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

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The Plants that Feed the World - rationale

• It is important that the PGRFA community, including ITPGRFA Parties, is able to access information on the current use of food and agricultural plants as well as interdependence regarding, demand for, supply of, and security of their genetic resources
  • e.g. toward MLS implementation, BSF allocation, Global Biodiversity Framework, and SDGs 2.5 and 15.6

• Pertinent information increasingly available but scattered, e.g.:
  • FAO’s Food and Agricultural Statistics Database (FAOSTAT)
  • FAO World Information and Early Warning System on Plant Genetic Resources for Food and Agriculture (WIEWS)
  • Data Store of the International Treaty on Plant Genetic Resources for Food and Agriculture
  • International Union for the Protection of New Varieties of Plants (UPOV)’s PLUTO Plant Variety Database
  • Genesys Plant Genetic Resources portal (Genesys PGR)
  • Botanic Garden Conservation International’s PlantSearch database
  • Global Biodiversity Information Facility (GBIF)
  • Svalbard Global Seed Vault’s Seed Portal
  • National Center for Biotechnology Information (NCBI)’s Entrez database
A reproducible set of metrics and associated baseline data that provides an evidence base enabling the community to strategize and prioritize actions regarding the conservation and availability for use of PGRFA.

Measured periodically, these metrics can also provide insights on change over time in the use of crops and issues regarding interdependence on, demand for, supply of, and security of their genetic resources.
The Plants that Feed the World - aim

This work on PGRFA metrics:

• does not create new information systems, but, rather, gathers and processes in a standardized manner data from several relevant systems

• does not substitute PGRFA indicators (such as those for Sustainable Development Goal Targets 2.5 or 15.6) gathered through country-driven efforts

• Is most appropriately complemented by other sources of information and analysis that cannot be made available in the form of reproducible metrics, as evident in the development of the Global Crop Conservation Strategies
5 Domains (98 metrics in total):

- **USE** - contribution of each crop to food supplies, agricultural production, trade, and other metrics (51 metrics)
- **INTERDEPENDENCE** among countries for each crop’s genetic resources (22 metrics)
- **DEMAND** for each crop’s genetic resources (7 metrics)
- **SUPPLY** of each crop’s genetic resources (i.e. *ex situ* conservation) (16 metrics)
- **SECURITY** – safety backup of each crop’s genetic resources (2 metrics)
The Plants that Feed the World - scope

• Coverage: **355 food and agricultural crops**
  • Inclusive of all those covered in FAOSTAT, Annex I of the International Treaty, and CGIAR mandate major crops, as well as other crops deemed internationally significant

• Time point – **recent year** (generally between 2019 to 2022), with some metrics averaged across years, data dependent
The Plants that Feed the World – results formats

- 3 calculation types:
  - **Average** (calculated data)
  - **Indicator**
  - **Normalized** indicator (0-1)

- 2 scales:
  - **All crops**
  - **By crop use type** - 11 food categories (beverage, cereal, fruit, herb and spice, nut, oil, pulse, root and tuber, stimulant, sugar, and vegetable crops) as well as fibre, forage, and industrial crops

- Available as:
  - **Text and figures** in main study
  - **Excel spreadsheets** – supplementary materials
  - **Online interactive figures** (coming!)

- **Vignettes** on: oil crops, plant-based protein, crops of the future, PGRFA and climate change, capacity building, biofuel crops, DSI, SGSV, and safety backup for vegetatively propagated crops

Use of crops in global agricultural production as measured in terms of production quantity (tonnes). The results are presented as the proportion of the value of the crop, compared with all crops per use type. Top 10 crops for the metric shown.
The Plants that Feed the World – crop use

Crop use

• 11 metrics - Crop use data from FAOSTAT
• 11 metrics - Crop use data from FAOSTAT - Count of countries
• 11 metrics - Crop use data from FAOSTAT - Equality of use (GINI)
• 11 metrics - Crop use data from FAOSTAT - Change over time
• 4 metrics - Crop research investigation - Google Scholar and PubMed Central
• 3 metrics - Crop public interest/awareness - Wikipedia pageviews

Geographic spread of crops in global agricultural production as measured in terms of the proportion of countries in which the crop is significant compared with the total number of countries reported in FAOSTAT (205).
The Plants that Feed the World – crop use

Geographic evenness of crops in terms of agricultural production in different world regions. The results are presented based on a mathematical metric of evenness called the Gini coefficient, in this case with values close to 100 representing high evenness in use across regions, and those close to 0 representing unevenness.

