worldwide as recorded in UPOV's PLUTO
  - Average annual number of varietal releases worldwide as recorded in FAO WIEWS

# Concise, data-driven GCCS reports – products to date

- 30 reports to date (produced in 2025), including 15 updates of existing long-form GCCS, and 15 new crops without previous GCCS.
- Format – about 10-12 pages of text and tables, accompanied by SI tables and links to spreadsheets, data, and code.
- Available at:  
<https://www.croptrust.org/what-we-do/projects/mainstreaming-the-global-crop-conservation-strategies/>



With support from



Federal Ministry  
of Agriculture, Food  
and Regional Identity

# Concise, data-driven GCCS reports – reflections

- Reports can be made:
  - Shorter - 1/10 of full GCCS length
  - Cheaper - ~\$3000 per crop (=3% of full GCCS cost)
- Online PGRFA data can be gathered (still with some help needed from some sources) and code can be built to (semi)automatize acquisition, processing, and generation of tables for reports.
- Results are only as good as input data – online databases are not currently fully:
  - Comprehensive (missing collections; missing data e.g. storage fields, MLS status fields, etc.)
  - Standardized (taxonomy, data field names, etc.)
  - Current (some pertinent data already quite old, e.g. regeneration status, germplasm distributions from FAO)
  - Thus, significant effort (still) needed to standardize, remove duplicates, identify gaps, etc.
- Data systems have changed enormously in the past few decades (many old GCCS spoke about crop-specific databases or the need for them, which are largely replaced now by Genesys, etc.). FAIR (and CARE) principles have been established to improve accessibility and attribution. More change is likely to come with AI, etc.
- To better strategize with existing data, we need to better understand change and threats – e.g. regeneration and duplication status – information is currently only partly available, at best.
- GCCS reports are efficient, concise, data-driven syntheses of readily available PGRFA data for crops. These reports are NOT full GCCS and cannot capture the knowledge and wisdom accessible only through stakeholder processes.
- To better strategize, need ways to harness inputs from crop PGRFA experts. The Opinion paper and White paper provide some recommendations.

# Concise, data-driven GCCS reports – recommendations for PGRFA professionals

- Invest in your PGRFA data – make your data as comprehensive and accurate as possible.
- Invest in global databases (Genesys, WIEWS, Plant Treaty Data Store and GLIS, etc.) – report frequently and comprehensively, and encourage partners/colleagues to do so.
- Encourage global databases to improve - these systems can do more to make it as easy as possible to report to them, to standardize the data in their systems, and to make the data easier to access.
- Add important data such as regeneration status to accession level data and encourage its reporting up to global databases.
- Be responsive and creative as more change comes to data systems through AI, etc. It is ever more possible to integrate, standardize, combine, etc., and great benefits in terms of better understanding the state of the Global System can come through these innovations.
- Support the development of social (stakeholder-based) processes that can supplement the metrics to deliver a more holistic understanding of the current Global System.
- Your feedback on the metrics, and on further needed steps for strategizing about PGRFA, are very much appreciated! Please be in touch.

# Concise, data-driven GCCS reports – links and references

## Links

All GCCS - <https://www.croptrust.org/knowledge-hub/crop-conservation-strategies/>

Newer GCCS and opinion paper -

<https://www.croptrust.org/what-we-do/projects/breathing-new-life-into-global-crop-conservation-strategies/>

GCCS summaries and metrics reports, and associated resources -

<https://www.croptrust.org/what-we-do/projects/mainstreaming-the-global-crop-conservation-strategies/>

## References

Dulloo and Khoury (2023) *Towards Mainstreaming Global Crop Conservation Strategies*. Global Crop Diversity Trust. Bonn, Germany. doi: 10.5281/zenodo.7610356. <https://doi.org/10.5281/zenodo.7610356>

Dulloo and Khoury (2023) *White paper on Mainstreaming Global Crop Conservation Strategies in Plant Treaty Processes*. Global Crop Diversity Trust. Bonn, Germany. <https://www.fao.org/3/cc8285en/cc8285en.pdf>

Khoury *et al.* (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 *et al.* (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>

Van Hintum *et al.* (2011) Quality indicators for passport data in *ex situ* genebanks. *Plant Genetic Resources* 9(3): 478–485.