DRAFT THEMATIC STUDY

for
THE THIRD REPORT ON THE STATE OF THE WORLD'S PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE

(Not for Quotation or Citation)

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GERMPLASM EXCHANGE

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Executive Summary

This study of global germplasm exchange is primarily based on an analysis of two complementary information sources, both covering the period 2012 to 2019:

The FAO World Information and Early Warning System on Plant Genetic Resources for Food and Agriculture (WIEWS) Indicators 28 (Number of accessions), 29 (Number of samples distributed by genebanks to users of germplasm) and 6 (Number of farmers’ varieties/landraces distributed by national or local genebanks to farmers). These datasets primarily record distributions of germplasm from national genebanks. Provider countries, provider institutions, types of recipient (optionally), crops and total numbers of accessions and samples distributed, are reported for two periods (2012 to 2014 and 2014 to 2019).

The Data Store of the Multilateral System of Access and Benefit Sharing of the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGFRA, herein also referred to as the Treaty). This dataset includes all distributions made under the Treaty’s Standard Material Transfer Agreement (SMTA) that have been reported to the Governing Body of the Treaty, including distributions made by genebanks as well as by breeding programmes and other organizational types. It is primarily composed of distributions made by the genebanks and breeding programmes of CGIAR centres. Countries where providers and recipients are located, the crops involved and the numbers of samples distributed are reported for each year from 2012 to 2019.

These datasets were standardized and supplemented with additional information. In the case of providers and recipients, the additions included world region classifications, country income level and Contracting Party status with respect to the Treaty and the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity (Nagoya Protocol). For crops, additional information included use categorization, status with respect to inclusion in Annex 1 of the Treaty, FAOSTAT global crop production and food-supply contribution metrics, and information on germplasm type/seed storage behaviour. Supplementary information was also synthesized from CGIAR genebank distribution data and from published literature.

This analysis of the 2012 to 2019 period documents the distribution of over 1.2 million accessions (an average of circa 159 000 per year) and over 4.1 million samples (circa 523 000 per year), as recorded in the WIEWS dataset, and over 3.9 million samples (circa 497 000 per year), as recorded in the Treaty dataset. This is a considerably larger number of distributions than were documented in The State of the World’s Plant Genetic Resources for Food and Agriculture (FAO, 1997) and The Second Report on the State of the World’s Plant Genetic Resources for Food and Agriculture (FAO, 2010).

The WIEWS dataset mainly documents domestic genetic resource exchange activities, with well over 90 percent of distributions made within the respective country. In terms of accessions, national agricultural research centres (NARCs) were the foremost in-country recipients, followed by recipients classed as others, farmers or non-governmental organizations (NGOs), the private sector and recipients classed unknown. In terms of samples, the private sector and NARCs received the largest shares, followed by farmers or NGOs, recipients classed others and recipients classed as unknown.
The Treaty dataset documents a very different germplasm distribution pattern, with three-quarters (76.5 percent) of distributions occurring across international borders, and only a quarter (23.5 percent) in-country. This dataset primarily reflects CGIAR distributions (88.9 percent of the total) and indicates that 80.8 percent of these were made to recipients outside the country where the CGIAR centre was located.

The WIEWS dataset records the distribution of germplasm from providers in 87 countries, with more than half of them distributing more than 1 000 accessions each over the eight-year period. Asia and Europe were the regions that were the foremost providers, followed by Oceania, the Americas and Africa. High-income countries distributed 39.4 percent of all accessions, upper middle-income countries 35.7 percent, lower middle-income 18.9 percent, and low-income countries 6 percent. Analysis of the data at the sample level paints a similar picture, although it may be confounded by the reporting of relatively large numbers of samples for a few crops from a few countries; these data may not reflect a consistent interpretation of “samples” across providers. Almost half the countries distributed more than 10 000 samples each over the eight-year period. Providers in the Americas, Europe and Asia distributed the most samples, followed by those in Africa and Oceania. Lower middle-income countries distributed 38.3 percent of all samples, high-income counties 33.3 percent, upper middle-income countries 18.8 percent, and low-income countries 9.6 percent. Approximately 69.9 percent of accessions and 86.1 percent of samples were distributed by providers located in countries that were Contracting Parties to the Treaty, while 37.3 percent of accessions and 35.5 percent of samples were distributed by providers located in countries that were Contracting Parties to the Nagoya Protocol.

The Treaty dataset records the distribution of germplasm from providers located in 48 countries, with more than 1 000 samples distributed by providers in 34 of those countries. Providers located in the Americas accounted for 47.9 percent of total distributions, those in Asia for 29.5 percent, those in Africa for 14.1 percent, those in Europe for 8.4 percent, and those in Oceania for 0.2 percent. Approximately 59.7 percent of all the samples distributed came from providers in upper middle-income countries, 27 percent from those in lower middle-income countries, 10.5 percent from those in high-income countries, and 2.9 percent from those in low-income countries. Approximately 53.2 percent of all samples were provided by organizations located in countries that were Contracting Parties to the Treaty, and 52.2 percent by those in countries that were Contracting Parties to the Nagoya Protocol. However, these statistics must be interpreted in light of an understanding that CGIAR centres were the providers of almost 90 percent of distributions in the Treaty dataset.

The Treaty dataset records distributions to recipients in 179 countries, with over 1 000 samples received in 131 countries over the eight-year period. The countries where recipients received the largest numbers of samples were India, Kenya, Mexico, Türkiye, the United States of America, Germany, Canada, China, Pakistan and the Islamic Republic of Iran, each of which received over 100 000 samples under the SMTA. Recipients in Asia received 42.1 percent of the samples, Africa 22.5 percent, the Americas 21.2 percent, Europe 13.2 percent, and Oceania 1 percent. Recipients in lower middle-income countries received 38.6 percent of the samples, upper middle-income countries 26.7 percent, high-income countries 23.8 percent, and low-income countries 10.8 percent. Recipients in least developed countries (LDCs) received 11 percent of the
samples, those in landlocked developing countries (LLDCs) 12.5 percent, and those in small island developing states (SIDS) 0.3 percent. The relative lack of demand from low-income countries implies a need to further build the capacity of institutions concerned with the conservation and use of crop germplasm. Approximately 80.3 percent of the samples distributed using the SMTA were received by organizations located in countries that were Contracting Parties to the Treaty, and 41.3 percent were received by organizations located in countries that were Contracting Parties to the Nagoya Protocol.

The *WIEWS dataset* records the distribution of germplasm belonging to 843 crops or crop groups. Over 100 000 accessions of each of three crops (wheat, rice and soybean) were distributed, between 10 000 and 100 000 accessions of each of 22 crops, between 1 000 and 10 000 accessions of each of 72 crops, between 100 and 1 000 of each of 98 crops, and fewer than 100 accessions of each of 643 crops. Specific crops with the highest number of accessions distributed included wheat, rice, soybean, barley, common bean, chickpea, *Brassica* crops, maize, oat, sorghum, pea, cotton, citrus, potato, tomato, broad bean and vetch, tobacco and lentil, each with over 10 000 accessions distributed. In terms of samples, ten crops were reported as having had over 100 000 samples distributed, 48 crops as having between 10 000 and 100 000 samples distributed, 126 crops as having between 1 000 and 10 000 samples distributed, 133 crops as having between 100 and 1 000 samples distributed, and 526 crops as having between 1 and 100 samples distributed. The specific crops with the highest number of samples distributed were dragon fruit, rice, wheat, citrus crops, pistachio, soybean, cocoa, avocado, barley and coffee, all with over 100 000 samples distributed.

At the crop-type level, food crop germplasm comprised 86.5 percent of total accessions and 87.8 percent of total samples recorded in the *WIEWS dataset*. The most distributed in terms of accessions were cereals, oil plants, food legumes and vegetables. The most distributed in terms of samples were nuts, fruits and berries; cereals; medicinal plants, aromatic plants, spices and stimulant plants; vegetables; oil plants; industrial and ornamental plants; and food legumes. Germplasm distribution quantities generally aligned with global production and food-supply metrics. However, on certain metrics, some crops – for example sugar cane, oil palm, beet, cassava, soybean, banana and plantain, grape, yam, sunflower, coconut, groundnut and olive – stood out as making very large contributions to global production or food-supply but having relatively few reported germplasm distributions.

Approximately 56.3 percent of accessions and 38 percent of samples recorded as distributed in the *WIEWS dataset* were of crops listed in Annex 1 of the Treaty. Among the non-Annex 1 crops comprising the other 43.7 percent of the accessions distributed were soybean, cotton, tomato, tobacco, *Capsicum* crops, *Acacia*, pear, sesame, cocoa, okra, teff, flax, tea, beet, cucumber and melon, each with over 5 000 accessions distributed. The non-Annex 1 crops comprising the other 62 percent of samples distributed included dragon fruit, pistachio, soybean, avocado, coffee, mango, *Arabidopsis*, rubber, tomato, *Acacia*, grape, *Annona* crops, coconut, *Capsicum* crops, sugar cane, fig, pear, cotton, cucumber, melon, lettuce, guava, tobacco, okra, flax, sapote and papaya, each with over 10 000 samples distributed. This high level of demand for germplasm of non-Annex 1 crops underscores the importance of giving attention to ways and means of further
facilitating access to genetic resources, while also ensuring the fair and equitable sharing of any benefits arising from such access.

The Treaty dataset records the distribution of over 270 crops or crop groups. One crop had more than 1,000,000 samples distributed, four had between 100,000 and 1,000,000 samples distributed, 16 had between 10,000 and 100,000 samples distributed, 30 had with between 1,000 and 10,000 samples distributed, 38 had between 100 and 1,000 samples distributed, and 181 had between 1 and 100 samples distributed. Crops with the highest total numbers of samples distributed included wheat, maize, rice, barley, chickpea, lentil, bean, sorghum, pearl millet, Brassicaceae crops, broad bean and vetch, pigeon pea, cowpea, potato, groundnut, oat, lettuce, grass pea and other Lathyrus, soybean and pea, all with over 10,000 samples distributed.

At the crop-type level, food crop germplasm comprised 97.1 percent of the samples recorded as distributed in the Treaty dataset, with cereals, food legumes, vegetables, roots and tubers, forages and oil plants among the most distributed. This is not surprising given that the data pertain mainly to distribution of materials from the CGIAR centres, and the numbers of samples distributed generally aligned with global production and food-supply metrics. However, for certain metrics, some crops – for example cassava, soybean, potato, tomato, banana and plantain, soybean, sunflower, groundnut and olive – stood out as having high production or food-supply values relative to the amount of germplasm reported distributed. This probably reflects the difficulty of conserving and distributing certain crops, the exclusion of some from Annex 1, and/or the relative paucity of major breeding programmes for some. Approximately 95.3 percent of samples belonged to crops listed in Annex 1. Chief among the non-Annex 1 crops distributed were groundnut, lettuce, soybean, Capsicum crops, tomato, flax and spinach, each with over 5,000 samples distributed.
1. INTRODUCTION

1.1 Plant Genetic Resources and their Conservation and Use

Seeds and other reproductive propagules of cultivated plant species and their wild relatives are a critically important resource that underpins the productivity, quality, sustainability, resilience and adaptive capacity of food and agricultural systems (Hoisington et al., 1999; Esquinas-Alcázar, 2005; Gepts, 2006). Farmers’ varieties (landraces) and their wild relatives have been the basis of agricultural production for over 10,000 years (Larson et al., 2014), but their value as a genetic resource only began to be recognized by scientists in the late nineteenth and early twentieth centuries (Baur, 1914; Zeven, 1998), in parallel with the rediscovery of Mendel’s laws of inheritance and the development of modern genetics (Harwood, 2016; Khoury et al., 2021). *Ex situ* repositories (genebanks) were subsequently established to maintain genetic resource (germplasm) collections and distribute them to support the breeding of new crop varieties (Vavilov, 1926; Lehmann, 1981; Saraiva, 2013).

In parallel, concerns began to be raised over the loss of crop diversity from farmers’ fields and from wild habitats due to rapid agricultural, environmental, socioeconomic and other changes (Baur, 1914; Harlan and Martini, 1936). Such concerns were eventually highlighted at the Food and Agriculture Organization of the United Nations (FAO), particularly in light of the large-scale replacement of traditional varieties by modern cultivars during the “Green Revolution” (Bennett, 1964, 1968; Frankel and Bennett, 1970; Frankel, 1974; Pistorius, 1997; Fensin and Bonneuil, 2016). There was also a growing awareness of the susceptibility of modern crop cultivars to pests and diseases because of their genetic uniformity (Tatum, 1971; National Research Council, 1972; U.S. Senate, 1980).

These concerns resulted in the expansion of efforts around the world to collect and maintain plant genetic resources *ex situ* (Plucknett et al., 1987). At the international level, the International Board for Plant Genetic Resources (IBPGR) was established in 1974 to coordinate a global initiative to conserve threatened genetic resources. IBPGR supported the collecting of over 200,000 samples of landraces, crop wild relatives and other materials in 136 countries between 1975 and 1995, and helped to establish international genebank collections to maintain these samples (Thormann, Engels and Halewood, 2019).

Over the course of the 1980s and 1990s, while national, regional and international *ex situ* collections were amassed, there was growing concern about the vulnerability of these collections, due largely to insufficient funding and infrastructure. Genebanks were encouraged to duplicate their holdings to mitigate these challenges and protect the holdings from natural disasters, war and civil strife (Holden, 1984; Lyman, 1984; Peeters and Williams, 1984).

At the same time, plant genetic resources were increasingly recognized as important not only for breeding but also in underpinning the resilience and adaptive capacity of agrarian communities and their agroecosystems (Mijatovic et al., 2013; Fensin and Bonneuil, 2016; Sirami et al., 2019). Support for the *in situ* conservation of landraces on farms increased (Brush, 1991; Wood and Lenne, 1997; Bellon, 2004), though
some questioned its efficacy in the face of widespread environmental and societal change (Frankel and Soule, 1981; Zeven, 1996; Peres, 2016).

In the 1990s, concern about the loss of biodiversity in all its forms became a global priority and resulted in the adoption of the Convention on Biological Diversity (CBD), which mandated its conservation and sustainable use, and the fair and equitable sharing of the benefits arising from such use (CBD, 1992). With the coming into force of the CBD, earlier international agreements on plant genetic resources (e.g. FAO, 1983) were renegotiated, resulting in the adoption in 2001 of the legally binding International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA, also referred to in this study as the Treaty) (FAO, 2009). In 2004, the Global Crop Diversity Trust (Crop Trust) was established by FAO and the Consultative Group on International Agricultural Research (CGIAR) to help provide long-term funding for the *ex situ* conservation of PGRFA (Esquinas-Alcázar, 2005).

By the end of 2020, 5.7 million accessions of plant genetic resources for food and agriculture (PGRFA) were reportedly conserved under medium- or long-term conditions in 831 genebanks by 114 countries and 17 regional and international research centres (FAO, 2021a). A proportion of this diversity is safety duplicated among the genebanks themselves and at the Svalbard Global Seed Vault (Westengen, Jeppson and Guarino, 2013), where over 1.2 million samples are now duplicated (Norwegian Ministry of Agriculture and Food, 2023; NordGen, 2023). Genetic resources are also conserved by botanic gardens, universities, non-profit organizations, community seedbanks, local conservation networks and private companies, while plant breeding and other research programmes also store genetic resources, at least for short periods (Miller *et al*., 2015; Vernooy *et al*., 2017). Numerous initiatives continue to focus on *in situ* conservation (e.g. Stenner *et al*., 2016; AGUAPAN, 2023; Global Environmental Facility, 2023).

These decades of efforts have been both substantial and global, but conservation gaps continue to exist (FAO, 2010; Castañeda-Álvarez *et al*., 2016; Khoury *et al*., 2021; Ramirez-Villegas *et al*., 2022). Two Global Plans of Action for Plant Genetic Resources for Food and Agriculture have been adopted to address these gaps (FAO, 1996; FAO, 2011). In recent decades, the Aichi Biodiversity Targets of the CBD and the subsequent Kunming-Montreal Global Biodiversity Framework, as well as the United Nations Sustainable Development Goals set urgent targets for enhanced conservation of plant genetic resources (CBD, 2010, 2023; United Nations 2015; Díaz *et al*. 2020).

The global status, patterns and trends of many important genetic resource activities remain poorly understood. One key area for which information has been historically limited is the distribution of germplasm by genebanks and other providers. *The Second Report on the State of the World’s Plant Genetic Resources for Food and Agriculture* (Second Report) stated that distribution trends from national genebanks were seldom provided in the country reports (i.e. the documents submitted by countries as inputs to the preparation of the global report) and that only data from the international agricultural research centres were comprehensively available (FAO, 2010). The Second Report presented distribution statistics from the international genebanks and provided examples of germplasm distribution data for a few countries, including China, Ethiopia, Germany, India, Japan, Kenya, Malawi, Pakistan, Poland and Switzerland. However, in the
case of the national data, only summary statistics were generally available, thus very limited information could be synthesized regarding the extent of distribution of particular crops to different recipients. While these examples meant that the Second Report provided somewhat more information than the original report on *The State of the World’s Plant Genetic Resources for Food and Agriculture* (First Report) (FAO, 1997), it was unable to provide a comprehensive global picture of germplasm distribution. Academic and research literature, meanwhile, has generally focused on the distribution of germplasm by CGIAR centres, as data on this were more readily available through the CGIAR System-wide Information Network on Genetic Resources (SINGER) (Fowler, Smale and Gaiji, 2001; Galluzzi *et al.*, 2016) and more recently through the Online Reporting Tool (ORT) maintained by the Crop Trust in its role as coordinator of the CGIAR Genebank Research Programme (2012 to 2016) and Genebank Platform (2017 to 2021) (Halewood *et al.*, 2020).

Global germplasm distribution has begun to be much more comprehensively documented over the last 10 to 15 years. At the international level, this is largely the result of increased efforts promoted by the Second Global Plan of Action for Plant Genetic Resources for Food and Agriculture (Second GPA) to standardize national-level reporting through FAO’s World Information and Early Warning System on Plant Genetic Resources for Food and Agriculture (WIEWS) (FAO, 2011). In addition, the Data Store of the Multilateral System of Access and Benefit Sharing of the ITPGRFA documents germplasm distribution made with the Treaty’s Standard Material Transfer Agreement (SMTA). These two information systems provide the foundation for this present analysis.

1.2 The Third Report on the State of the World’s Plant Genetic Resources for Food and Agriculture and the call for a thematic background study on germplasm exchange

The First Report was launched in 1996 during the Fourth International Technical Conference on Plant Genetic Resources, in Leipzig (FAO, 1997). Over 155 countries contributed to its preparation, providing the first ever global summary of the state of conservation and use of plant genetic resources. The findings triggered the adoption of the first Global Plan of Action on the Conservation and Sustainable Use of Plant Genetic Resources for Food and Agriculture (First GPA) by the Fourth International Technical Conference as basis on which to begin to address gaps and needs (FAO, 1996).

In 2009, FAO launched the Second Report, which was endorsed by the Commission on Genetic Resources for Food and Agriculture at its Twelfth Regular Session (FAO, 2010). Country reports contributed by 115 countries provided the main source of information, enabling changes and developments that had occurred since the First Report to be highlighted and the identification of the most significant gaps needing to be addressed. In response to the Second Report, the Commission agreed to revise the First GPA and, in 2011, approved the Second GPA, which was subsequently adopted by the FAO Council on behalf of the FAO Conference (FAO, 2011).

In 2013, the Commission decided that a draft *Third Report on the State of the World’s Plant Genetic Resources for Food and Agriculture* (Third Report) should be made available at its Eighteenth Regular Session in 2021. In
2017, at its Sixteenth Regular Session, the Commission revised the timeline for the preparation of the Third Report, and at its Nineteenth Regular Session, it took note of the draft third Report and invited Members and observers of the Commission and of the Treaty to provide comments on it by 30 November 2023. The Commission recommended that the Third Report be made available in due time for the Twelfth Session of the Intergovernmental Technical Working Group on Plant Genetic Resources for Food and Agriculture in 2024 (CGRFA-19/23/Report).

In 2019, the Commission requested National Focal Points (NFPs) to report on the implementation of the Second GPA for the period July 2014 to December 2019 through WIEWS. In addition, it invited the NFPs to provide a summative narrative of progress made between January 2012 and December 2019 and to identify remaining gaps and constraints. The Commission also requested FAO to propose thematic background studies, including on the global exchange of germplasm from and to genebanks, to complement the other information to be used for the preparation of the Third Report. It requested FAO to specify the purpose and content of the proposed studies, including how they would contribute to the Third Report (CGRFA-17/19/Report).

A document on progress made in gathering information for the Third Report prepared for the Eighteenth Regular Session of the Commission (FAO, 2021b) reported that the process no longer relied only on standalone country reports but also drew on data gathered and reported to WIEWS in two reporting periods, the first running from January 2012 to June 2014 and the second running from July 2014 to December 2019. The document also included the following statement on the scope of a revised list of proposed thematic background studies:

“The thematic background studies shall provide context for the Third Report. They shall review the relevant emerging issues, advances and/or trends, especially in scientific and technological disciplines, legal and regulatory matters, policies, norms and societal developments since the publication of the Second Report on the State of the World’s Plant Genetic Resources for Food and Agriculture (Second Report)” (FAO, 2021b)

It also detailed the terms of the proposed study on germplasm exchange:

“Purpose: The purpose of this study is to further explore the contributions of germplasm exchange to the conservation and sustainable use of PGRFA. The continued improvement of food security and nutrition largely depends on the possibility to exchange germplasm across countries and regions. Germplasm exchange and distribution may also play an important role for restoring crop collections in centres of origin or enhancing crop diversity in farmers’ fields, including after disaster situations. Information on germplasm exchange, as reported by countries through the World Information and Early Warning System on Plant Genetic Resources for Food and Agriculture (WIEWS) Reporting Tool on indicators 6, 28 and 29 of the Second GPA monitoring framework and under the Data Store of the Multilateral System of the International Treaty on Plant Genetic Resources for Food and Agriculture (Treaty) will form the basis for this thematic background study.”
“Content: The study will go beyond data usually reported by countries and make use of additional sources of information by incorporating data from other existing active collections currently not covered by country reporting in WIEWS. The study will also cover the germplasm collections of crops that do not fall under Annex 1 of the Treaty and, thus, complement information about material transferred with the Treaty’s Standard Material Transfer Agreement. The study, which will be conducted in collaboration with the Secretariat of the Treaty, will also provide information on the possible impacts of the COVID-19 pandemic on germplasm distribution.”

“Contribution to the Third Report: A review of the advances, trends and gaps in these areas shall provide context for data obtained from countries for Chapters 3 and 4 of the Report.” (FAO, 2021b).

The scope of this thematic background study was finalized with further inputs from FAO and the Treaty in 2021 and early 2022.

2. METHODOLOGY AND DATA SOURCES SUMMARY

This study of global germplasm exchange is primarily based on an analysis of two complementary information sources, covering the period 2012 to 2019:

1. The FAO WIEWS Indicators 28 and 29 (Number of accessions and Number of samples distributed by genebanks to users of germplasm) as well as Indicator 6 (Number of farmers’ varieties/landraces distributed by national or local genebanks to farmers). These datasets primarily report distributions of germplasm from national genebanks. Provider countries, provider institutions, types of recipient (optionally), crops and numbers of accessions (i.e. unique populations or genotypes maintained as individual entities) and samples (i.e. individual packets of seeds or other propagules) distributed in total as well as to various recipient types are reported for two periods (beginning of 2012 to mid-2014, and mid-2014 to end of 2019); specific recipient countries or recipient institutions are not reported.

2. The Data Store of the Multilateral System of Access and Benefit Sharing of the Treaty. This dataset includes all distributions made under the SMTA that have been reported to the Governing Body. It records numbers of samples distributed by any provider, including genebanks as well as breeding programmes and other organizational types; it is primarily composed of distributions made by CGIAR centres (genebanks and breeding programmes). Countries where providers and recipients are located, crops and numbers of samples distributed are reported for each year from 2012 to 2019; specific provider institutions, recipient institutions or recipient organizational types are not reported.

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1 FAO’s Genebank Standards defines an accession as “a distinct, uniquely identifiable sample of seeds representing a cultivar, breeding line or a population, which is maintained in storage for conservation and use” (FAO, 2014). This can be extrapolated to other reproductive propagules aside from seed.

2 Thus, many samples of a single accession can be distributed.
These datasets were standardized and supplemented with additional data and information. For providers and recipients, these included world region classifications (United Nations Statistical Division region and subregion names [M49]) (UNSTATS, 2022), country income levels (World Bank Country and Lending Groups classification system), and Contracting Party status with respect to the Treaty and the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity (Nagoya Protocol). For crops, additional data and information included crop use types (based on the Second Report and other categorizations), status with respect to inclusion in Annex 1 of the Treaty, crop use metrics (drawing on global production and food-supply data from FAOSTAT) and germplasm type/seed storage behaviour types (from literature and from Kew’s Seed Information Database [SER, INSBR and RBG Kew, 2023]). Supplementary information was also synthesized from CGIAR germplasm distribution data and from published literature.

An extended description of the methodology and data sources is provided in Annex 1 to this study. Compiled and processed datasets for the two main data sources are included alongside the study. Their data dictionaries are provided in Annex 2 and Annex 3. Data from the additional sources of information are available in Halewood et al. (2020) and Lusty et al. (2021).

3. RESULTS

3.1 Total Distributions

The WIEWS dataset indicates that from the beginning of 2012 to the end of 2019, providers distributed a total of 1,269,818 accessions (Figure 1): 258,288 between the beginning of 2012 and mid-2014, and 1,015,530 between mid-2014 and the end of 2019. This equates to an annual average of 158,727.3 accessions distributed over the full eight-year period, including 103,315.2 annually between 2012 and 2014, and 183,914.5 annually between 2014 and 2019.

In terms of samples, the WIEWS dataset indicates that between the beginning of 2012 and the end of 2019, providers distributed a total of 4,182,582 samples (Figure 1): 829,939 between the beginning of 2012 and mid-2014, and 3,352,643 between mid-2014 and the end of 2019. This equates to an annual average of 522,822.8 samples distributed over the full eight-year period, including 331,975.5 annually between 2012 and 2014, and 609,571.5 annually between 2014 and 2019.

The Treaty dataset indicates that, from the beginning of 2012 to the end of 2019, a total of 3,975,709 samples were distributed under the SMTA (Figure 1). This equates to an average of 496,963 samples per year.

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1 For the first reporting period, one data provider reported a limited number of distributions for a timeframe of 2009 to 2013. These distributions were reported only for samples (not accessions) and totalled 162,753 samples.
3.2 Domestic Versus International Distributions

The **WIEWS dataset** includes information on the distribution of 793,850 accessions for which specific information is provided on recipient organizational type (62.5 percent of the total accessions covered). Note that indicating the amounts distributed to the different categories of recipient was optional for Indicators 28 and 29. Assuming that the recipient categories NARC, Private Sector, Farmer or NGO, Others and Unknown all represent domestic organizations, with only the category Foreign Stakeholders representing international distributions, 747,551 accessions (94.2 percent of accessions distributed with recipient type information; 58.9 percent of all accessions distributed) were distributed domestically and 46,299 (5.8 percent of accessions distributed with recipient type information; 3.6 percent of all accessions distributed) were distributed internationally. Between 2012 and 2014, 180,336 (69.8 percent) out of 258,288 accessions distributed were attributed to recipient type; of these, 165,424 (91.7 percent of those with recipient information; 64 percent of the total) were distributed domestically and 14,912 (8.3 percent of those with recipient information; 5.8 percent of the total) were distributed internationally. Likewise, between 2014 and 2019, 613,514 (60.7 percent) out of 1,011,530 accessions distributed were attributed to recipient type; of these, 582,127 (94.9 percent of those with recipient information; 57.5 percent of the total) were distributed domestically, and 31,387 (5.1 percent of those with recipient information; 3.1 percent of the total) were distributed internationally. These figures equate to an annual average of 93,443.9 accessions distributed domestically and 5,787.4 internationally per year across the full period, including 66,169.6 domestically and 5,964.8 internationally between 2012 and 2014, and 105,841 domestically and 5,706.7 internationally between 2014 and 2019.
In terms of samples, the **WIEWS dataset** includes information on a total of 2,788,604 samples distributed with specific information on recipient organizational type, representing 66.7 percent of the total samples covered. Assuming that the recipient categories NARC, Private Sector, Farmer or NGO, Others and Unknown all represent domestic distributions, with only the category Foreign Stakeholders representing international distributions, 2,724,239 samples (97.7 percent of samples distributed with recipient type information; 65.1 percent of all samples distributed) were distributed domestically, and 64,365 samples (2.3 percent of samples distributed with recipient type information; 1.5 percent of all samples distributed) were distributed internationally. Between 2012 and 2014, 478,148 (57.6 percent) out of 829,939 samples distributed were attributed to recipient type; of these, 454,844 (95.1 percent of those with recipient information; 54.8 percent of the total) were distributed domestically and 23,304 (4.9 percent of those with recipient information; 2.8 percent of the total) were distributed internationally. Likewise, between 2014 and 2019, 2,310,456 (68.9 percent) out of 3,352,643 samples distributed were attributed to recipient type; of these, 2,269,395 (98.2 percent of those with recipient information; 67.7 percent of the total) were distributed domestically, and 41,061 (1.8 percent of those with recipient information; 1.2 percent of the total) were distributed internationally. These figures equate to an annual average of 340,529.9 samples distributed domestically and 8,045.6 internationally per year across the full period, including 181,937.6 distributed domestically and 9,321.6 internationally between 2012 and 2014, and 412,617.3 domestically and 7,465.6 internationally from 2014 to 2019.

The **Treaty dataset** includes information on 933,984 (23.5 percent) samples distributed domestically and 3,041,725 (76.5 percent) internationally. This equates to an annual average of 116,748 samples distributed domestically and 380,215.6 internationally across the entire period. The annual number of domestic distributions grew on average over the eight-year period, while the number of international distributions fell.
Figure 2. Proportions of accessions and samples distributed domestically and internationally during the period 2012 to 2019 (WIEWS and Treaty datasets). For the WIEWS dataset, domestic versus international distributions were estimated based on information on recipient type, under the assumption that recipient categories NARC, Private Sector, Farmer or NGO, Others and Unknown all represent domestic organizations, with only the category Foreign Stakeholders representing international distributions. For the Treaty dataset, provider and recipient country information was used.

3.3 Distributions by International Centres Versus National or Other Institutions

Distributions by international centres were not included in the main WIEWS dataset. A supplementary dataset provided by FAO for the same indicators and the same eight-year period indicates that a total of 328,069 accessions were distributed by 11 CGIAR centres and the World Vegetable Center, including 148,985 accessions between 2012 and 2014, and 179,084 between 2014 and 2019. These equate to an annual average of 41,008.6 accessions distributed by international centres over the full period, including 59,594 annually between 2012 and 2014 and 32,560.7 annually between 2014 and 2019. If added to the main WIEWS dataset (covering national and other providers), distributions by international centres would equal 20.5 percent of total world distributions of accessions, and those by national and other institutions 79.5 percent. From 2012 to 2014, 36.6 percent of world total distributions of accessions were by made by international centres and 63.4 percent by national and other institutions. Likewise, between 2014 and 2019, 15 percent of total world distributions of accessions were by made by international centres, and 85 percent by national and other institutions (Figure 3).
Figure 3. Proportions of accessions and samples distributed by international centres and national and other providers between 2012 and 2019 (WIEWS dataset). A supplementary WIEWS dataset for the 2012 to 2019 period and covering 11 CGIAR centres and the World Vegetable Center was combined with the main FAO WIEWS dataset for this analysis.

In terms of samples, the supplementary international centre WIEWS dataset indicates that a total of 707,194 samples were distributed by 11 CGIAR centres and the World Vegetable Center during the entire period, including 244,267 samples between 2012 and 2014, and 462,927 between 2014 and 2019. This equates to an annual average of 88,399.3 samples distributed by international centres over the full period, including 97,706.8 annually between 2012 and 2014, and 84,168.5 annually between 2014 and 2019. If added to the main (national and other providers) WIEWS dataset, distributions by international centres would equal 14.5 percent of total world distributions of samples, and those by national and other institutions would equal 85.5 percent. Between 2012 and 2014, 22.7 percent of total world distributions of samples were by international centres and 77.3 percent by national and other institutions. Likewise, between 2014 and 2019, 12.1 percent of world total distributions of accessions were by international centres and 87.9 percent by national and other institutions (Figure 3). Note that given the much higher number of samples distributed by international centres reported in the Treaty dataset (see immediately below), the international centre WIEWS dataset should not be considered a comprehensive account of these transfers, thus the true proportion of total global distributions made from international centres is likely to be larger than the estimates presented here.

The Treaty dataset indicates that 3,534,349 samples (88.9 percent of the total) were distributed by international (CGIAR) centres during the eight-year period and that 441,360 samples (11.1 percent) were distributed by other providers (Figure 4). This equates to an annual average of 441,793.6 samples distributed by international centres and 55,170 by other providers across the entire period. The relative proportion of samples distributed by international centres did not change significantly over the eight-year period. Depending on the year, they distributed between 83.7 percent and 92.2 percent of total samples, while other providers distributed between 7.8 percent and 16.3 percent.

The Treaty dataset also indicates that 680,067 (19.2 percent) of samples distributed by CGIAR centres went to recipients within country where the centre was located, while 2,854,282 samples (80.8 percent) were sent...
from CGIAR centres to recipients outside the country. This equates to an annual average of 85 008.4
samples distributed by international centres domestically and 546 785.3 to recipients in other countries
across the entire period. Distributions from CGIAR centres to recipients within the country where the
centre was located grew on average annually over the eight-year period, while international distributions
declined slightly.

Figure 4. Proportions of samples distributed by international centres and national and other providers between 2012 and
2019 (Treaty dataset).

3.4 Distributions by Countries, Regions and Income Categories

According to the WIEWS dataset, germplasm was distributed by 87 provider countries during one or both
reporting periods. At the accession level, a total of 81 provider countries distributed more than 100
accessions with 54 distributing more than 1 000 accessions, 22 distributing more than 10 000 accessions,
and three distributing more than 100 000 accessions over the eight-year period. Those provider countries
distributing the largest numbers of accessions included Australia, Bangladesh, Canada, China, Ethiopia,
France, Germany, India, the Islamic Republic of Iran, Italy, the Kingdom of the Netherlands, Pakistan and
Sweden, all of which distributed more than 20 000 total accessions between 2012 and 2019 (Figure 5). In
terms of average annual distributions, 56 provider countries reported distributing more than 100 accessions
per year over the full period, 27 reported distributing more than 1 000 accessions, and four (Australia, China,
Germany and India) reported distributing more than 10 000 accessions.

For the 2012 to 2014 period, 63 provider countries were reported. Fifty-three of these countries distributed
more than 100 accessions each, 27 of which distributed more than 1 000 and eight of which distributed
more than 10 000. Where annual averages are concerned, 42 provider countries distributed more than 100
accessions per year, seven of which distributed more than 1 000 accessions per year and three of which
(Bangladesh, Germany and Pakistan) distributed more than 10 000 accessions per year. For the 2014 to 2019
period, 79 provider countries were reported. Sixty-seven of these distributed more than 100 accessions each,
459 44 of which distributed more than 1 000, 18 of which distributed more than 10 000, and two of which
460 (Australia and China) distributed more than 100 000. Where annual averages are concerned, 49 provider
countries distributed more than 100 accessions per year, 24 of which distributed more than 1 000 accessions
462 per year, and four of which (Australia, China, Germany and India) distributed more than 10 000 accessions
463 per year.

464 The total numbers of accessions distributed by providers in the various regions of the world, as recorded in
465 the WIEWS dataset for the full period (Figure 6), were as follows (in descending order):

466 • Asia – 627 716 (49.4 percent; 22 countries), largest numbers in Eastern and Southern Asia;
467 • Europe – 314 313 (24.8 percent; 24 countries), largest numbers in Western Europe;
468 • Oceania – 128 466 (10.1 percent; 2 countries), overwhelmingly Australia;
469 • Americas – 99 986 (7.9 percent; 16 countries), fairly evenly distributed across subregions; and
470 • Africa – 99 337 (7.8 percent; 23 countries), largest numbers in Eastern Africa.

471 Figure 5. Provider-country totals for accession distributions between 2012 and 2019 (WIEWS dataset).

472 The numbers of accessions distributed by providers in the various regions of the world during the period
474 2012 to 2014 were as follows (in descending order):

475 • Asia – 103 260 accessions (40 percent of the total; annual average 41 304 accessions);
476 • Europe – 94 642 accessions (36.6 percent of the total; annual average 37 856.8);
477 • Africa – 30 466 (11.8 percent of the total; annual average 12 186.4);
• Americas – 25 687 (9.9 percent of the total; annual average 10 274.8); and
• Oceania – 4 233 (1.6 percent of the total; annual average 1 693.2).

The numbers for the period 2014 to 2019 were as follows (again in descending order):
• Asia – 524 456 accessions (51.8 percent of the total; annual average 95 355.6 accessions);
• Europe – 219 671 accessions (21.7 percent of the total; annual average 39 940.2);
• Oceania – 124 233 (12.3 percent of the total; annual average 22 587.8);
• Americas – 74 299 (7.3 percent of the total; annual average 13 508.9); and
• Africa – 68 871 (6.8 percent of the total; annual average 12 522).

Seventeen countries identified by the United Nations as LDCs\(^4\) reported distributing 108 223 accessions (8.5 percent of the total) across the eight-year period, 18 classified as LLDs\(^5\) reported distributing 66 356 accessions (5.2 percent of the total), and four classified as SIDS\(^6\) reported distributing 11 190 accessions (0.9 percent of the total). Note that countries can be assigned to more than one of these categories.

Figure 6. Provider-region totals for accession distributions between 2012 and 2019 (WIEWS dataset)

Figures from the WIEWS dataset for distributions by providers from countries in the various World Bank country-income categories were as follows (in descending order):
• high-income countries distributed between 499 400 and 501 166 accessions (39.3–39.5 percent) depending on whether the country classification was based on the first (2012 or 2014) or final (2014 or 2019) year of the respective reporting period, with an average of 500 283 (39.4 percent);
• upper middle-income countries distributed between 448 533 and 458 650 accessions (35.3–6.1 percent), with an average of 453 591.5 (35.7 percent);

\(^4\) In descending order of accessions distributed, these were Ethiopia, Bangladesh, United Republic of Tanzania, Sudan, Nepal, Zambia, Uganda, Bhutan, Yemen, Chad, Mali, Malawi, Eritrea, Niger, Madagascar, Togo and Senegal.
\(^5\) In descending order of accessions distributed, these were Ethiopia, Uzbekistan, Mongolia, Zambia, Zimbabwe, Uganda, Azerbaijan, Armenia, Bhutan, Botswana, Tajikistan, Chad, Mali, Malawi, Kyrgyzstan, Niger and Republic of Moldova.
\(^6\) In descending order of accessions distributed, these included Trinidad and Tobago, Cuba, Guyana and Papua New Guinea.
lower middle-income countries distributed between 229,036 and 250,002 accessions (18–19.7 percent), with an average of 239,519 (18.9 percent); and

- low-income countries distributed between 60,000 and 92,849 accessions (4.7–7.3 percent), with an average of 76,424.5 (6 percent).

At the sample level, the WIEWS dataset indicates that a total of 85 provider countries distributed more than 100 samples over the full period, 64 of which provided more than 1,000 samples, 39 provided more than 10,000 samples, and 12 provided more than 100,000. The provider countries that reported distributing the largest numbers of samples included Australia, Bangladesh, China, Ethiopia, France, Germany, India, Indonesia, Nicaragua, Nigeria, Spain and Togo, all with over 100,000 total samples distributed between 2012 and 2019 (Figure 7). In terms of average annual distributions, 65 provider countries reported distributing more than 100 samples, 40 more than 1,000 samples, 14 more than 10,000 samples and one (Nicaragua) more than 100,000 samples per year on average over the full period.

For the 2012 to 2014 period, 65 provider countries were reported. Fifty-eight of these countries distributed more than 100 samples, 40 more than 1,000 samples, 19 more than 10,000 samples and one (France) more than 100,000 samples. Fifty-two provider countries distributed more than 100 samples per year on average, 28 of which distributed more than 1,000, and 11 of which distributed more than 10,000. For the period 2014 to 2019, 79 provider countries were reported. Seventy-two of these countries distributed more than 100 samples, 54 of which distributed more than 1,000, 31 more than 10,000 and nine more than 100,000. Fifty-eight provider countries distributed more than 100 samples per year on average, 37 of which distributed more than 1,000, 15 more than 10,000 and one (Nicaragua) more than 100,000.
Figure 7. Provider-country totals for sample distributions between 2012 and 2019 (WIEWS dataset).

The numbers of samples distributed by providers in the various regions of the world, as recorded in the WIEWS dataset for the eight-year period (Figure 8), were as follows (in descending order):

- **Americas** – 1,213,063 (29 percent; 16 countries), largest numbers in Central America;
- **Europe** – 1,204,883 (28.8 percent; 24 countries), largest numbers in Western Europe;
- **Asia** – 1,074,221 (25.7 percent; 22 countries), largest numbers in Eastern, Southern and South-eastern Asia;
  - • Africa – 561,788 (13.4 percent; 23 countries), largest numbers in Western and Eastern Africa; and
  - • Oceania – 128,627 (3.1 percent; 2 countries), largest numbers in Melanesia.

The figures for the 2012 to 2014 period were as follows:

- **Europe** – 408,536 samples (49.2 percent of the total; annual average 163,414.4);
- **Asia** – 236,034 samples (28.4 percent of the total; annual average 94,413.6);
- **Americas** – 95,230 (11.5 percent of the total; annual average 38,092);
- **Africa** – 85,906 (10.4 percent of the total; annual average 34,362.4); and
- • **Oceania** – 4,233 (0.5 percent of the total; annual average 1,693.2).

Those for the 2014 to 2019 period were as follows:

- **Americas** – 1,117,833 (33.3 percent of the total; annual average 203,242.4);
- **Asia** – 838,187 samples (25 percent of the total; annual average 152,397.6);
Europe – 796 347 samples (23.8 percent of the total; annual average 144 790.4);

- Africa – 475 882 (14.2 percent of total; annual average 86 524); and

- Oceania – 124 394 (3.7 percent of total; annual average 22 617.1).

Figure 8. Provider-region totals for sample distributions between 2012 and 2019 (WIEWS dataset)

According to the WIEWS dataset, 17 countries identified by the United Nations as LDCs\(^6\) distributed 535 433 samples (12.8 percent of the total), 18 classified as LLDCs\(^7\) distributed 130 627 samples (3.1 percent of total); and four classified as SIDS\(^8\) distributed 132 910 samples (3.2 percent of total). Note that countries can be assigned to more than one of these categories.

Figures for distributions by providers from countries in the various World Bank income categories were as follows (in descending order):

- lower middle-income countries distributed between 1 501 429 and 1 701 933 samples (35.9–40.7 percent), depending on whether the country classification was based on the first (2012 or 2014) or final (2014 or 2019) year of the reporting period, with an average of 1 601 681 (38.3 percent);

- high-income countries distributed between 1 368 055 and 1 418 838 samples (32.7–33.9 percent), with an average of 1 393 446.5 (33.3 percent);

- upper middle-income countries distributed between 680 368 and 894 938 samples (16.3–21.4 percent), with an average of 787 653 (18.8 percent); and

- low-income countries distributed between 367 377 and 43 226 samples (8.8–10.3 percent), with an average of 39 801.5 (9.6 percent).

The Treaty dataset contains information on distributions from providers located in 48 countries between 2012 and 2019. Over 100 samples were distributed from 38 countries, more than 1 000 samples from 34 of these, more than 10 000 samples from 21, more than 100 000 samples from nine, and more than 1 million samples from one. The countries from which the largest numbers of samples were distributed included

\(^6\) In descending order of samples distributed, these were Togo, Bangladesh, Ethiopia, United Republic of Tanzania, Sudan, Nepal, Zambia, Uganda, Malawi, Bhutan, Yemen, Senegal, Chad, Mali, Eritrea, Niger and Madagascar.

\(^7\) In descending order of samples distributed, these were Ethiopia, Uzbekistan, Nepal, Zambia, Uganda, Mongolia, Malawi, Zimbabwe, Armenia, Azerbaijan, Bhutan, Botswana, Tajikistan, Kyrgyzstan, Chad, Mali, Niger and Republic of Moldova.

\(^8\) In descending order of samples distributed, these were Guyana, Trinidad and Tobago, Cuba and Papua New Guinea.
Colombia, Germany, India, Kenya, Lebanon, Mexico, Morocco, the Philippines and Türkiye, each with over 100 000 samples distributed (Figure 9). These statistics mainly reflect the presence of CGIAR centres within the borders of the respective countries. With regard to average annual distributions, providers in 37 countries distributed more than 100 samples per year on average over the full period, those in 23 distributed more than 1 000 samples, those in nine distributed more than 10 000 samples, and those in one distributed more than 100 000 samples.

The numbers of samples distributed by providers in the various regions of the world, as recorded in the Treaty dataset (Figure 10), were as follows (in descending order):

- **Americas** – 1 903 518 samples (47.9 percent of the total; annual average of 237 939.8 samples distributed by providers in 8 countries), largest numbers in Central America;
- **Asia** – 1 171 880 samples (29.5 percent of the total; annual average of 146 485 samples distributed by providers in 11 countries), including large distributions from Western, South-eastern and Southern Asia;
- **Africa** – 560 659 samples (14.1 percent of the total; annual average of 70 082.4 samples distributed by providers in 15 countries), largest numbers in Northern and Eastern Africa;
- **Europe** – 333 675 samples (8.4 percent of the total; annual average of 41 709.4 samples distributed by providers in 11 countries), largest numbers in Western Europe; and
- **Oceania** – 5 977 samples (0.2 percent of the total; annual average of 747.1 samples distributed by providers in 3 countries), largest numbers in Australia.

These statistics mainly reflect the presence of CGIAR centres within the various regions. The regional figures fluctuated considerably from year to year, but there was no discernible pattern of increase or decrease over time.
Figure 10. Provider-region totals for sample distributions between 2012 and 2019 (Treaty dataset)

Nine countries identified by the United Nations as LDCs\(^9\) were home to the providers of 70,569 samples (1.8 percent of the total distributed; annual average of 8,821.1 samples across all years). Providers in six countries classified as LLDCs\(^10\) distributed 93,583 samples (2.4 percent of the total; annual average of 11,697.9). Providers in two countries classified as SIDS\(^11\) distributed 877 samples (0.02 percent of the total; annual average of 109.6). Note that countries can be assigned to more than one of these categories. The regional figures fluctuated considerably from year to year, but there was no discernible pattern of increase or decrease over time.

Figures for distributions by providers from countries in the various World Bank income categories across the eight-year period, as recorded in the Treaty dataset, were as follows (in descending order):

- upper middle-income countries distributed 237,1934 samples (59.7 percent of the total; annual average of 296,491.8);
- lower middle-income countries distributed 107,4913 samples (27 percent of the total; annual average of 134,364.1);
- high-income countries distributed 415,480 samples (10.5 percent of the total; annual average of 51,935.0); and
- low-income countries distributed 113,382 samples (2.9 percent of the total; annual average of 14,172.8).

These statistics again mainly reflect the location of CGIAR centres. The figures fluctuated considerably from year to year, but there was no general discernible pattern of increase or decrease over time for the country categories. If only distributions made by CGIAR centres are considered, the general pattern is the same: upper middle-income countries distributed 2346,873 samples (66.4 percent; annual average of 293,359.1

\(^9\) In descending order of samples distributed, these were Benin, Niger, Ethiopia, Mali, Sudan, Malawi, United Republic of Tanzania, Uganda and Madagascar.

\(^10\) In descending order of samples distributed, these were Zimbabwe, Niger, Ethiopia, Mali, Malawi and Uganda.

\(^11\) In descending order of samples distributed, these were Fiji and Papua New Guinea.
over the eight-year period; lower middle-income countries distributed 1 070 497 samples (30.3 percent; annual average of 133 812.1); low-income distributed 111 803 samples (3.2 percent; annual average of 13 975.4); and high-income countries distributed the considerably lower total of 5 176 samples (0.1 percent; annual average of 647).

The Treaty dataset contains information on samples distributed to recipients in 179 countries between 2012 and 2019. Over 100 samples were distributed to recipients in a total of 158 countries, over 1 000 samples were distributed to recipients in 131 of these countries, over 10 000 samples to those in 61, and over 100 000 to those in ten. Countries to which the largest number of samples were distributed included India, Kenya, Mexico, Türkiye, the United States of America, Germany, Canada, China, Pakistan and the Islamic Republic of Iran, each of which received more than 100 000 samples under the SMTA (Figure 11). As distributions from CGIAR centres comprised most of the distributions (88.9 percent of the total), these recipients primarily obtained samples under the SMTA from these centres. Where average annual distributions are concerned, recipients in 131 countries received more than 100 samples per year on average over the full period, 75 of which received more than 1 000 samples, and 11 of which received more than 10 000 samples.

The numbers of samples distributed to recipients in the various regions of the world, as recorded in the Treaty dataset (Figure 12), were as follows (in descending order):

- Asia – 1 672 930 samples distributed to recipients in 46 countries (42.1 percent of the total; annual average of 209 116.3), with Southern and Western Asia receiving the most;
Africa – 896 174 samples distributed to recipients in 50 countries (22.5 percent; annual average of 112 021.8), with Eastern and Northern Africa receiving the most;

Americas – 842 543 samples distributed to recipients in 31 countries (21.2 percent; annual average of 105 317.9), with South America, Northern America and Central America receiving roughly similar amounts;

Europe – 524 174 samples distributed to recipients in 37 countries (13.2 percent; annual average of 65 521.8), with Western Europe receiving the most; and

Oceania – 39 888 samples distributed to recipients in 15 countries (1 percent; annual average of 4 986), with Australia and New Zealand receiving the most.

The regional figures fluctuated considerably from year to year, but there was no discernible pattern of increase or decrease over time.

Figure 12. Recipient-region totals for distributions of samples between 2012 and 2019 (Treaty dataset).

Recipients in 45 countries identified by the United Nations as a LDCs\(^ {12} \) received 435 535 samples (11 percent of the total; annual average of 54 441.9 samples), 32 classified as LLDCs\(^ {13} \) received 496 871 samples (12.5 percent of the total; annual average of 62 108.9 samples), and 30 classified as SIDS\(^ {14} \) received 11 890 samples (0.3 percent of the total; annual average of 1 486.3 samples). Note that countries can be assigned to more than one of these categories. The figures fluctuated considerably from year to year, but

\(^ {12} \) In descending order of samples received, these were Ethiopia, Afghanistan, Bangladesh, Sudan, Nepal, Uganda, Zambia, Myanmar, United Republic of Tanzania, Mali, Malawi, Senegal, Niger, Eritrea, Mozambique, Burkina Faso, Rwanda, Madagascar, Burundi, Benin, Democratic Republic of the Congo, Bhutan, Sierra Leone, Angola, Togo, Yemen, Lao People’s Democratic Republic, Gambia, Cambodia, Haiti, Guinea, Lesotho, Mauritania, Liberia, Somalia, South Sudan, Guinea-Bissau, Chad, Kiribati, Timor-Leste, Comoros, Tuvalu, Solomon Islands, Central African Republic and Djibouti.

\(^ {13} \) In descending order of samples received, these were Ethiopia, Zimbabwe, Afghanistan, Bolivia (Plurinational State of), Uzbekistan, Uganda, Zambia, Kazakhstan, Azerbaijan, Paraguay, Tajikistan, Mali, Malawi, Niger, Armenia, Burkina Faso, Rwanda, Burundi, Kyrgyzstan, Turkmenistan, Bhutan, Mongolia, Lao People’s Democratic Republic, Lesotho, Republic of Moldova, Eswatini, South Sudan, Chad, Botswana, North Macedonia and Central African Republic.

\(^ {14} \) In descending order of samples received, these were Dominican Republic, Guyana, Singapore, Haiti, Suriname, Cuba, Dominica, Fiji, Papua New Guinea, Guinea-Bissau, Jamaica, Mauritius, Trinidad and Tobago, Belize, Kiribati, Timor-Leste, Marshall Islands, Comoros, Tuvalu, Vanuatu, Samoa, Solomon Islands, Nauru, Grenada, Palau, Bahamas, Saint Vincent and the Grenadines, Cook Islands and Micronesia (Federated States of).
there was no generally discernible increasing or decreasing trend, except in the case of SIDS recipients, who received fewer samples in more recent years.

Figures for recipients in countries in the various World Bank income categories across the eight-year period, as recorded in the Treaty dataset, were as follows (in descending order):

- recipients in lower middle-income countries received 1,535,605 samples (38.6 percent of the total; annual average of 191,950.6);
- recipients in upper middle-income countries received 1,063,435.5 samples (26.7 percent; annual average of 132,929.4);
- recipients in high-income countries received 947,390 samples (23.8 percent; annual average of 118,432.8); and
- recipients in low-income countries received 429,214 (10.8 percent; annual average of 53,651.8).

The figures fluctuated considerably from year to year, but there was no general discernible increasing or decreasing trend. If only CGIAR distributions are considered, the general pattern is similar: recipients in lower middle-income countries received 1,508,495 samples (42.7 percent; annual average of 188,561.9); those in upper middle-income countries received 1,011,792 samples (28.6 percent; annual average of 126,474); those in high-income countries received 585,515 (16.7 percent; annual average of 73,689.4); and those in low-income countries received 424,547 samples (12 percent; annual average of 53,068.4).

3.5 Distributions to Specific Recipient Types

3.5.1 Distributions to recipient organizational types

The WIEWS dataset records 793,850 accessions distributed with specific information on recipient type (62.5 percent of all accessions distributed) and 2,788,604 samples distributed with specific information on recipient type (66.7 percent of all samples distributed). Note that indicating the amounts distributed to the different categories of recipient was optional for those reporting on Indicators 28 and 29. Analyses of these data is based on the premise that the categories NARC, Private Sector, Farmer or NGO, Others and Unknown all represent domestic distributions, with the category Foreign Stakeholders representing international distributions.

The numbers of accessions received by the different recipient types (Figure 13) were as follows (in descending order):

- NARC – 480,266 (60.5 percent of designated accessions; 37.8 percent of the total accessions; annual average of 60,033.3 accessions);
- others – 139,973 (17.6 percent of designated; 11 percent of the total; annual average of 17,496.6);
- farmers or NGOs – 62,272 (7.8 percent of designated; 4.9 percent of the total; annual average of 7,784);
- private sector – 46,405 (5.8 percent of designated; 3.7 percent of the total; annual average of 5,800.6);
- foreign stakeholders – 46,299 (5.8 percent of designated; 3.6 percent of the total; annual average of 5,787.4); and
The figures for 2012 to 2014 were as follows:

- NARC – 95 570 (53 percent of designated accessions; 37 percent of the total accessions; annual average of 38 228 accessions);
- others – 45 944 (25.5 percent of designated; 17.8 percent of the total; annual average of 18 377.6);
- foreign stakeholders – 14 912 (6.1 percent of designated; 5.8 percent of the total; annual average of 5 964.8);
- private sector – 11 938 (6.6 percent of designed; 4.6 percent of the total; annual average of 4 775.2);
- farmers or NGOs – 7 797 (4.3 percent of designated; 3 percent of the total; annual average of 3 118.8); and
- unknown – 4 175 (2.3 percent of designated; 1.6 percent of the total; annual average of 1 670).

The figures for 2014 to 2019 were as follows:

- NARC – 384 696 (62.7 percent of designated accessions; 38 percent of the total accessions; annual average of 69 944.7 accessions);
- others – 94 029 (15.3 percent of designated; 9.3 percent of the total; annual average of 17 096.2);
- farmers or NGOs – 54 475 (8.9 percent of designated; 5.4 percent of the total; annual average of 9 904.5);
- private sector – 34 467 (5.6 percent of designed; 3.4 percent of the total; annual average of 6 266.7);
- foreign stakeholders – 31 387 (4.4 percent of designated; 3.1 percent of the total; annual average of 5 706.7); and
- unknown – 14 460 (2.4 percent of designated; 1.4 percent of the total; annual average of 2 629.1).

Figure 13. Proportions of accessions distributed to different recipient organizational types between 2012 and 2019 (WIEWS dataset).
The numbers of samples received by the different recipient types (Table 1, Figure 14) were as follows (in descending order):

- private sector – 1 047 760 (36.6 percent of designated samples; 25.1 percent of the total samples; annual average of 130 970);
- NARC – 864 478 (31 percent of designated; 20.7 percent of the total; annual average of 108 059.8);
- farmers or NGOs – 550 427 (19.7 percent of designated; 13.2 percent of the total; annual average of 68 803.4);
- others – 211 485 (7.6 percent of designated; 5.1 percent of the total; annual average of 26 435.6);
- foreign stakeholders – 64 365 (2.1 percent of designated; 1.5 percent of the total; annual average of 8 045.6); and
- unknown – 50 089 (1.8 percent of designated; 1.2 percent of the total; annual average of 6 261.1).

The figures for 2012 to 2014 were as follows:

- NARC – 279 029 (58.4 percent of designated samples; 33.6 percent of the total samples; annual average of 111 611.6 samples);
- farmers or NGOs – 71 321 (14.9 percent of designated; 8.6 percent of the total; annual average of 28 528.4);
- others – 54 049 (11.3 percent of designated; 6.5 percent of the total; annual average of 21 619.6);
- private sector – 45 256 (9.5 percent of designated; 5.5 percent of the total; annual average of 18 102.4);
- foreign stakeholders – 23 304 (3.5 percent of designated; 2.8 percent of the total; annual average of 9 321.6); and
- unknown – 5 189 (1.1 percent of designated; 0.6 percent of the total; annual average of 2 075.6).

The figures for 2014 to 2019 were as follows:

- Private Sector – 1 002 504 samples (43.4 percent of designated samples; 29.9 percent of the total samples; annual average of 182 273.5 samples per year);
- NARC – 585 499 (25.3 percent of designated; 17.9 percent of the total; annual average of 106 445.3);
- farmers or NGOs – 479 106 (20.7 percent of designated; 14.3 percent of the total; annual average of 87 110.2);
- others – 157 436 (6.8 percent of designated; 4.7 percent of the total; annual average of 28 624.7);
- unknown – 44 900 (1.9 percent of designated; 1.3 percent of the total; annual average of 8 163.6); and
- foreign stakeholders – 41 061 (1.5 percent of designated; 1.2 percent of the total; annual average of 7 465.6).
3.5.2 Number of farmers’ varieties/landraces distributed by national or local genebanks to farmers (either directly or through intermediaries)

The WIEWS dataset records a total of 58,324 farmers’ varieties/landraces distributed by national or local genebanks to farmers (either directly or through intermediaries) over the eight-year period (average of 7,290.5 per year). From the beginning of 2012 to mid-2014, 6,917 farmers’ varieties/landraces were reported distributed (average of 2,766.8 per year). Between mid-2014 and the end of 2019, 51,407 farmers’ varieties/landraces were reported distributed (average of 9,346.7 per year).

These data were reported by 70 countries, which include most of the 86 countries reporting on Indicators 28 and 29 (Number of accessions and Number of samples distributed by genebanks to users of germplasm), and include in addition contributions from Benin, the Democratic Republic of the Congo, Guatemala and Guinea. The countries that reported distributing the most farmers’ varieties/landraces to farmers included Bangladesh, Brazil, Mexico, Peru and Spain, all of which distributed over 1,000 farmers’ varieties/landraces during the entire period (Figure 15).
Figure 15. Provider-country totals for distributions of farmers’ varieties/landraces by national or local genebanks to farmers (either directly or through intermediaries) between 2012 and 2019 (WIEWS dataset).

The numbers of farmers’ varieties/landraces distributed to farmers by organizations in the various regions of the world were as follows:

- Americas – 36,067 varieties/landraces (61.8 percent of the total; annual average of 4,508.4), especially South America;
- Europe – 11,102 (19 percent; annual average of 1,387.8), especially Southern Europe;
- Asia – 7,887 (13.5 percent; annual average of 985.9), especially Southern Asia;
- Africa – 3,213 (5.5 percent; annual average of 401.6), especially Eastern Africa; and
- Oceania – 55 (0.1 percent; annual average of 6.9), entirely by organizations in Australia.

Sixteen countries identified by the United Nations as LDCs\(^\text{15}\) reported distributing 7,899 farmers’ varieties/landraces (13.5 percent of the total; annual average of 987.4); 15 LLDCs\(^\text{16}\) reported distributing 3,165 farmers’ varieties/landraces (5.4 percent of the total; annual average of 395.6); and one SIDS (Guyana) reported distributing 150 farmers’ varieties/landraces (0.3 percent of the total; annual average of 18.8). Note that countries can be assigned to more than one of these categories.

\(^{15}\) In descending order of samples distributed, these were Bangladesh, Nepal, Guinea, Uganda, Ethiopia, Niger, Zambia, Mali, United Republic of Tanzania, Benin, Bhutan, Madagascar, Malawi, Senegal, Democratic Republic of the Congo and Eritrea.

\(^{16}\) In descending order of samples distributed, these were Zimbabwe, Nepal, Uganda, Ethiopia, Niger, Azerbaijan, Zambia, Botswana, Mali, Kyrgyzstan, Armenia, Bhutan, Uzbekistan, Tajikistan and Malawi.
The figures for the various World Bank income categories were as follows (in descending order):

- upper middle-income countries distributed between 37 092 and 37 164 farmers’ varieties/landraces (63.6–63.7 percent), depending on whether the country classification was based on the first (2012 or 2014) or final (2014 or 2019) year of the reporting period, with an average of 37 128 (63.7 percent);
- high-income countries distributed between 10 798 and 10 826 farmers’ varieties/landraces (18.5–18.6 percent), with an average of 10 812 (18.5 percent);
- lower middle-income countries distributed between 7 232 and 8 509 farmers’ varieties/landraces (12.4–14.6 percent), with an average of 7 870.5 (13.5 percent), and
- low-income countries distributed between 1 825 and 3 202 farmers’ varieties/landraces (3.1–5.5 percent), with an average of 2 513.5 (4.3 percent).

Farmers’ varieties/landraces belonging to a total of 250 crops or general crop categories were distributed to farmers during the eight-year period. Many of the data were not specifically attributed to crops but were rather categorized as multiple crops (18 022 varieties/landraces; 30.9 percent of the total), vegetables (9 845; 16.9 percent), cereals (1 222; 2.1 percent), pulses (1 184; 2 percent) or fruits (910; 1.6 percent). The crops that were specifically reported included maize (3 592; 6.2 percent), cassava (3 568; 6.1 percent), common bean (1 418; 2.4 percent), sweet potato (1 296; 2.2 percent), rice (1 295; 2.2 percent) and groundnut (982; 1.7 percent). The numbers of farmers’ varieties/landraces belonging to the various crop groups distributed to farmers were as follows (in descending order): multiple crops – 18 002 (30.9 percent of the total); vegetables – 13 690 (23.5 percent); cereals – 8 808 (15.1 percent), roots and tubers – 7 291 (12.5 percent); legumes – 5 826 (10 percent); and nuts, fruits and berries – 2 770 (4.7 percent). The remaining categories (fibre plants; forages; industrial and ornamental plants; medicinal plants, aromatic plants, spices and stimulant plants; not specified; oil plants; and sugar plants) each comprised 1 percent or less of total distributions.

3.5.3 Transfers made to international and regional genebank recipients

The WIEWS dataset does not contain a recipient organizational type permitting clear identification of international and regional genebanks as recipients. It offers only the categories NARC, Private Sector, Farmer or NGO, Others, Foreign Stakeholders and Unknown. It is possible that distributions made to Others or Foreign Stakeholders represent some distributions to international and regional genebanks. A total 139 973 accessions and 211 485 samples were distributed to Others, and 46 299 accessions and 64 365 samples to Foreign Stakeholders (Table 1). The Treaty dataset did not contain information on recipient organizational types, only on recipient countries.

Information from the Online Reporting Tool (ORT) for CGIAR centres maintained by the Crop Trust indicates that during the period 2010 to 2019 (inclusive), the CGIAR genebanks acquired about 90 000 samples for inclusion in Article 15 collections (Halewood et al., 2020; Lusty et al., 2021). Approximately 35 percent of the samples came from the centres’ own breeding programmes. As these are internal transfers, they would not be reported by the centres to the Governing Body of the Treaty as transfers using the SMTA, and therefore would not be counted in the statistics on such transfers cited in this paper. Most of the
germplasm acquired by the centres – approximately 65 percent – came from providers in 142 different countries; 84 percent of those countries are developing countries or countries with economies in transition.

Where the period focused on in the present study is concerned, the CGIAR genebanks received almost 14 000 samples in 2012. The numbers dropped thereafter, with fewer than 5 000 samples received in 2019. The peak period of acquisition (generally from 2010 to 2014) was at least partly the result of an internationally funded project coordinated by the Crop Trust that assisted national genebanks to regenerate and safety-duplicate unique and threatened PGRFA. Many of the national genebanks collaborating in this project elected to send samples of the respective materials to CGIAR genebanks. All the samples were either received under the SMTA or under other agreements whereby the providers gave the CGIAR centres permission to subsequently distribute the material under the SMTA; such permission includes material provided by countries that are not currently Contracting Parties to the Treaty (Halewood et al., 2020; Lusty et al., 2021).

3.5.4 Inter-genebank exchanges or safety duplications

Neither the WIEWS nor the Treaty datasets analysed here offer clear information regarding inter-genebank exchanges or safety duplications. The ORT for CGIAR centres maintained by the Crop Trust likewise does not specifically track inter-genebank exchanges, but it does indicate that approximately 25 000 to 50 000 accessions are typically safety duplicated at the Svalbard Global Seed Vault annually and that approximately 5 000 to 50 000 accessions are safety duplicated at other CGIAR or other regional or national genebanks annually (Halewood et al., 2020; Lusty et al., 2021). These safety duplications are not included in the Treaty dataset, as they are not transferred under the SMTA.

3.6 Distributions by Contracting-Party Status of the Country in which Provider or Recipient is Located

3.6.1 Distributions and receipts by providers and recipients located in countries that are Contracting Parties to the Treaty and in those that are not

The WIEWS dataset in combination with information on Treaty Contracting Party status indicates that between 880 501 and 894 937 accessions (69.3–70.5 percent of the total) were distributed by providers located in countries that are Contracting Parties to the Treaty, the figure depending on whether the Contracting Party status is assigned based on the first (2012 or 2014) or final (2014 or 2019) year of the reporting period. Taking averages between the two alternative sets of figures provides the following results: 887 719 accessions; 69.9 percent of the total; average of 110 964.9 accessions per year across the period.

Thus the number of accessions distributed by providers located in countries that were not Contracting Parties was between 374 881 and 389 317 (29.5–30.7 percent of the total). Taking averages between the two alternative sets of figures provides the following results: 382 099 accessions; 30.1 percent of the total; average of 47 762.4 accessions per year (Figure 16). The WIEWS dataset does not contain information on the recipient country, and thus it is not possible to determine the Treaty Contracting Party status of the recipients of these germplasm distributions.
During the 2012 to 2014 period, the number of accessions distributed by Contracting Parties to the Treaty (based on the country location of the provider) was 238,209 or 248,902 (92.2 percent or 96.4 percent of the total), depending on whether Contracting Party status is assigned based on the first (2012) or final (2014) year of the reporting period. Taking averages between the two alternative sets of figures provides the following results: 243,555.5 accessions; 94.3 percent of the total; annual average of 97,422.2 accessions per year across the period. The number of accessions distributed by providers located in non-Contracting Party countries was thus 9,386 or 20,079 accessions (3.6 percent or 7.8 percent of the total) depending on the year for which Contracting Party status is assigned. Taking averages between the two alternative sets of figures provides the following results: 14,732.5 accessions; 5.7 percent of the total; average of 5,893 accessions per year across the period.

During the 2014 to 2019 period, the number of accessions distributed by Contracting Parties to the Treaty (based on the country location of the provider) was 642,292 or 646,035 (63.5 percent or 63.9 percent of the total), depending on whether Contracting Party status is assigned based on the first (2014) or final (2019) year of the reporting period. Taking averages between the two alternative sets of figures provides the following results: 644,163.5 accessions; 63.7 percent of the total; average of 117,120.6 accessions per year across the period. The number of accessions distributed by providers located in non-Contracting Party countries was thus 365,495 or 369,238 (36.1 percent or 36.5 percent of the total). Taking averages between the two alternative sets of figures provides the following results: 367,366.5 accessions; 36.3 percent of the total; average of 66,793.9 accessions per year across the period.

Where samples are concerned, the WIEWS dataset in combination with information on Treaty Contracting Party status indicates that between 3,557,533 and 3,642,055 samples (85.1–87.1 percent of the total), were distributed by Contracting Parties to the Treaty (based on the country location of the provider), depending on whether Contracting Party status is assigned based on the first (2012 or 2014) or final (2014 or 2019).
year of the reporting period. Taking averages between the two alternative sets of figures provides the following results: 3,599,794 samples; 86.1 percent of the total; average of 449,974.3 samples per year across the period. The number of samples distributed by providers located in non-Contracting Party countries was thus between 540,527 and 625,049 samples (12.9–14.9 percent of the total). Taking averages between the two alternative sets of figures provides the following results: 582,788 samples; 13.9 percent of the total; average of 72,848.5 samples per year across the period (Figure 17).

Figure 17. Proportions of samples distributed by providers located in Treaty Contracting Parties and non-Parties between 2012 and 2019 (WIEWS dataset).

During the 2012 to 2014 period, the number of samples distributed by Contracting Parties to the Treaty (based on the country location of the provider) was 768,880 or 789,217 (92.6 percent or 95.1 percent of the total), depending on whether Contracting Party status is assigned based on the first (2012) or final (2014) year of the reporting period. Taking averages between the two alternative sets of figures provides the following results: 779,048 samples; 93.9 percent of the total; average of 311,619.4 samples per year across the period. The number of samples distributed by providers located in non-Contracting Party countries was thus 40,722 or 61,059 samples (4.9 percent or 7.4 percent of the total). Taking averages between the two alternative sets of figures provides the following results: 50,890.5 samples; 6.1 percent of the total; average of 20,356.2 samples per year across the period.

During the 2014 to 2019 period, the number of samples distributed by Contracting Parties to the Treaty (based on the country location of the provider) was 2,788,653 or 2,852,838 (83.2 percent or 85.1 percent of the total), depending on whether Contracting Party status is assigned based on the first (2014) or final (2019) year of the reporting period. Taking averages between the two alternative sets of figures provides the following results: 2,820,745.5 samples; 84.1 percent of the total; average of 512,862.8 samples per year across the period. The number of samples distributed by providers located in non-Contracting Party countries was thus 499,805 or 563,990 (14.9 percent or 16.8 percent of the total). Taking averages between the two
alternative sets of figures provides the following results: 531,897.5 samples; 15.9 percent of the total; average of 96,708.6 samples per year across the period.

The *Treaty dataset* in combination with information on Treaty Contracting Party status indicates that 2,114,348 samples (53.2 percent of the total; average of 264,293.5 samples per year across the period) were distributed using the SMTA by organizations located in countries that were Contracting Parties to the Treaty, and 1,861,361 (46.8 percent; annual average of 232,670.1) samples were distributed by organizations located in countries that were not Contracting Parties (*Figure 18*). Given that a) the Treaty dataset overwhelmingly comprises CGIAR distribution data (88.9 percent of total distributions were by international centres), b) germplasm maintained by CGIAR centres is made available in the Multilateral System according to the agreements concluded under the provisions of Article 15 of the Treaty, and c) various CGIAR centres are located in countries that are not currently Contracting Parties to the Treaty (e.g. Colombia, Mexico and Nigeria), it is very likely that these statistics based solely on country location of providers drastically underestimate the total distributions made under the terms and conditions of the Treaty.

![Figure 18. Proportions of samples distributed by providers located in Contracting Parties and non-Parties to the Treaty between 2012 and 2019 (Treaty dataset).](image)

The Treaty dataset in combination with information on Treaty Contracting Party status indicates that 3,194,162 samples (80.3 percent of the total; average of 399,270.3 samples per year across the whole period) that were distributed using the SMTA were received by organizations located in countries that were Contracting Parties to the Treaty, and that 781,547 (19.7 percent; annual average of 97,693.4) were received by organizations located in countries that were non-Contracting Parties (*Figure 19*). The proportion of samples received by recipients in non-Contracting Parties declined in general over the eight-year period.
3.6.2 Distributions by providers and receipts by recipients located in countries that are Parties to
the Nagoya Protocol and those that are not

The WIEWS dataset in combination with information on Nagoya Protocol Contracting Party status
indicates that between 178 222 and 769 389 accessions (14–60.6 percent of the total), were distributed by
providers located in countries that were Contracting Parties to the Nagoya Protocol, depending on whether
Contracting Party status was assigned based on the first (2012 or 2014) or final (2014 or 2019) year of the
reporting period. Taking averages between the two alternative sets of figures provides the following results:
473 805.5 accessions; 37.3 percent of the total; average of 59 225.7 accessions per year. The number of
accessions distributed by non-Contracting parties was thus between 500 429 and 1 091 596 accessions (39.4–
86 percent of the total). Taking averages between the two alternative sets of figures provides the following
results: 796 012.5 accessions; 62.7 percent of the total; average of 99 501.6 accessions per year (Figure 20).
The WIEWS dataset does not contain information on recipient countries, and thus it is not possible to
determine the Contracting Party status of the recipients of these distributions with respect to the Nagoya
Protocol.

During the 2012 to 2014 period, the number of accessions distributed by providers located in countries that
were Contracting Parties to the Nagoya Protocol was zero or 39 946 (0 percent or 15.5 percent of the total),
depending on whether status is assigned based on the situation in 2012 or 2014. Taking averages between
the two alternative sets of figures provides the following results: 19 973 accessions; 7.7 percent of the total;
average of 7 989.2 accessions per year. The number of accessions distributed by providers located in non-
Contracting Party countries was thus 218 342 or 258 288 (84.5–100 percent of the total), depending on the
year of assignment. Taking averages between the two alternative sets of figures provides the following results:
238 315 accessions; 92.3 percent of the total; annual average of 95 326 accessions per year.
During the 2014 to 2019 period, the number of accessions distributed by providers located in countries that were Contracting Parties to the Nagoya Protocol was 178,222 or 729,443 (17.6 percent or 72.1 percent of the total), depending on whether Contracting Party status is assigned based on the situation in 2014 or 2019. Taking averages between the two alternative sets of figures provides the following results: 453,832.5 accessions; 44.9 percent of the total; average of 82,515 accessions per year. The number of accessions distributed by providers located in non-Contracting Party countries was thus 282,087 or 833,308 (27.9–82.4 percent of the total). Taking averages between the two alternative sets of figures provides the following results: 557,697.5 accessions; 55.1 percent of the total; average of 101,399.5 accessions per year.

**Figure 20.** Proportions of accessions distributed by providers located in Nagoya Protocol Contracting Parties and non-Parties between 2012 and 2019 (WIEWS dataset).

Where samples are concerned, the WIEWS dataset in combination with information on Nagoya Protocol Contracting Party status indicates that the number of samples distributed by providers located in countries that were Contracting Parties to the Nagoya Protocol was between 771,523 and 2,196,858 (18.4–52.5 percent of the total), depending whether Contracting Party status is assigned based on the first (2012 or 2014) or final (2014 or 2019) year of the reporting period. Taking averages between the two alternative sets of figures provides the following results: 1,484,190.5 samples; 35.5 percent of the total; average of 185,523.8 samples per year. The number of samples distributed by non-Contracting Parties was thus between 1,985,724 and 3,411,059 samples (47.5–81.6 percent of the total). Taking averages between the two alternative sets of figures provides the following results: 2,698,391.5 samples; 64.5 percent of the total; average of 337,298.9 samples per year (Figure 21).

During the 2012 to 2014 period, the number of samples distributed by providers in countries that were Contracting Parties to the Nagoya Protocol was 0 or 296,046 samples (0 percent or 35.7 percent of the total), depending on whether Contracting Party status is assigned based on the situation in 2012 or 2014. Taking averages between the two alternative sets of figures provides the following results: 148,023 samples; 17.8 percent of the total; average of 59,209.2 samples per year. The number of samples distributed by providers located in non-Contracting Party countries was thus 533,893 or 829,939 (64.3 percent or
100 percent of the total). Taking averages between the two alternative sets of figures provides the following results: 681,916 samples; 82.2 percent of the total; average of 272,766.4 samples per year.

During the 2014 to 2019 period, the number of samples distributed by providers in countries that were Contracting Parties to the Nagoya Protocol was 771,523 or 1,900,812 (23 percent or 56.7 percent of the total), depending on whether contracting party status was assigned based on the situation in 2014 or 2019. Taking averages between the two alternative sets of figures provides the following results: 1,336,167.5 samples; 39.9 percent of the total; average of 242,939.5 samples per year. The number of samples distributed by providers located in non-Contracting Party countries was thus 1,451,831 or 2,581,120 (43.3 percent or 77 percent of the total). Taking averages between the two alternative sets of figures provides the following results: 2,016,475.5 samples; 60.1 percent of the total; average of 366,631.9 samples per year.

The Plant Treaty dataset in combination with information on Nagoya Protocol Contracting Party status indicates that 2,076,603 samples (52.2 percent of the total; average of 259,575.4 samples per year across the whole period) were distributed under the SMTA by providers located in countries that were Contracting Parties to the Nagoya Protocol. Conversely, 1,899,106 samples (47.8 percent of the total; average of 237,388.3 samples per year across the whole period) were provided by organizations located in countries that were non-Contracting Parties (Figure 22). Note that the Treaty dataset is overwhelmingly composed of distributions by CGIAR providers.

Figure 21. Proportions of samples distributed by providers located in Nagoya Protocol Contracting Parties and non-Parties between 2012 and 2019 (WIEWS dataset).
The Treaty dataset indicates that 1,643,252 samples (41.3 percent of the total; annual average of 205,406.5 samples) were distributed under the SMTA to receiving organizations located in countries that were Contracting Parties to the Nagoya Protocol. Conversely, 2,332,457 samples (58.7 percent of the total; annual average of 291,557.1 samples) were received by organizations located in countries that were not Contracting Parties (Figure 23). The relative proportion of samples received by recipients in non-Contracting Parties declined in general over the eight-year period.

Figure 22. Proportions of samples distributed by providers located in Contracting Parties and non-Parties to the Nagoya Protocol between 2012 and 2019 (Treaty dataset).

Figure 23. Proportions of samples distributed to recipients located in Contracting Parties and non-Parties to the Nagoya Protocol between 2012 and 2019 (Treaty dataset).
3.7 Distributions by Crops and Crop Types

3.7.1 Distributions by crops

The WIEWS dataset contained over 1 750 crop names or combinations. These were standardized to 843 distinct crops or (when it was not possible to identify specific crop) crop groups. The number of reported distributions per crop ranged from as low as one accession or sample to as high as 177 808 accessions or 371 107 samples over the eight-year period.

Where accessions are concerned, the dataset shows that more than 100 000 accessions of each of three crops (wheat, rice and soybean) were distributed, between 10 000 and 100 000 accessions of each of 22 crops, between 1 000 and 10 000 accessions of each of 72 crops, between 100 and 1 000 of each of 98 crops, and fewer than 100 accessions of each of 643 crops (Figure 24). The crops or crop groups with the highest total numbers of accessions distributed over the full period, in descending order, were wheat, rice, soybean, barley, multiple crops, cereal crops, unspecified crops, common bean, chickpea, Brassica crops, maize, fruit crops, vegetable crops, oat, sorghum, pea, cotton, citrus, potato, oil crops, pulse crops, tomato, broad bean and vetch, tobacco and lentil, all with over 10 000 accessions distributed (and all with more than 1 250 accessions distributed on average annually); these 25 crops or crop groups represent over three-quarters (76.8 percent) of all accessions distributed.
Figure 24. Numbers of accessions distributed per crop or crop group (when specific crops were not listed) between 2012 and 2019 (WIEWS dataset).

During the 2012 to 2014 period, the crops or crop groups with the largest numbers of accessions distributed included wheat, multiple crops, cereal crops, unspecified crops, rice, oil crops, barley, vegetable crops, pulse crops, *Acacia*, sorghum, *Brassica* crops, potato, chickpea, forage crops, common bean and *Capsicum* crops, all with over 1 000 accessions distributed on average annually. During the 2014 to 2019 period, the crops or crop groups with the largest numbers of accessions distributed included wheat, rice, soybean, barley, common bean, fruit crops, maize, chickpea, multiple crops, *Brassica* crops, unspecified crops, oat, citrus crops, cotton, cereal crops, pea, vegetable crops, sorghum, tomato, potato, tobacco, broad bean and vetch, lentil, finger millet, pear, oil crops, *Capsicum* crops, cocoa, tea, okra, sesame and oil crops, all with over 1 000 accessions distributed on average annually.

Where samples are concerned, more than 100 000 samples were distributed of each of 10 crops, between 10 000 and 100 000 samples of 48 crops, between 1 000 and 10 000 samples of 126 crops, between 100 and...
1 000 samples of 133 crops, and fewer than 100 samples of 526 crops (Figure 25). The crops or crop groups with the highest total numbers of samples distributed over the full period, in descending order, were dragon fruit, rice, wheat, citrus crops, pistachio, soybean, cocoa, avocado, barley and coffee, all with over 100 000 samples distributed (and over 13 000 samples distributed on average annually); these ten crops or crop groups represent 49 percent of all samples distributed.

**Figure 25.** Number of samples distributed per crop or crop group (when specific crops were not listed) between 2012 and 2019 (WIEWS dataset).

During the 2012 to 2014 period, the crops or crop groups with the largest numbers of samples distributed included rice, wheat, *Arabidopsis*, multiple crops, cereal crops, unspecified crops, fig, sorghum, potato, vegetable crops, pulse crops, barley, maize and tomato, all with an average of more than 5 000 samples distributed annually. During the 2014 to 2019 period, the crops or crop groups with the largest numbers of samples distributed included dragon fruit, rice, pistachio, citrus crops, wheat, soybean, cocoa, coffee, avocado, barley, mango, vegetable crops, rubber, unspecified crops, maize, cassava, *Brassica* crops, grape, *Acacia*, tomato, common bean, coconut, *Annona*, sugar cane, cereal crops and chickpea, all with an average of more than 5 000 samples distributed annually.
The *Treaty dataset* contained over 560 crop names or combinations, which were standardized to 270 distinct crops and (when not possible to identify the specific crop) crop groups. As few as one to as many as 1,874,121 samples were distributed per crop over the eight-year period. For the full dataset, more than 1,000,000 samples were distributed of one crop (wheat), between 100,000 and 1,000,000 samples of four crops, between 10,000 and 100,000 samples of 16 crops, between 1,000 and 10,000 samples of 30 crops, between 100 and 1,000 samples of 38 crops and between one and 100 samples of 181 crops (Figure 26).

The crops or crop groups with the highest total numbers of samples distributed over the eight-year period, in descending order, were wheat, maize, rice, barley, chickpea, unspecified crops, lentil, bean, sorghum, pearl millet, *Brassicaceae* crops, broad bean and vetch, pigeon pea, cowpea, potato, groundnut, oat, lettuce, grass pea and other *Lathyrus*, soybean and pea, all with over 10,000 samples distributed (and over 1,250 samples distributed on average annually). These 21 crops or crop groups account for 96.5 percent of all samples distributed. Annual distributions per crop varied from year to year, but there was no discernible trend across years.

**Figure 26.** Number of samples distributed per crop or crop group (when specific crops were not listed) between 2012 and 2019 (Treaty dataset).
3.7.2 Distributions by crop types

In the WIEWS dataset, crops that are primarily used for food comprised by far the largest numbers of accessions (1,098,101 accessions; 86.5 percent of the total; annual average of 137,262.6) and samples (3,673,106 samples; 87.8 percent of the total; annual average of 459,204) distributed over the eight-year period. Note that crops can have more than one use and information on specific purposes of germplasm use/crop breeding for each distribution was not available in the WIEWS dataset. Other categories of clearly designated crop types included, in descending order in terms of distributions of accessions, industrial crops, fibre crops, forage crops and medicinal crops.

Following the system of crop type categories utilized in the Second Report (FAO, 2010), 11 clearly identified crop types, as well as three unspecified categories, were represented in the WIEWS dataset. In terms of accessions, distributions by crop type ranged from as low as 2,093 (other plants) to as high as 536,360 (cereals) over the full period. The crop types with the highest total numbers of accessions distributed, in descending order, were cereals, oil plants, food legumes and vegetables, each with over 100,000 accessions distributed (and an average of more than 12,000 accessions distributed per year). These were followed by nuts, fruits and berries; multiple crops; medicinal plants, aromatic plants, spices and stimulant plants; unspecified crops; forages; roots and tubers, fibre plants; industrial and ornamental plants; sugar plants; and other plants (Figure 27).

During the 2012 to 2014 period, the crop types with the largest numbers of accessions distributed included cereals, food legumes, vegetables, multiple crops, oil plants, industrial and ornamental plants, unspecified crops and forages, each with over 10,000 accessions distributed in total (and an average of more than 4,000 accessions distributed per year). During the 2014 to 2019 period, the crop types with the largest numbers of accessions distributed included cereals; oil plants; food legumes; nuts, fruits and berries; vegetables; medicinal plants, aromatic plants, spices and stimulant plants; multiple crops; and forages, each with over 22,000 accessions distributed in total (and an average of more than 4,000 accessions distributed per year).
Figure 27. Numbers of accessions distributed per crop type between 2012 and 2019 (WIEWS dataset).

Where samples are concerned, the number of distributions per crop type recorded in the WIEWS dataset ranged from 2 097 (other plants) to 1 333 733 (nuts, fruits and berries) over the eight-year period. The crop types with the highest total numbers of samples distributed were, in descending order, nuts, fruits and berries; cereals; medicinal plants, aromatic plants, spices and stimulant plants; vegetables; oil plants; industrial and ornamental plants; and food legumes, each with a total of more than 225 000 samples distributed (and an average of more than 25 000 samples distributed per year). These were followed by roots and tubers; unspecified crops; multiple crops; forages; sugar plants; fibre plants; and other plants (Figure 28).

During the 2012 to 2014 period, the crop types with the largest numbers of samples distributed included cereals; vegetables; nuts, fruits and berries; industrial and ornamental plants; and food legumes, each with a total of more than 50 000 samples distributed (and an average of more than 20 000 samples distributed per year). During the 2014 to 2019 period, the crop types with the largest numbers of samples distributed included nuts, fruits and berries; cereals; medicinal plants, aromatic plants, spices and stimulant plants; vegetables; oil plants; food legumes; industrial and ornamental plants; and roots and tubers, each with more than 100 000 samples distributed in total (and an average of more than 20 000 samples distributed per year).

Like the WIEWS dataset, the Treaty dataset indicates that crops used primarily for food comprised by far the largest number of samples distributed over the eight-year period (3 861 441 samples; 97.1 percent of the total; annual average of 482 680.1). Note that crops can have more than one use and information on specific purposes of germplasm use/crop breeding for each sample distributed was not available in the Treaty dataset. After food crops, other categories of clearly designated crop types, in descending order in terms of distributions of samples, included forage crops, industrial (including forestry and ornamental purposes) crops, fibre crops and medicinal crops.
Following the system of crop type categories utilized in the Second Report (FAO, 2010), ten clearly identified crop types, as well as one unspecified category, were represented in the Treaty dataset. Distributions by crop type ranged from as few as 285 samples over the full period (fibre plants, with an annual average of 35.6) to as many as 3,226,629 samples (cereals, with an annual average of 403,328.6).

The crop types with the highest total numbers of samples distributed were, in descending order, cereals, food legumes, vegetables, unspecified crops, roots and tubers, forages and oil plants, each with over 20,000 samples distributed between 2012 and 2019 and an annual average of at least 2,500 samples distributed. These were followed by medicinal plants, aromatic plants, spices and stimulant plants; nuts, fruits and berries; industrial and ornamental plants; and fibre plants (Figure 29). Annual distributions per crop type varied from year to year, but there was no discernible trend over time.

Figure 28. Number of samples distributed per crop type between 2012 and 2019 (WIEWS dataset).
3.7.3 Distributions by crop improvement types (wild versus cultivated germplasm)

Neither the WIEWS nor the Treaty datasets contain specific information on the improvement type (i.e. wild, weedy, landrace, breeding material, cultivar, etc.) of the germplasm distributed. Nonetheless, based on notations in the original data and from the taxonomic name, it was possible to roughly estimate the proportions of wild relative versus domesticated crop germplasm among the materials distributed.

For the **WIEWS dataset**, it is estimated that at least 15 561 crop wild relative accessions (1.2 percent of the total; annual average of 1 945.1) and 27 500 crop wild relative samples (0.7 percent of the total; annual average of 3 437.5) were distributed over the eight-year period. The remaining 1 254 257 accessions (98.8 percent of the total; annual average of 156 782.1) and 4 155 082 samples (99.3 percent of the total; annual average of 519 385.3) distributed are estimated to have been domesticated crop germplasm. Proportions of wild versus domesticated germplasm distributed in the two periods (2012 to 2014, and 2014 to 2019) were similar to those for the eight-year period. As the WIEWS dataset does not specifically record whether germplasm belongs to a cultivated taxon or to a wild relative, the numbers of distributions of wild relatives or other wild taxa may have been considerably larger than the numbers reported here. Wild relatives of oat, lettuce, rice, wheat, barley, potato, tomato, cowpea, beet, jute mallow, tree tomato, pearl millet, spinach, groundnut, apple, unspecified *Solanum* crops, grape and carrot were the most distributed in terms of accessions, each with over 100 accessions distributed. In the case of samples, the same crops top the list.

For the **Treaty dataset**, it is estimated that at least 3 013 crop wild relative samples (0.1 percent of the total; annual average of 376.6 samples) of were distributed, with the remaining 3 972 696 samples (99.9 percent of the total; annual average of 496 587 samples) comprising domesticated crop germplasm. The proportions of wild relative and crop germplasm among the materials distributed varied from year to year, but there was no discernible trend across the years. As the Treaty dataset does not specifically record whether germplasm belongs to a cultivated taxon or a wild relative, the numbers of distributions of wild relatives or other wild...
taxa may be considerably higher than those reported here. Wild relatives of cowpea, lettuce, carrot, wheat, oat, barley, lentil and grass pea were the most distributed, each with more than ten samples distributed.

Information from the ORT for CGIAR centres maintained by the Crop Trust indicates that for the period 2017 to 2019 approximately 50 percent of samples distributed were traditional varieties/landraces, 24 percent were breeding materials, 13 percent were wild relatives, 8 percent were “other” and 6 percent were advanced/improved cultivars (Halewood et al., 2020).

3.7.4 Distributions by crop germplasm and storage behaviour types

Germplasm is typically distributed either as seed (sexually reproductive propagules) or as a clonal/vegetative (asexually reproductive) propagules, such as a tubers or cuttings. Many crops are commonly distributed using only one of these techniques, although some can be distributed in both ways.

Based on a rapid assessment of germplasm types, the WIEWS dataset indicates that at least 1,030,245 accessions (81.1 percent of the total; annual average of 128,780.6) were probably distributed by seed, and 111,609 accessions (8.8 percent of the total; annual average of 13,951.1) were probably distributed clonally/vegetatively, with a further 127,964 accessions (10.1 percent of the total) not readily attributable to germplasm type. Proportions of seed versus clonal/vegetative germplasm distributed in the two periods (2012 to 2014, and 2014 to 2019) were fairly similar to each other and to the eight-year period statistics, ranging between 75 percent and 82.7 percent for seed, and between 4.4 percent and 9.9 percent for clonal/vegetative germplasm.

In terms of samples, at least 2,170,424 samples (51.9 percent of the total; annual average of 271,303) were probably distributed as seed, and 1,645,711 samples (39.3 percent of the total; annual average of 205,713.9) were probably distributed clonally/vegetatively, with 366,417 samples (8.8 percent of the total) not readily attributable to germplasm type. Proportions of seed versus clonal/vegetative germplasm distributed in the two periods (2012 to 2014, and 2014 to 2019) varied considerably: 72 percent seed and 16.3 percent clonal in the first period reporting, and 46.9 percent seed and 45 percent clonal in the second. The relatively high proportion of clonal/vegetative germplasm distributed in the second period (and reflected in the eight-year period statistics) was due to very large distributions reported for dragon fruit, citrus, pistachio, cocoa, avocado, mango, cassava, potato, grape and other crops.

Based on a rapid assessment of germplasm types, the Treaty dataset indicates that at least 3,846,574 samples (96.8 percent of the total; annual average of 480,821.8) were probably distributed as seed, and 44,187 (1.1 percent of the total; annual average of 5,523.4) clonally/vegetatively, with the remaining 84,948 (2.1 percent of the total) not readily attributable to germplasm type. Annual distributions of seed versus clonal/vegetative germplasm varied by year, but there was no discernible trend over the years.

For seed-producing plants, germplasm can also be classified according to its storage behaviour, i.e. according to its ability to tolerate the low-humidity and low-temperature conditions typically employed in ex situ conservation. Orthodox seeds tolerate drying and cooling well and can be stored in cool, dry...
conditions. Recalcitrant seeds do not tolerate such conditions. Intermediate seeds tolerate cool, dry
conditions to a limited or variable extent.

Based on a rapid assessment of seed storage behaviour, drawing on information mainly from the Kew Seed
Information Database, the **WIEWS dataset** indicates that at least 1 024 047 distributed accessions
(80.6 percent of the total; annual average of 128 005.9) belonged to crops with orthodox or probably
orthodox seeds. At least 28 174 (2.2 percent of the total; annual average of 3 521.8) belonged to crops with
intermediate or probably intermediate seeds. At least 9 427 accessions (0.7 percent of the total; annual
average of 1 178.4) belonged to crops with recalcitrant or probably recalcitrant seeds. Finally, 208 170
accessions (16.4 percent of the total) were listed as uncertain or were not readily attributable to any seed
storage type. Proportions of orthodox, intermediate and recalcitrant types distributed in the two reporting
periods (2012 to 2014, and 2014 to 2019) were fairly similar to each other and to the eight-year period
statistics, ranging between 68.1 percent and 83.9 percent for orthodox, 0 percent and 2.8 percent for
intermediate, and 0.4 percent and 0.8 percent for recalcitrant seeds.

In terms of samples, at least 2 331 343 of those distributed (55.7 percent of the total; annual average of
291 417.9) belonged to crops with orthodox or probably orthodox seeds. At least 365 696 (8.7 percent of
the total; annual average of 45 712) belonged to crops with intermediate or probably intermediate seeds. At
least 455 654 (10.9 percent of the total; annual average of 56 956.8) belonged to crops with recalcitrant or
probably recalcitrant seeds. Finally, 1 029 889 (24.6 percent of the total) were listed as uncertain or were not
readily attributable to any seed storage type. Proportions of orthodox, intermediate and recalcitrant types
distributed in the two periods (2012 to 2014, and 2014 to 2019) varied considerably: 63.6 percent orthodox,
1.1 percent intermediate and 1.7 percent recalcitrant in the first reporting period, and 53.8 percent orthodox,
10.6 percent intermediate and 13.2 percent recalcitrant in the second reporting period.

Based on a rapid assessment of seed storage behaviour, the **Treaty dataset** indicates that at least 3 868 537
distributed samples (97.3 percent of the total; annual average of 483 567.1) belonged to crops with orthodox
or probably orthodox seeds. At least 7 123 (0.2 percent of the total; annual average of 890.4) belonged to
crops with intermediate or probably intermediate seeds. At least 55 (0.001 percent of the total; annual
average of 6.9) belonged to crops with recalcitrant or probably recalcitrant seeds, and 99 994 samples
(2.5 percent of the total) were listed as uncertain or were not readily attributable to seed storage type. Annual
distributions of orthodox, intermediate and recalcitrant types varied from year to year, but there was no
discernible trend over the years.

3.7.5 Distributions of crops in the context of their global use

Approximately 210 crops in the **WIEWS dataset** (24.9 percent of all crops in the dataset, but representing
65.5 percent of all accessions and 56.5 percent of all samples distributed) are tracked by FAOSTAT in terms
of production and/or food-supply metrics, either specifically (e.g. pineapple or potato) or within general
commodity groupings (e.g. pigeon pea, which is included under “Pulses, Other”, or passionfruit, which is
included under “Fruits, Other”).
An analysis of alignment between estimated global production metrics – including total production (tonnes), harvested area (hectares) and production value (gross constant thousand USD) – and numbers of accessions and samples distributed, as reported in the WIEWS dataset, indicated a generally positive correlation, with cereal crops such as wheat and rice having especially high production and germplasm distribution values (Figures 30, 31). Some crops, for example sugar cane, oil palm, beet, cassava and soybean, stood out as having very high global production but relatively low reported germplasm distributions.

A parallel analysis of alignment between global food-supply metrics – measured in terms of the contribution of crops to global calories (kcal/capita/day), protein (g/capita/day), fat (g/capita/day) and food weight (g/capita/day) – and numbers of accessions and samples distributed indicated similar trends in three metrics (calories, protein and food weight). Wheat, rice, maize, soybean, and potato had the highest food-supply values and the highest numbers of accessions and samples distributed (Figures 30, 31). Cassava, banana and plantain, grape and yam stood out as crops making a considerable contribution to food supplies (especially in terms of food weight) but having relatively low reported germplasm distributions. For fat, such outliers were even more evident, and included soybean, oil palm, sunflower, coconut, groundnut and olive, all with a very high contributions to fat in food supplies but a relatively small number of accessions and samples distributed. At the crop-type level, cereals and legumes showed the strongest correlation in terms of global production or food-supply values and the numbers of accessions/samples distributed, while sugar plants, oil plants, and roots and tubers had the smallest numbers of reported distributions relative to their global production levels or contributions to food supplies.

Figure 30. Numbers of accessions distributed per crop between 2012 and 2019 (WIEWS dataset) and contributions of crops to global production and food supplies (FAOSTAT)

Approximately 119 of the crops in the Treaty dataset (44.1 percent of all crops in the dataset but representing 97 percent of all samples distributed) are tracked by FAOSTAT in terms of production and/or food-supply metrics. An analysis of alignment between global production metrics and the numbers of
samples distributed revealed a correlation generally similar to that seen in the WIEWS dataset, with wheat, maize and rice standing out in terms of very large production levels and a high number of germplasm samples distributed (Figure 32). This general trend was also evident in global food-supply metrics (Figure 33). For production metrics, outlier crops with very high production values but relatively low numbers of samples distributed included cassava, soybean and potato. These same crops showed similar trends in terms of contribution to calories, protein and food weight in global food supplies. Tomato, banana and plantain were similar, especially regarding their contribution to food weight. Soybean, sunflower, groundnut and olive stood out in terms of making large contributions to global supplies of fat but having relatively low numbers of samples distributed. At the crop-type level, cereals showed the strongest correlation between global production or food-supply values and numbers of germplasm samples distributed, while roots and tubers, oil plants, vegetables and fibre plants had the smallest numbers of distributions relative to their production or food-supply values.

Figure 31. Numbers of samples distributed per crop between 2012 and 2019 (WIEWS dataset) and contributions of crops to global production and food supplies (FAOSTAT)
3.7.6 Distributions by the Treaty Multilateral System of Access and benefit-sharing (Annex 1)

According to the WIEWS dataset, distributions of crops clearly listed under the Multilateral System of the Treaty (i.e. listed in Annex 1) amounted to 714,471 accessions (56.3 percent of the total; annual average of 89,308.9) over the eight-year period (Figure 34). The figures for the 2012 to 2014 period were 111,024 accessions (43 percent of the total; annual average of 44,409.6), and those for the 2014 to 2019 period were 603,447 accessions (59.7 percent of the total; annual average of 109,717.6).
Note that this analysis was based on the crops distributed, not the provider. Some Contracting Party providers include public crop germplasm within the Multilateral System and distribute it under the SMTA even if the particular crops are not listed in Annex 1. Conversely providers located in countries that are not Contracting Parties to the Treaty may distribute crops listed in Annex 1 without their being part of the Multilateral System. Also note that many distributions in the dataset could not be attributed to specific crops but only to crop groups (e.g. multiple crops, cereal crops, unspecified crops, fruit crops, vegetable crops, oil crops and pulse crops). For this analysis, the crop groups were considered not to be specifically listed in Annex 1.

In terms of samples, distributions of Annex 1 crops amounted to 1,587,666 samples (38 percent of the total; annual average of 198,458.3) over the eight-year period. During the 2012 to 2014 period, such distributions totalled 362,574 samples (43.7 percent of the total; annual average of 145,029.6). During the 2014 to 2019 period, they totalled 1,225,092 samples (36.5 percent of the total; annual average of 222,744).
Figure 34. Numbers of accessions and samples distributed between 2012 and 2019 per crop type with and without Annex 1 status (WIEWS dataset).

Distributions of crops not specifically listed in Annex 1 amounted to 555,347 accessions (43.7 percent of the total; annual average of 69,418.4) over the full period. During the 2012 to 2014 period, distributions of crops not specifically listed in Annex 1 of the Treaty totalled 147,264 accessions (57 percent of the total; annual average of 58,905.6). During the 2014 to 2019 period, such distributions totalled 408,083 accessions (40.3 percent of the total; annual average of 74,196.9). Note that, as mentioned above, accessions that could not be attributed to specific crops but only to crop groups were not considered to be included in Annex 1.
This explains, in part, the relatively high numbers of non-Annex 1 distributions. Specific non-Annex 1 crops with the largest numbers of accessions distributed during the full period included soybean, cotton, tomato, tobacco, Capsicum crops, Acacia, pear, sesame, cocoa, okra, teff, flax, tea, beet, and cucumber and melons, each with over 5 000 accessions distributed.

Crop types with the largest germplasm distributions during the eight-year period in terms of absolute numbers of accessions of non-Annex 1 crops included oil plants; vegetables; cereals; nuts, fruits and berries; medicinal plants, aromatic plants, spices and stimulant plants; fibre plants; food legumes; industrial and ornamental plants; and forages, all with over 15 000 accessions distributed. The leading crop types in terms of the proportions of their total germplasm distributions (accessions) belonging to crops that are not listed in Annex 1 included fibre plants (100 percent); sugar plants (100 percent); other plants (100 percent); industrial and ornamental plants (99.9 percent); medicinal plants, aromatic plants, spices and stimulant plants (91.5 percent); oil plants (90 percent); vegetables (79.5 percent); and forages (49.1 percent).

Where samples are concerned, non-Annex 1 crops comprised 2 594 916 of those distributed over the eight-year period (62 percent of the total; annual average of 324 364.5). During the 2012 to 2014 period, such distributions totalled 467 365 (56.3 percent of the total; annual average of 186 946). During the 2014 to 2019 period, they totalled 2 127 551 (63.5 percent of the total; annual average of 386 827.5). Specific non-Annex 1 crops with the largest numbers of samples distributed included dragon fruit, pistachio, soybean, cocoa, avocado, coffee, mango, Arabidopsis, rubber, tomato, Acacia, grape, Annona crops, coconut, Capsicum crops, sugar cane, fig, pear, cotton, cucumber and melons, lettuce, guava, tobacco, okra, flax, sapote and papaya, each with over 10 000 samples distributed.

The crop types that had the largest germplasm distributions during the full period in terms of absolute numbers of samples of non-Annex 1 crops included nuts, fruits and berries; medicinal plants, aromatic plants, spices and stimulant plants; vegetables; industrial and ornamental plants; oil plants; and cereals (all with over 100 000 samples distributed). The leading crop types in terms of the proportions of their total germplasm distributions (samples) belonging to crops not listed in Annex 1 included fibre plants (100 percent); sugar plants (100 percent); other plants (100 percent); industrial and ornamental plants (99.9 percent); medicinal plants, aromatic plants, spices and stimulant plants (98 percent); oil plants (90.5 percent); vegetables (84.6 percent); nuts, fruits and berries (81.1 percent); and forages (44.4 percent).

According to the Treaty dataset, the distribution of crops listed in Annex 1 amounted to 3 787 498 samples (95.3 percent of the total; annual average of 473 437.3), while that of crops not specifically listed in Annex 1 amounted to 188 211 samples (4.7 percent of the total; annual average of 23 526.4) (Figure 35). Relative proportions of Annex 1 and non-Annex 1 crop samples distributed per year were fairly consistent across the eight-year period. As in the case of the WIEWS dataset, there were considerable distributions of germplasm of crops that could only be attributed to crop groups (e.g. unspecified crops and unspecified forages), and these were again considered not to be listed in Annex 1 for the purposes of the analysis. Specific non-Annex 1 crops with the largest quantities of germplasm distributed over the eight-year period included groundnut, lettuce, soybean, Capsicum crops, tomato, flax and spinach, each with over 5 000
samples distributed. Crop types with the largest germplasm distributions over the full period and that included within them the largest numbers of samples of non-Annex 1 crops, included unspecified crops, vegetables, food legumes and oil plants, all with over 15,000 samples distributed. The leading crop types in terms of the proportions of their total germplasm distributions belonging to crops that are not listed in Annex 1 included fibre plants (100 percent); industrial and ornamental plants (100 percent); medicinal plants, aromatic plants, spices and stimulant plants (100 percent); unspecified crops (100 percent); oil plants (83.6 percent); vegetables (37.2 percent); and forages (31.2 percent).

Figure 35. Numbers of Annex 1 and non-Annex 1 samples distributed per crop type between 2012 and 2019 (Treaty database).

3.8. Change over Time in Distributions within and beyond the Study Period

The WIEWS dataset contained two reporting periods: January 2012 to June 2014 (2.5 years), during which 258,288 accessions and 829,939 samples were distributed by 63 countries (in terms of accessions) or 65 (in
terms of samples); and July 2014 to December 2019 (5.5 years), during which 1 011 530 accessions and 33 526 433 samples were distributed by 79 countries.

Annual averages amounted to 103 315.2 accessions distributed per year during the first period, 183 914.5 per year during the second period and 158 727.3 per year during the full eight years. In the case of samples, the figures were 331 975.6 per year during the first period, 609 571.5 per year during the second period and 522 822.8 per year across the full eight years. There were thus 78 percent (accessions) and 83.6 percent (samples) more distributions per year on average during the second period than during the first period.

These larger reported distributions are explained, at least in part, by the additional countries reporting in the second period, some of which were among those with the largest numbers of reported distributions, especially in terms of samples (e.g. China, Nicaragua and Togo, and to a lesser degree, Hungary, Italy, the Philippines and Sri Lanka). Analysing change in distributions solely for the 57 countries reporting for both time periods, the annual average number of accessions distributed increased from 94 116.4 in the first period to 110 921.1 in the second period (an increase of 17.9 percent), while the annual average number of samples distributed increased from 310 948.4 to 317 701.5 (+2.2 percent). Annual average distributions of accessions and samples varied considerably across the 57 countries, with some reporting increasing annual average distributions, others reporting decreasing distributions, and a very few reporting a steady number of distributions. No trend was discernible across countries or in terms of accessions versus samples.

Total annual distributions recorded in the Treaty dataset varied from year to year, but there was no discernible trend across the eight-year period. This included a low of 407 512 samples distributed in 2019 and a high of 602 521 samples distributed in 2018. Reporting of distributions to the Treaty generally takes several years to complete, and thus it is possible that year 2019 distributions are not yet fully accounted for.

The Second Report offered examples of germplasm distributions by national genebanks from the mid-1990s to the late 2010s, with the exact time period depending on the specific country report (FAO, 2010). While direct comparisons of those statistics with the WIEWS dataset for 2012 to 2019 is confounded by variation in reporting style and period covered, as well as uncertainty regarding the consistency of use of the terms “accessions” and “samples”, examples from China, Ethiopia, Germany, India, Japan, Kenya, Malawi, Pakistan, Poland and Switzerland generally indicate that distributions by most national genebanks in the recent reporting period were similar to or larger than those in the period covered by the Second Report.

The Second Report also documented more than 1.1 million samples distributed by the CGIAR centres and the World Vegetable Center (formerly Asian Vegetable Research and Development Center, AVRDC) during the respective reporting period, 615 000 of which (about 50 000 per year) were sent to external recipients (FAO, 2010). The Second Report states that total distributions by international centres remained more or less steady over the period from 1996 to 2007 at about 100 000 accessions each year, and notes that these annual numbers were similar to those reported in the First Report for the period 1993 to 1995 (FAO, 2010). The Treaty dataset filtered only for distributions made by the CGIAR centres indicates that a total of 3 534 349 samples were distributed between 2012 and 2019, amounting to an average of 441 793.6 samples distributed per year. Thus, it appears that CGIAR centres may have distributed more germplasm in the
current reporting period than in the periods covered by the First Report and Second Report. However, it should be noted that the comparison is confounded by uncertainty regarding extent to which the figures for the different reporting periods cover only genebank distributions or also include distributions of material from breeding programmes.

4 DISCUSSION

4.1. Key Findings and Implications

The analysis presented in this study covers the distribution of over 1.2 million accessions (circa 159,000 per year on average) and over 4.1 million samples (circa 523,000 per year) made primarily by national genebanks between 2012 and 2019, as recorded in the WIEWS dataset. It also covers the distribution of over 3.9 million samples (circa 497,000 per year) from genebanks, breeding programmes and other organizational types using the SMTA, as recorded in the Treaty dataset, during the same period. These distributions are considerably larger than those indicated by information on germplasm distributions synthesized from the First Report (FAO, 1998) and the Second Report (FAO, 2010) for previous periods. However, the true extent of any increase in distribution since the earlier studies is hard to assess, as the post-2012 data are far more comprehensive.

The WIEWS dataset essentially documents domestic genetic resource exchange activities, with well over 90 percent of distributions in the dataset made within the respective country. In terms of accessions distributed, the dataset indicates that NARCs were the foremost in-country recipients, followed by recipients classed as Others, Farmers or NGOs, Private Sector and Unknown. In terms of samples, the Private Sector and NARCs were the foremost recipient categories, followed by Farmers or NGOs, Others and Unknown. The relatively small proportion of material that is distributed internationally from national genebanks may reflect a reluctance to send material abroad (e.g. in the case of genebanks in countries that are not members of the Treaty or material that is not in Annex 1 of the Treaty), inability to do so (e.g. because of limited germplasm availability) or an absence of external demand. The latter may, in turn, reflect a relative lack of access to information on what is available or, alternatively, greater ease in obtaining material from other national or international genebanks.

The Treaty dataset documents a very different germplasm distribution pattern, with three-quarters (76.5 percent) of distributions occurring across international borders, and one-quarter (23.5 percent) within the respective country. This dataset primarily reflects CGIAR distributions (88.9 percent of the total) and shows that 80.8 percent of these were made to recipients outside the country in which the CGIAR centre was located. This kind of distribution pattern is to be expected given the widespread importance of the crops the CGIAR curates, the size and comprehensiveness of the collections, and the relative ease with which they can be accessed.

The WIEWS dataset records the distribution of germplasm by 87 countries or territories, more than half of which distributed more than 1,000 accessions each over the eight-year period. Asian and European providers were the main contributors, with Asia accounting for almost half of the total accessions distributed.
and Europe almost a quarter. The Oceania, Americas and Africa regions each provided around 10 percent. High-income countries distributed 39.4 percent of all accessions, upper middle-income countries 35.7 percent, lower middle-income 18.9 percent and low-income countries 6 percent. LDCs distributed 8.5 percent of total accessions, LLDCs distributed 5.2 percent, and SIDS distributed 0.9 percent. Assessments at the sample level paint a similar picture, although they may be confounded by relatively large numbers of samples reported for a few crops from a few countries. In terms of samples, almost half the reporting countries distributed more than 10 000 each over the eight-year period. Providers in the Americas (29 percent), Europe (28.8 percent) and Asia (25.7 percent) distributed the most samples, followed by Africa (13.4 percent) and Oceania (3.1 percent). Lower middle-income countries distributed 38.3 percent of all samples, high-income counties 33.3 percent, upper middle-income countries 18.8 percent and low-income countries 9.6 percent. LDCs distributed 12.8 percent of total samples, LLDCs 3.1 percent and SIDS 3.2 percent. Approximately 69.9 percent of total accessions and 86.1 percent of total samples were distributed by providers located in countries that were Contracting Parties to the Treaty. Approximately 37.3 percent of total accessions and 35.5 percent of total samples were distributed by providers located in countries that were Contracting Parties to the Nagoya Protocol. It is interesting to note that providers in countries that were not Contracting Parties to the Nagoya Protocol were active in distributing germplasm internationally, providing approximately half of the international distributions. This was not the case for providers in countries that were not Contracting Parties to the Treaty, which distributed relatively few accessions and samples internationally.

The Treaty dataset contains information on the distribution of germplasm from providers located in 48 countries, with more than 1 000 samples distributed by providers in each of 34 of those countries. Analysis by region shows that providers located in the Americas accounted for 47.9 percent of total distributions, those in Asia for 29.5 percent, those in Africa for 14.1 percent, those in Europe for 8.4 percent and those in Oceania for 0.2 percent. Providers located in upper middle-income countries accounted for 59.7 percent of total samples distributed, followed by those in lower middle-income countries (27 percent), high-income countries (10.5 percent) and low-income countries (2.9 percent). Approximately 53.2 percent and 52.2 percent of total samples distributed using the SMTA were provided by organizations located in countries that were Contracting Parties to the Treaty and to the Nagoya Protocol, respectively. However, it should be remembered that CGIAR centres were the providers of almost 90 percent of total distributions in the Treaty dataset and thus the terms and conditions under which international centres distribute germplasm are more pertinent to understanding these exchange patterns.

The Treaty dataset records the distribution of samples to recipients in 179 countries, with over 1 000 samples received in each of 131 countries between 2012 and 2019. The countries where recipients received the largest numbers of samples were India, Kenya, Mexico, Türkiye, the United States of America, Germany, Canada, China, Pakistan and the Islamic Republic of Iran, each receiving over 100 000 samples under the SMTA. Recipients in Asia received 42.1 percent of total samples, Africa 22.5 percent, the Americas 21.2 percent, Europe 13.2 percent and Oceania 1 percent. Recipients in lower middle-income countries received 38.6 percent of total samples, upper middle-income countries 26.7 percent, high-income countries 23.8 percent, and low-income countries 10.8 percent. Recipients in LDCs received 11 percent of total
samples, those in LLDCs 12.5 percent and those in SIDS 0.3 percent. Approximately 80.3 percent of total samples distributed using the SMTA were received by organizations located in countries that were Contracting Parties to the Treaty, and 41.3 percent by organizations located in countries that were Contracting Parties to the Nagoya Protocol. The relatively small distribution of material to low-income countries and LDCs is almost certainly a reflection of relative lack of demand due to capacity gaps in these countries’ plant breeding and other agricultural research institutions. If this situation is to be improved and such countries are to benefit more from access to genetic resources, capacity building needs to be given greater attention.

The WIEWS dataset records the distribution of germplasm for 843 crops or crop groups. However, generalized reporting within the dataset means that the actual number of crops and species distributed may be considerably higher. For one crop (wheat), as many as 177 808 accessions and 371 107 samples were distributed over the eight-year period. More than 100 000 accessions of each of three crops (wheat, rice and soybean) were distributed, between 10 000 and 100 000 accessions of each of 22 crops, between 1 000 and 10 000 accessions of each of 72 crops, between 100 and 1 000 of each of 98 crops, and fewer than 100 accessions of each of 643 crops. Crops with the highest numbers of accessions distributed included wheat, rice, soybean, barley, multiple crops, cereal crops, unspecified crops, common bean, chickpea, Brassica crops, maize, fruit crops, vegetable crops, oat, sorghum, pea, cotton, citrus, potato, oil crops, pulse crops, tomato, broad bean and vetch, tobacco and lentil, each with over 10 000 accessions distributed; these 25 crops or crop groups represent over three-quarters (76.8 percent) of all accessions distributed. More than 100 000 samples were distributed of each of 10 crops (see below), between 10 000 and 100 000 samples of 48 crops, between 1 000 and 10 000 samples of 126 crops, between 100 and 1 000 samples of 133 crops, and between 1 and 100 samples of 526 crops. The crops or crop groups with the highest total numbers of samples distributed were dragon fruit, rice, wheat, citrus crops, pistachio, soybean, cocoa, avocado, barley and coffee, all with over 100 000 samples distributed. These ten crops or crop groups represent 49 percent of all samples distributed. While the distribution of accessions largely reflects the importance of the crop concerned at the global level, including those handled by the CGIAR centres, the distribution of samples appears to be skewed by a high, and possibly anomalous, demand during the reporting period for a few crops of lesser global importance, such as dragon fruit and pistachio. It will be interesting to see if this remains the case in the future, and with the growing impact of climate change it will be important to continue to monitor the changing distribution of different crops over time, in particular those that are more heat and drought resistant.

At the crop-type level, food crop germplasm comprised 86.5 percent of total accessions and 87.8 percent of total samples documented in the WIEWS dataset, with cereals, oil plants, food legumes and vegetables being the most distributed in terms of accessions, and nuts, fruits and berries; cereals; medicinal plants, aromatic plants, spices and stimulant plants; vegetables; oil plants; industrial and ornamental plants; and food legumes in terms of samples. Approximately 81.1 percent of total accessions and 51.9 percent of samples were distributed by seed, while 8.8 percent of accessions and 39.3 percent of samples were distributed vegetatively. The quantities of germplasm distributed generally aligned well with global production metrics for crops and with their contributions to global food supplies. However, on certain metrics, some crops – for example,
sugar cane, oil palm, beet, cassava, soybean, banana and plantain, grape, yam, sunflower, coconut, groundnut and olive – stood out as making very large contributions to global production or food-supply but having relatively few reported germplasm distributions.

According to the WIEWS dataset, approximately 56.3 percent of total accessions and 38 percent of samples distributed belonged to crops listed in Annex 1 of the Treaty. The non-Annex 1 crops that comprised the other 43.7 percent of accessions distributed included soybean, cotton, tomato, tobacco, Capsicum crops, Acacia, pear, sesame, cocoa, okra, teff, flax, tea, beet, and cucumber and melon, each with over 5 000 accessions distributed. The non-Annex 1 crops that comprised the other 62 percent of samples distributed included dragon fruit, pistachio, soybean, cocoa, avocado, coffee, mango, Arabidopsis, rubber, tomato, Acacia, grape, Annona crops, coconut, Capsicum crops, sugar cane, fig, pear, cotton, cucumber and melon, lettuce, guava, tobacco, okra, flax, sapote and papaya, each with over 10 000 samples distributed.

This high level of demand for germplasm of non-Annex 1 crops underscores the importance of prioritizing ways and means of further facilitating access to such germplasm, while also ensuring the fair and equitable sharing of any benefits arising from such access.

The Treaty dataset records the distribution of over 270 crops or crop groups, with up to 1 874 121 samples per crop distributed over the eight-year period. One crop had more than 1 000 000 samples (wheat) distributed, 4 crops between 100 000 and 1 000 000 samples, 16 crops between 10 000 and 100 000 samples, 30 crops between 1 000 and 10 000 samples, 38 crops between 100 and 1 000 samples, and 181 crops between 1 and 100 samples. Crops with the highest total numbers of samples distributed included wheat, maize, rice, barley, chickpea, unspecified crops, lentil, bean, sorghum, pearl millet, Brassicaceae crops, broad bean and vetch, pigeon pea, cowpea, potato, groundnut, oat, lettuce, grass pea and other Lathyrus, soybean and pea, all with over 10 000 samples distributed. These 21 crops or crop groups represent 96.5 percent of all samples distributed. Again, the data primarily reflect the crops handled by the CGIAR centres. Given the high demand for germplasm of non-CGIAR crops that is evident in the WIEWS dataset, it is important that consideration be given to ways of developing and/or strengthening international mechanisms for the conservation and distribution of such crops.

At the crop-type level, the Treaty dataset indicates that food crop germplasm comprised 97.1 percent of the samples distributed, with cereals, food legumes, vegetables, unspecified crops, roots and tubers, forages, and oil plants comprising the largest shares. It is likely that at least 96.8 percent of the samples were distributed as seed and 1.1 percent vegetatively. The numbers of samples distributed generally aligned well with global production metrics and with the crops’ contributions to global food supplies. However, for certain metrics, some crops – for example, cassava, soybean, potato, tomato, banana and plantain, sunflower, groundnut and olive stood – out as having high production or food-supply values relative to the amount of germplasm distributed. This probably reflects the difficulty of conserving and distributing certain crops (e.g. cassava, potato, and banana and plantain), exclusion of some of from Annex 1 (e.g. soybean, tomato and groundnut) and/or the relative paucity of major breeding programmes worldwide for some (e.g. sunflower, olive).
Approximately 95.3 percent of samples in the Treaty dataset belonged to crops listed in Annex 1 of the Treaty. The non-Annex 1 crops that comprised the other 4.7 percent of the samples distributed included groundnut, lettuce, soybean, Capsicum crops, tomato, flax and spinach, each with over 5,000 samples distributed.

4.2 Caveats and Information Gaps

The distributions documented in this study are clearly substantial, and they are also diverse in terms of the location, income and political status of the provider and recipient countries, as well as in terms of the organizational types and the crops and crop types involved. The two main datasets record germplasm flows largely from different providers and are thus complementary. With some notable exceptions, the distributions appear generally to be in alignment with the use of the respective crops as measured by global production and food-supply statistics.

Whether the distributions are in proportion to investments made in ex situ conservation or relate to present and future crop improvement and other research priorities is much more difficult to assess based on the data analysed. Whether they even need to be in alignment is itself a worthwhile question. As noted in the First Report, “The primary purpose of many base collections is long-term conservation, and, therefore, the rate of “utilization” may be expected to be low. In addition, the utilization of a relatively small part of a genebank’s collection can lead to large benefits, proportionally far greater than the quantity of accessions used” (FAO, 1998). Over the two decades since the publication of the First Report, based on the limited comparable information available, global germplasm distribution appears to have increased considerably, as have ex situ collections.

What is clearer is that while the two datasets used in this analysis represent a major leap forward in documenting and quantifying global germplasm exchange, neither dataset is fully comprehensive in terms of the distributions made during the eight-year period by providers of plant genetic resources. A number of countries – some with very large ex situ collections – did not contribute to the relevant indicators in WIEWS (Figure 5 and Figure 7). Data provided in the annual reports on technology transfer published by the United States Department of Agriculture indicate that in the period covered by this study (USDA, 2012–2019) the 21 repositories and units included in the National Genetic Resources Program (NGRP) of the USDA sent more than 2 million samples to foreign genebanks, international agricultural research centres, domestic and foreign commercial companies, and domestic and foreign research organizations and universities, with an average of 260,000 samples distributed per year. An average of 150,000 accessions were distributed per year during the period 2015 to 2019 (reports of previous years do not provide information about the number of accessions that were transferred, only samples). These USDA statistics indicate that the true volume of national and international distributions worldwide may be considerably larger than that documented in the WIEWS indicators. Further, the lack of information on the geographic location of germplasm recipients in this dataset, and the current sporadic reporting of distributions in terms of recipient types, impede a fuller understanding of users of plant germplasm.
Likewise, the Treaty dataset encompasses only international institutions that signed Article 15 agreements with the Treaty’s Governing Body and organizations in countries that were Contracting Parties to the Treaty, which were under obligation to use the SMTA for distributions during the eight-year period. The genebanks, breeding programmes and other providers of germplasm in many countries in Latin America (most of Central America, as well as the southern cone and various Andean countries, among others), Africa (most of Northern, Middle, and Southern Africa), Europe (most of Eastern Europe), Asia (most of Central and Western Asia, South-eastern Asia and parts of the Pacific region) are not included in these data (Figure 9). Other countries are only represented for the period in which they were a Contracting Party to the Treaty (e.g. the United States of America became a Contracting Party in 2016). Furthermore, Contracting Parties have various options as to whether they use the SMTA for domestic transfers, and most internal transfers (e.g. from genebanks to breeding programmes in the same institution) are not reported. Known delays in reporting also mean that the data available for recent years may not be complete. While all further additions of Contracting Parties to the Treaty will increase the comprehensiveness of the dataset, additional methods of quantifying germplasm exchange (especially beyond the national genebanks reported in WIEWS) will be needed if a truly global picture is to be obtained.
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Annexes

Annex 1: Extended Methodology and Data Sources

A1.1 Study timeframe

In accordance with the scope of the Third Report, this study covers the period 2012 to 2019, with supplementary information covering longer periods for additional context.

A1.2 Data sources

This study is based on two main information sources:

A1.2.1 The World Information and Early Warning System on Plant Genetic Resources for Food and Agriculture (WIEWS) Reporting Tool on Indicators 6, 28 and 29 of the Second GPA monitoring framework.

This dataset includes two main indicators as outlined in FAO (2020):

1. Indicators 28, Number of accessions distributed by genebanks to users of germplasm, and 29, Number of samples distributed by genebanks to users of germplasm (Question: 8.4 Indicate for each crop, crop group or preferably for each taxon, the number of accessions and the number of samples distributed during the reporting period by the national genebank[s] Optionally, indicate the amounts distributed to the different categories of recipients).

2. Indicator 6, Number of farmers’ varieties/landraces distributed by national or local genebanks to farmers (either directly or through intermediaries) (Question: 2.3 Indicate for each crop or crop group, the number of farmers’ varieties/landraces distributed during the reporting period by national or local genebanks to farmers (either directly or through intermediaries).

For both indicators, data were provided by stakeholders for two periods: 1 January 2012 to 30 June 2014, and 1 July 2014 to 31 December 2019. Data were received for this analysis directly from FAO in March 2022, with updates for specific providers received in June and July 2022. These data are limited to National Focal Point (NFP) contributions; distributions from the CGIAR centres were not included, as they are assumed to be well tracked in the Treaty dataset (below). The WIEWS dataset thus mainly covers national and subnational genebank distributions.

For Indicators 28 and 29, the data provide summary counts of accessions and samples distributed per crop or taxon, per stakeholder (institution) and per reporting period. These are presented in total count format as well (optionally) by recipient category. These categories include National Agricultural Research Centres (NARCs), Private Sector, Farmer or Non-Governmental Organization (NGO), Others, Foreign Stakeholders and Unknown. It is understood that all categories refer to within-country distributions, aside

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17 A limited number of distributions were reported for a timeframe of 2009 to 2013 for the first reporting period, by one data provider. These distributions were reported only for samples (not accessions), and total 162,753 samples.
from the Foreign Stakeholders category, which is not further disaggregated in terms of recipient organizational types. Recipient countries or institutions are not identified in these data.

For Indicator 6, the data provide summary counts of farmers’ varieties/landraces distributed by national or local genebanks to farmers, per crop or taxon, per stakeholder (institution) and per reporting period. Recipient countries or institutions are not identified in these data; it is assumed that distributions are mainly within-country.

A1.2.2 Data Store of the Multilateral System of Access and Benefit Sharing of the International Treaty on Plant Genetic Resources for Food and Agriculture (Treaty)

The Data Store includes all reported distributions made with the Standard Material Transfer Agreement (SMTA). The dataset used in the study was provided by the Secretariat of the Treaty and comprises the data contained in the Data Store (Easy-SMTA, https://mls.planttreaty.org) as of 17 February 2022, with additional data from one provider – the International Center for Tropical Agriculture (CIAT) – received in June 2022. The SMTA obliges the provider to report to the Governing Body of the Treaty (Article 5.3). The reporting is done for each transfer at the sample level at least once every two years. This dataset covers the period 2012–2019, and thus includes four two-year datasets (2012–2013, 2014–2015, 2016–2017 and 2018–2019). Data were provided both for all transfers and only for those from CGIAR centres, the latter including data from the Africa Rice Center (AfricaRice), Bioversity International, the International Center for Tropical Agriculture (CIAT), the International Maize and Wheat Improvement Center (CIMMYT), the International Potato Center (CIP), the International Center for Agricultural Research in the Dry Areas (ICARDA), the World Agroforestry Center (ICRAF), the International Crops Research Institute for the Semi-arid Tropics (ICRISAT), the International Institute of Tropical Agriculture (IITA), the International Livestock Research Institute (ILRI) and the International Rice Research Institute (IRRI).

The dataset provides summary counts of samples distributed per crop or taxon, per distributing country, per recipient country and per year. Specific distributor or recipient stakeholder names, institutions or categories/types are not specified; only the distributor or recipient country is. As the dataset covers all germplasm transfers under the SMTA, it offers information not solely on the distribution of genebank samples but also on materials derived from these samples and other sources, for example materials from breeding programmes.

A1.3 Data processing and analysis

Processing of the two main datasets for analysis followed as standardized a process as possible to maximize the potential for comparability between the two. This mainly included cleaning of existing data and adding supplementary data of use for analysis. These were processed using both manual methods and automated processes in the Python programming language. The programming code for the automated processing steps is available at: https://github.com/CIAT-DAPA/fao_sow.

A1.3.1 Cleaning and standardization of crop names
Crop names were as far as possible standardized to enable comparative analyses; some names were
generalized for this purpose. Names were typically standardized to the most common name for the crop in
English or a Latin (generally the genus) name.

A1.3.2 Designation and standardization of crop categories

WIEWS data included two crop category formats: a) crop groupings as standardized and reported in
Appendix 2 of the Second Report; and b) plant groupings further checked and processed by FAO WIEWS
staff. These fields were checked for consistency and updated per row in communication with FAO. The
Treaty dataset did not include information on crop categories. The two crop category formats from the
WIEWS dataset were added to the Treaty dataset by assigning crops on the basis of how the same or similar
crops were assigned in the WIEWS dataset.

To supplement the WIEWS crop categories, an additional crop grouping format was added. This category
derives from a current Treaty project (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) led by the International Center for Tropical
Agriculture (CIAT) (Khoury et al., 2023), which compiles and provides standardized information on the use
of more than 350 crops globally, including data on interdependence, demand, supply, and security of their
genetic resources. The project’s crop list offers crop grouping information at both general/primary and
specific levels; both fields were added to both datasets analysed here, with crops not on the 350-crop list
assigned to appropriate categories manually.

A1.3.3 Addition of information on whether crops are listed in Annex 1 of the Treaty

A field was added to each dataset marking whether the crop was listed in Annex 1 of the Treaty (FAO,
2009). This was accomplished by aligning the respective information from the project 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 (Khoury et al., 2023) to crops in the current datasets whose names matched, and then reviewing
Annex 1 and manually assigning the crops not on the 350-crop list.

A1.3.4 Addition of information on crop use

To provide additional context regarding crop use globally, information was compiled from FAOSTAT
global food-supply data (for calories [kcal/capita/day], protein [g/capita/day], fat [g/capita/day] and food
weight [g/capita/day]) and for global production (for production quantity [tonnes], harvested area [ha], and
production value [gross constant thousand USD]). An annual average for these metrics was calculated across
the years 2015 to 2018, representing the most recent years for these metrics in FAOSTAT at the time of
analysis. These data were brought in from the project 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 (Khoury et al., 2023),
matching by crop names. The 350 crops on the crop list from this project are inclusive of all crops reported
in FAOSTAT, thus crops in the current analysis not on the 350-crop list do not contain this supplementary
information.
While FAOSTAT data contain statistical information on the use of many crops (food-supply data contains approximately 54 relevant crop plant commodities ["items"], with data from 173 countries; production data contain approximately 142 relevant crop plant commodities, with data from 205 countries; value of production data contain approximately 140 relevant crop plant commodities, with data from 205 countries), many crops are not specifically listed (especially in food-supply data) but are instead grouped within general commodities (i.e. “Cereals, Other”, “Fruits, Other”, “Nuts, Other”, “Oilcrops, Other”, “Pulses, Other”, “Roots, Other”, “Spices, Other”, “Tea and Mate” and “Vegetables, Other” in food-supply data). Applying the full reported values for these general commodities to each crop listed under the respective item would lead to clear overestimations of each crop’s value and to a distorted understanding of their value compared to other crops that are included individually in the data (i.e. not within a general commodity).

To resolve this while attempting to provide FAOSTAT data for as many crops as possible, production information for each crop (production quantity metric) was used as a factor by which to disaggregate the general food-supply values. As a simple example, the “Tea and Mate” food-supply commodity comprises two crops – tea and mate. Global production of these crops in terms of production quantity consists of approximately 85.8 percent tea and 14.2 percent mate, based on 2018 data. Thus, in order to obtain separate food-supply values for tea and mate the respective values for the general commodity (e.g. kcal/capita/day in the case of calories) was assigned proportionally, i.e. 85.8 percent of the total to tea and 14.2 percent to mate. Note this disaggregation was not possible for the various crops in the “Beans” and “Millet” food-supply commodities because production data for crops pertinent to the commodities were also aggregated and thus were not specific to the individual crops. In these cases, all crops were given the full value of the respective commodity, which it should be noted leads to an overestimation of each crop’s individual use, especially the minor bean and millet crops (an alternative could have been to equally divide the general commodity value across the crops comprising these commodities, but this would have led to much smaller values than are likely to be accurate for many of the crops).

Following this disaggregation of food-supply values, the results were judged to be more accurate, except that many of the minor crops that are listed in production metrics as components of general commodities (i.e. “Agave fibres nes”, “Berries, nes”, “Cereals, nes”, “Fibre crops nes”, “Fruit, fresh nes”, “Fruit, tropical fresh nes”, “Nuts, nes”, “Oilseeds nes”, “Pulses, nes”, “Roots and tubers, nes”, “Spices, nes”, “Sugar crops, nes”, “Vegetables, fresh nes”) were judged to have food-supply values that were too high relative to crops that are specifically listed in the production metrics. To address this issue, the values for these general production commodities were divided equally among their component crops (e.g. bay leaf, dill, fenugreek, saffron, thyme and turmeric – the six crops listed within the production commodity “Spices, nes” – were all assigned the same production value, i.e. 1/6 of the total value of “Spices, nes”). Following this transformation of the production data, the food-supply transformation described above was redone and new food-supply values assigned to these crops.

A1.3.5 Addition of information on germplasm storage type and storage behaviour type
A field was added to each dataset marking the typical germplasm storage type of each crop (seed, clonal, or unknown). For crops that may be stored in multiple formats, the most common format was assigned. This information was drawn from Khoury et al. (2021), with designations made manually for crops not listed in the supplementary information of that resource.

A field was also added to each dataset marking the seed storage behaviour type for the crop as listed in the Royal Botanic Gardens, Kew Seed Information Database (SID) (SER, INSBR and RBG Kew, 2023). Seed storage behaviour as listed in the SID is categorized as orthodox, recalcitrant or intermediate, with some species listed as possibly in a category. These were standardized in this analysis. As described in the SID:

“Orthodox seeds can be dried, without damage, to low moisture contents, usually much lower than those they would normally achieve in nature. Over a wide range of storage environments their longevity increases with reductions in both moisture content and temperature, in a quantifiable and predictable way. Recalcitrant seeds do not survive drying to any large degree, and are thus not amenable to long term storage, although the critical moisture level for survival varies among species. In this database this category includes those seeds, of some aquatic species in particular, described as viviparous.

Intermediate seeds are more tolerant of desiccation than recalcitrants, though that tolerance is much more limited than is the case with orthodox seeds, and they generally lose viability more rapidly at low temperature. They do not conform to all the criteria defining orthodox seeds, especially in respect of the quantification and predictability of the relations between longevity and both drying and cooling.” (SER, 2023).

A1.3.6 Designation of providers and recipients in terms of world region classifications

Information from the UNSTATS m49 classification system of world regions and regional classifications (UNSTATS, 2022) was added for each country reported in the datasets. The WIEWS dataset contains country information only for providers; the Treaty dataset contains country information both for providers and recipients.

A1.3.7 Designation of providers and recipients in terms of country income level

Information from the World Bank Country and Lending Groups classification system (World Bank, 2022) was added for each country included in the datasets. The WIEWS dataset contains country information only for providers; the Treaty dataset contains country information for both providers and recipients.

This World Bank information is available by year and may change between years. For the Treaty dataset, where germplasm distribution information is available by year, countries were associated with their respective World Bank income levels for each reported year. Three recipient countries (Cook Islands, Nauru and Niue) were either not listed in the World Bank dataset or were not assigned an income level for relevant years and are thus not attributable in the analysis; these cases account for an extremely small number of samples (65 in total).
For the WIEWS dataset, where germplasm distribution information is provided for only two periods (2012–2014 and 2014–2019), countries were associated with their respective World Bank income levels as assigned by the World Bank at both the first (2012 or 2014) and the final (2014 or 2019) years of the reporting periods; total counts/percentages for each income category are provided based on the country assignments in the first and the final year of the respective period and an average between the two.

**A1.3.8 Designation of providers' and recipients' locations in terms of country status as Contracting Parties to the Treaty**

Information regarding whether providers and recipients were located in countries that were Contracting Parties to the Treaty at the time of germplasm distribution was added to the datasets based on data provided directly to the authors from the Treaty in February 2022. The WIEWS dataset contains country information only for providers; the Treaty dataset contains country information for both providers and recipients.

The Treaty Contracting Party data contained year of entry into force for each country. For the analysis, if the year of entry into force was the same as or earlier than the year of the germplasm distribution, the country was marked as a Contracting Party to the Treaty at the time of the distribution. For the Treaty germplasm distributions dataset, where distribution information is available by year, countries were associated with their Contracting Party status in the respective year. For the WIEWS dataset, where distributions are assigned only to multiyear periods (2012–2014 and 2014–2019), countries were associated with their Treaty Contracting Party status as recorded for the first (2012 or 2014) and for final (2014 or 2019) years of the reporting period; total counts/percentages for both alternatives (assignment based on the first and last years of the respective period) as well as averages between respective figures were calculated.

**A1.3.9 Designation of providers' and recipients' locations in terms of status as Contracting Parties to the Nagoya Protocol of the Convention on Biological Diversity**

Information regarding status as Contracting Parties to the Nagoya Protocol was added to the datasets based on data obtained from the Convention on Biological Diversity (CBD, 2022). The WIEWS dataset contains country information only for providers; the Treaty dataset contains country information for both providers and recipients.

The Nagoya Protocol Contracting Party data contained the year of ratification for each country. For the purposes of the analysis, if the year of ratification was the same as, or earlier than, the year of the germplasm distribution, the country was marked as a Contracting Party to the Nagoya Protocol at the time of the distribution. For the Treaty dataset, where distribution information is available by year, countries were associated with their Contracting Party status in the respective year. For the WIEWS dataset, where distribution information is provided in only for multiyear periods (2012–2014 and 2014–2019), countries were associated with their Nagoya Contracting Party status as recorded in both the first (2012 or 2014) and the final (2014 or 2019) years of the reporting period; total counts/percentages for both alternatives (assignment based on the first and last years of the respective period) as well as averages between respective figures were calculated.
A1.4. Additional sources of information

The eleven CGIAR centres hosting international PGRFA collections pursuant to their 1994 in-trust agreements with FAO and their 2006 Article 15 agreements with the Governing Body of the Treaty maintain records of their genebanks’ acquisitions and distributions of PGRFA, on the Online Reporting Tool (ORT) maintained by the Global Crop Diversity Trust as coordinator of the CGIAR Genebank Research Programme (2012 to 2016) and Genebank Platform (2017 to 2021). The ORT includes data on the types of materials transferred by the genebanks as well as the types of recipients to whom it was transferred. Unfortunately, no such centralized, aggregate data exist for CGIAR breeding programmes. The ORT data are used by the Crop Trust and CGIAR to develop reports to relevant international fora (FAO, 2017a, b, 2019a, b) and other publications (Halewood et al., 2020; Lusty et al., 2021).

A1.5 Data availability

Compiled and processed datasets for the two main data sources are accessible in WIEWS (link TBD), and their data dictionaries are provided as Annex 2 and 3 of this report. Data from the additional sources of information are available in Halewood et al. (2020) and Lusty et al. (2021).

References for Annex 1


**ANNEX 2: WIEWS Germplasm Distribution Dataset Dictionary**

Dictionary/notes on FAO WIEWS dataset fields:

- Dataset: Denotes which WIEWS data indicator. Data complete.
  - Germplasm_distributions – FAO WIEWS indicators 28 and 29 (8.4 Indicate for each crop, crop group or preferably for each taxon, the number of accessions and the number of samples distributed during the reporting period by the national genebank(s). Optionally, indicate the amounts distributed to the different categories of recipients)
  - landraces_to_farmers – FAO WIEWS indicator 6 (2.3 Indicate for each crop or crop group, the number of farmers’ varieties/landraces distributed during the reporting period by national or local genebanks to farmers (either directly or through intermediaries).

- Answer_id – Unique code for each report. Original data. Data complete aside from a very small number of records.


- Provider_iso3_cleaned – Origin country of distribution. Data fixed for Romania (ROU instead of ROM). Data complete.

- Provider_stakeholder – Institution. Original data. Data complete.

- ProviderInstcode – Code for institution. Original data. Data complete aside from a very small number of records.

- Crop_original – Original crop name(s). Original data. Data not complete.


- SOW2_grouping – Crop type as per SOWII categorization. Original data. Data complete aside from a very small number of records.

- SOW2_grouping_cleaned – Cleaned/processed crop type as per SOWII categorization. New data. Data complete.

- PL_group – Plant group categorization. Original data. Data complete aside from a very small number of records.

- PL_group_cleaned – Cleaned/processed crop type as per PL_group categorization. New data. Data complete.

- Taxon – Scientific name. Original data. Data complete aside from a very small number of records.

- Genus – Genus. Original data. Data complete aside from a very small number of records.

- Species – Species. Original data. Data not complete.
Wild_relative – Y/N if the sample is a wild relative based on taxonomy and crop names. New data.
Completed to the extent possible.
Farmer_varieties – Data from landraces_to_farmers dataset. Original data.
Total_Accs – Data from germplasm_distributions dataset. Original data. Refers to accession level (# of accessions distributed).
Accs_to_NARC – Data from germplasm_distributions dataset. Original data. Refers to within country distributions.
Accs_to_FarmerOrNGO – Data from germplasm_distributions dataset. Original data. Refers to within country distributions.
Accs_to_Others – Data from germplasm_distributions dataset. Original data. Refers to within country distributions.
Accs_to_ForeignStakeholders – Data from germplasm_distributions dataset. Original data.
Accs_to_Unknown – Data from germplasm_distributions dataset. Original data. Refers to within country distributions.
Total_Samples – Data from germplasm_distributions dataset. Original data. Refers to samples level (# of samples distributed).
Samples_to_NARC – Data from germplasm_distributions dataset. Original data. Refers to within country distributions.
Samples_to_FarmerOrNGO - data from germplasm_distributions dataset. Original data. Refers to within country distributions.
Samples_to_Others – Data from germplasm_distributions dataset. Original data. Refers to within country distributions.
Samples_to_ForeignStakeholders – Data from germplasm_distributions dataset. Original data.
Samples_to_Unknown – Data from germplasm_distributions dataset. Original data. Refers to within country distributions.
CropList_equivalent – Name of crop in Crop List (Treaty Crop Indicator project) for those crops matching. All other crops listed here as None. New data. Data complete.
CropList_Use_primary – General crop type category. Field from Crop List (Treaty Crop Indicator project). Field further filled manually for crops not matching to Crop List. Data complete.
CropList_Use_detailed – Specific crop type category. Field from Crop List (Treaty Crop Indicator project). Field further filled manually for crops not matching to Crop List. Data complete.
CropList_MLS_Annex1_crop – Y/N. lists if crop in Annex 1 of Plant Treaty MLS (only based on crop, not on provider or country). Field from Crop List (Treaty Crop Indicator project). Field further filled manually for crops not matching to Crop List. Data complete.
CropList_Seed_storage_behaviour – Orthodox/recalcitrant info, from Kew SID. Field from Crop List (Treaty Crop Indicator project). Field only filled for crops matching to Crop List. Data not complete.
CropList_Seed_storage_behaviour_cleaned – Orthodox/recalcitrant info, from Kew SID. Field from Crop List (Treaty Crop Indicator project). Field further filled manually for crops not matching to Crop List, as possible. Data not complete.
Provider_iso3 – Origin country of distribution. Original data, data complete (but error existing for Romania iso3).
Germplasm_storage_type – Seed/clonal/unknown. Refers to main likely way germplasm distributed for crop. Data from Khoury et al. 2021 and further filled manually as possible. Data complete.
Provider_region_name – Region of provider country. Data from UNSTATs (2022). Data complete.
Crop use (FAOSTAT food supplies and production)

- FAOSTAT_Fat_supply_quantity_g_capita_day – Data on contribution of crop to global food supplies in terms of fat, based on FAOSTAT data, averaged across years 2015–2018. Data for each row are total global data for crop, thus not summable across rows. Data only for crops in Crop List (Treaty Crop Indicator project).

- FAOSTAT_Food_supply_kcal_capita_day – Data on contribution of crop to global food supplies in terms of calories, based on FAOSTAT data, averaged across years 2015–2018. Data for each row are total global data for crop, thus not summable across rows. Data only for crops in Crop List (Treaty Crop Indicator project).

- FAOSTAT_Food_supply_quantity_kg_capita_yr – Data on contribution of crop to global food supplies in terms of food weight, based on FAOSTAT data, averaged across years 2015–2018. Data for each row are total global data for crop, thus not summable across rows. Data only for crops in Crop List (Treaty Crop Indicator project).

- FAOSTAT_Protein_supply_quantity_g_capita_day – Data on contribution of crop to global food supplies in terms of protein, based on FAOSTAT data, averaged across years 2015–2018. Data for each row are total global data for crop, thus not summable across rows. Data only for crops in Crop List (Treaty Crop Indicator project).

- FAOSTAT_Production_area_harvested – Data on contribution of crop to global production in terms of harvested area, based on FAOSTAT data, averaged across years 2015–2018. Data for each row are total global data for crop, thus not summable across rows. Data only for crops in Crop List (Treaty Crop Indicator project).

- FAOSTAT_Production_quantity – Data on contribution of crop to global production in terms of production quantity, based on FAOSTAT data, averaged across years 2015–2018. Data for each row are total global data for crop, thus not summable across rows. Data only for crops in Crop List (Treaty Crop Indicator project).

- FAOSTAT_Production_value_cnst_2014-16_us – Data on contribution of crop to global production in terms of production value, based on FAOSTAT data, averaged across years 2015–2018. Data for each row
are total global data for crop, thus not summable across rows. Data only for crops in Crop List (Treaty Crop Indicator project).

Political contracting party status:

Nagoya Protocol:

- Provider_Nagoya_party_cleaned – Y/N if the provider country is currently Contracting Party to Nagoya Protocol (from Nagoya dataset). Data complete.

- Provider_Nagoya_party_year_cleaned – Year of provider country joining as a Contracting Party (for provider countries Contracting Party to Nagoya Protocol) or blank (for provider countries not Contracting Party to Nagoya Protocol).

- Provider_Nagoya_party_during_transfer_startyear - TRUE (provider country is Contracting Party to Nagoya Protocol) or FALSE (provider country is not Contracting Party to Nagoya Protocol) during year of germplasm distribution. Data based on field “Provider_Nagoya_Party_year_cleaned” (if that year is same or previous to distribution year (field “analysis_year_startyear”), then TRUE, if more recent or blank, then FALSE). Data complete.

- Provider_Nagoya_party_during_transfer_endyear - TRUE (provider country is Contracting Party to Nagoya Protocol) or FALSE (provider country is not Contracting Party to Nagoya Protocol) during year of germplasm distribution. Data based on field “Provider_Nagoya_Party_year_cleaned” (if that year is same or previous to distribution year (field “analysis_year_endyear”), then TRUE, if more recent or blank, then FALSE). Data complete.

The Treaty:

- Provider_Treaty_contracting_party_cleaned – Yes/No if the provider country is currently Contracting Party to the Plant Treaty (from Plant Treaty contracting party dataset). Data complete.

- Provider_Treaty_entry_into_force_cleaned – Year of provider country joining as a Contracting Party (for provider countries Contracting Party to Plant Treaty) or blank (for provider countries not Contracting Party to Plant Treaty).

- Provider_Treaty_party_during_transfer_startyear – TRUE (provider country is Contracting Party to Plant Treaty) or FALSE (provider country is not Contracting Party to Plant Treaty) during year of germplasm distribution. Data based on field “Provider_Treaty_entry_into_force_cleaned” (if that year is same or previous to distribution year (field “analysis_year_startyear”), then TRUE, if more recent or blank, then FALSE). Data complete.

- Provider_Treaty_party_during_transfer_endyear – TRUE (provider country is Contracting Party to Plant Treaty) or FALSE (provider country is not Contracting Party to Plant Treaty) during year of germplasm distribution. Data based on field “Provider_Treaty_entry_into_force_cleaned” (if that year is same or previous to distribution year (field “analysis_year_endyear”), then TRUE, if more recent or blank, then FALSE). Data complete.

ANNEX 3: The Treaty Germplasm Distribution Dataset Dictionary

Dictionary/notes on Treaty dataset fields:

- Dataset: Denotes which the Treaty dataset. Original data. Data complete.

- CGIAR only – International centres as provider (note provider_iso3 and provider_country list country where CGIAR center is located.

- Total transfers – Full dataset (including CGIAR as well as all other transfers).

- Provider_iso3 – Origin country code of distribution. Original data. Data complete.

- Provider_country – Origin country of distribution. Original data. Data complete.

- Crop_original – original crop name(s). Original data. Data complete.
Crop_cleaned – Processed/cleaned crop names. New data. Data complete.

Taxonomic_name – Scientific name. New data. Data not complete.

Wild_relative – Y/N if the sample is a wild relative based on taxonomy and crop names. New data. Completed to the extent possible.

CropList_equivalent – Name of crop in Crop List (Treaty Crop Indicator project) for those crops matching. All other crops listed here as None. New data. Data complete.

Year – Year of germplasm distribution. Original data. Data complete.

Number of samples – Number of samples distributed. Original data. Data complete.


SOW2_grouping_cleaned – Cleaned/processed crop type as per SOWII categorization. New data. Data complete.

PL_group_cleaned – cleaned/processed crop type as per PL_group categorization. New data. Data complete.

CropList_seed_storage_behaviour_cleaned – Orthodox/recalcitrant info, from Kew SID. Field from Crop List (Treaty Crop Indicator project). Field further filled manually for crops not matching to Crop List, as possible. Data not complete.

Germplasm storage type – Seed/clonal/unknown. Refers to the main likely way germplasm distributed for crop. Data from Khoury et al. (2021) and further filled manually as possible. Data complete.

CropList_seed_storage_behavior – Orthodox/recalcitrant info, from Kew SID. Field from Crop List (Treaty Crop Indicator project). Field only filled for crops matching to Crop List. Data not complete.

CropList_Use_detailed – Specific use category. Field from Crop List (Treaty Crop Indicator project). Field further filled manually for crops not matching to Crop List. Data complete.

CropList_Use_primary – General use category. Field from Crop List (Treaty Crop Indicator project). Field further filled manually for crops not matching to Crop List. Data complete.

CropList_MLS_Annex1_crop – Y/N. lists if crop in Annex 1 of Treaty MLS (only based on crop, not on provider or country). Field from Crop List (Treaty Crop Indicator project). Field further filled manually for crops not matching to Crop List. Data complete.

Provider_region_name – Region of provider country. Data from UNSTATs (2022). Data complete.

Provider_subregion_name – Subregion of provider country. Data from UNSTATs (2022). Data complete.


Provider_country_or_area – Provider country name. Data from UNSTATs (2022). Data complete.

Provider_iso2 – Iso2 code of provider country of distribution. Data from UNSTATs (2022). Data complete.

Provider_least_developed_countries_ldc. Y/N. Data from UNSTATs (2022). Data complete.

Provider_land_locked_developing_countries_lldc. Y/N. Data from UNSTATs (2022). Data complete.

Provider_small_island_developing_states_sids. Y/N. Data from UNSTATs (2022). Data complete.

Recipient_region_name – Region of recipient country. Data from UNSTATs (2022). Data complete.

Recipient_subregion_name – Subregion of recipient country. Data from UNSTATs (2022). Data complete.

Recipient_country_or_area – Recipient country name. Data from UNSTATs (2022). Data complete.

Recipient_iso2 - iso2 code of recipient country of distribution. Data from UNSTATs (2022). Data complete.

Recipient_least_developed_countries_ldc. Y/N. Data from UNSTATs (2022). Data complete.


Recipient_small_island_developing_states_sids. Y/N. Data from UNSTATs (2022). Data complete.

Provider_income_category – Income level of provider country. Data from World Bank. Based on year of distribution, as income levels can change year to year. Data complete.

Recipient_income_category – Income level of recipient country. Data from World Bank. Based on year of distribution, as income levels can change year to year. Data complete.

Crop importance (food supplies and production)

FAOSTAT_Fat_supply_quantity_g_capita_day – Data on contribution of crop to global food supplies in terms of fat, based on FAOSTAT data, averaged across years 2015–2018. Data for each row are total global data for crop, thus not summable across rows. Data only for crops in Crop List (Treaty Crop Indicator project).

FAOSTAT_Food_supply_kcal_capita_day – Data on contribution of crop to global food supplies in terms of calories, based on FAOSTAT data, averaged across years 2015–2018. Data for each row are total global data for crop, thus not summable across rows. Data only for crops in Crop List (Treaty Crop Indicator project).

FAOSTAT_Food_supply_quantity_kg_capita_yr – Data on contribution of crop to global food supplies in terms of weight, based on FAOSTAT data, averaged across years 2015–2018. Data for each row are total global data for crop, thus not summable across rows. Data only for crops in Crop List (Treaty Crop Indicator project).

FAOSTAT_Protein_supply_quantity_g_capita_day – Data on contribution of crop to global food supplies in terms of protein, based on FAOSTAT data, averaged across years 2015–2018. Data for each row are total global data for crop, thus not summable across rows. Data only for crops in Crop List (Treaty Crop Indicator project).

FAOSTAT_Production_area_harvested – Data on contribution of crop to global production in terms of harvested area, based on FAOSTAT data, averaged across years 2015–2018. Data for each row are total global data for crop, thus not summable across rows. Data only for crops in Crop List (Treaty Crop Indicator project).

FAOSTAT_Production_quantity – Data on contribution of crop to global production in terms of production quantity, based on FAOSTAT data, averaged across years 2015–2018. Data for each row are total global data for crop, thus not summable across rows. Data only for crops in Crop List (Treaty Crop Indicator project).

FAOSTAT_Production_value_cnst_2014-16_us – Data on contribution of crop to global production in terms of production value, based on FAOSTAT data, averaged across years 2015–2018. Data for each row are total global data for crop, thus not summable across rows. Data only for crops in Crop List (Treaty Crop Indicator project).

Political contracting party status:

Nagoya Protocol:

Provider_Nagoya_Party_cleaned – Y/N if the provider country is currently a Contracting Party to Nagoya Protocol (from Nagoya dataset). Data complete.
The Treaty:

- Provider_Treaty_contracting_party_cleaned – Y/N if the provider country is currently Contracting Party to the Plant Treaty (from Plant Treaty contracting party dataset). Data complete.
- Provider_Treaty_entry_into_force_cleaned – Year of joining (for provider countries Contracting Party to Plant Treaty) or blank (for provider countries not Contracting Party to Plant Treaty)
- Recipient_Treaty_contracting_party_cleaned – Y/N if the recipient country is currently a Contracting Party to the Plant Treaty (from Plant Treaty contracting party dataset). Data complete.
- Recipient_Treaty_entry_into_force_cleaned – Year of joining (for recipient countries Contracting Party to ITPGRFA) or blank (for recipient countries not Contracting Party to ITPGRFA)
- Provider_Treaty_party_during_transfer – TRUE (provider country is Contracting Party to Plant Treaty) or FALSE (provider country is not Contracting Party to Plant Treaty) during year of germplasm distribution. Data based on field “Provider_Treaty_entry_into_force_cleaned” (if that year is same or previous to distribution year, then TRUE, if more recent or blank, then FALSE). Data complete.
- Recipient_Treaty_party_during_transfer – TRUE (recipient country is Contracting Party to Plant Treaty) or FALSE (recipient country is not Contracting Party to Plant Treaty) during year of germplasm distribution. Data based on field “Recipient_Treaty_entry_into_force_cleaned” (if that year is the same or previous to the distribution year, then TRUE, if more recent or blank, then FALSE). Data complete.

References for Annex 3

**UNSTATS (United Nations Statistical Division).** 2022. *Standard country or area codes for statistical use (M49).* [Cited 31 July 2022]. https://unstats.un.org/unsd/methodology/m49/overview/