Research significance of crops as measured in terms of Google Scholar citations based on appearance of the common name of the crop in the article title. The results are presented as the proportion of the number of publications of the crop, compared with all crops in the crop use type.
The Plants that Feed the World – interdependence

Interdependence regarding crop genetic resources

• 11 metrics - Crop plant genetic resource interdependence
• 11 metrics - Crop plant genetic resource interdependence - Change over time

Significance of each crop in terms of agricultural production outside its geographic origins and primary region(s) of diversity. The results are presented as the proportion of the production of each crop outside its origins and primary region(s) of diversity, compared with total production of the crop worldwide.
Demand for crop genetic resources

- 1 metric - Germplasm distributions - Plant Treaty
- 1 metric - Germplasm distributions - Plant Treaty - Count of countries
- 1 metric - Germplasm distributions - Plant Treaty - Equality of distributions (GINI)
- 2 metrics - Genebank distributions - FAO WIEWS
- 1 metric - Varietal registrations - UPOV
- 1 metric - Varietal releases - FAO WIEWS

The Plants that Feed the World – demand

Demand for crop genetic resources as measured in terms of germplasm distributions under the SMTA of the International Treaty. The results are presented as the proportion of distributions of the crop, compared with total distributions of all crops per crop use type.
The Plants that Feed the World – demand

Varietal registrations as reported by UPOV. The results are presented as the proportion of registrations of the crop, compared with total registrations of all crops per crop use type.

Varietal releases as reported by WIEWS. The results are presented as the proportion of releases of the crop globally, compared with total releases of all crops per crop use type.
Supply of crop genetic resources

- 2 metrics - Ex situ collections - FAO WIEWS, Genesys PGR, and GBIF
- 4 metrics - Ex situ collections - FAO WIEWS, Genesys PGR, and GBIF - MLS status
- 2 metrics - Ex situ collections - Botanic Gardens
- 2 metrics - Research supply - GBIF
- 4 metrics - Research supply - NCBI

The Plants that Feed the World – supply

Supply of genetic sequence and other related data on crops. The results are presented as the proportion of nucleotide resources of the crop, compared with total nucleotide resources of all crops per crop use type.
The Plants that Feed the World – supply

Supply of crop genetic resources as measured in terms of *ex situ* germplasm collections. The results are presented as the proportion of accessions of the crop, compared with total accessions of all crops per crop use type.

Coverage of crop genetic resources within the International Treaty’s Multilateral System as measured by direct notation in global *ex situ* collections databases. The results are presented as the proportion of accessions of the crop included in the Multilateral System, compared with total global accessions of the same crop.
The Plants that Feed the World – security

Security of crop genetic resources

- 2 metrics - Ex situ backup - Svalbard Global Seed Vault

Safety backup of crop genetic resources at the Svalbard Global Seed Vault. The results are presented as the proportion of records of the crop in the SGSV, compared with total records of the crop in all ex situ collections.
The Plants that Feed the World – main findings

• Hundreds of different crops are widely grown, traded, present in food supplies, and researched around the world.

• Crop use is not static and a plant’s utilization can vary widely both spatially and temporally. Crops that were not considered important on a global or regional scale a few decades ago have become widely utilized today. Likewise, plants that are currently grown only on a small scale could become major crops of the future.

• There is a high level of interdependence among countries with respect to PGRFA of most crops. Many of the crops studied also show large directly quantified germplasm distributions to recipients in many different countries and regions.

• There is wide variation among crops in terms of the amount of PGRFA held ex situ. Genebanks and botanic gardens appear to complement one another with different crops.

• The availability of botanical research specimens and digital sequence information (DSI) are likewise highly variable among crops.

• While much has already been duplicated in the Svalbard Global Seed Vault, particularly for major cereals, pulses, and a few other crop types, many of the world’s ex situ accessions are not documented as safety duplicated.

• In short, there is tremendous use of crops and large interdependence regarding, demand for, supply of, and security of PGRFA globally. These vary substantially among crops.

• Important to improving the assessment:
  • Broaden the scope of crops reported in FAOSTAT
  • More comprehensively report genetic resource distributions data in FAO WIEWS and the ITPGRFA Data Store
  • Enhance the completeness and accuracy of PGRFA supply data in FAO WIEWS, Genesys PGR, and PlantSearch, including more comprehensive notation of whether accessions are covered in the MLS, and enhance other data sources such at GBIF
  • Encourage accessibility to other pertinent databases such as UPOV’s PLUTO.
  • Encourage alignment and standardization of data among data sources.
Resources - The Plants That Feed the World:

Main product:

Associated information, including links to data, codes, and associated products:
https://www.fao.org/plant-treaty/areas-of-work/the-multilateral-system/plant_genetic_metrics

Earlier version, for GB9: