



Center for Agriculture
& Food Systems

VERMONT LAW & GRADUATE SCHOOL



Digital Sequence Information on Plants

Who Owns It, and Who's Owed?

Mapping Governance Under the Convention on Biological Diversity and the International Treaty
on Plant Genetic Resources for Food and Agriculture

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Glossary

All definitions are from the U.S. Department of Agriculture's Agricultural Biotechnology Glossary.

Genetic Engineering — Manipulation of an organism's genes by introducing, eliminating or rearranging specific genes using the methods of modern molecular biology, particularly those techniques referred to as recombinant DNA techniques.

Genetic Sequencing — Determining the exact sequence of nucleotide bases in a strand of DNA to better understand the behavior of a gene.

Genome — All the genetic material in all the chromosomes of a particular organism.

Genotype — The genetic identity of an individual. Genotype often is evident by outward characteristics, but may also be reflected in more subtle biochemical ways not visually evident.

Plant Breeding — The use of cross-pollination, selection, and certain other techniques involving crossing plants to produce varieties with particular desired characteristics (traits) that can be passed on to future plant generations.

Variety — A subdivision of a species for taxonomic classification also referred to as a 'cultivar.' A variety is a group of individual plants that is uniform, stable, and distinct genetically from other groups of individuals in the same species.

Acronyms

ABS — Access and Benefit Sharing

CBD — Convention on Biological Diversity

DSI — Digital Sequence Information

FAO — Food and Agriculture Organization of the United Nations

INSDC — International Nucleotide Sequence Database Collaboration

ITPGRFA — International Treaty on Plant Genetic Resources for Food and Agriculture

NPGS — National Plant Germplasm System

SMTA — Standard Material Transfer Agreement

UN — United Nations

UNDRIP — United Nations Declaration on the Rights of Indigenous Peoples

UNDROP — United Nations Declaration on the Rights of Peasants and Other People Working in Rural Areas

UPOV — International Union for the Protection of New Varieties of Plants

WIPO — World Intellectual Property Organization

WTO — World Trade Organization

Introduction



Plant breeding is the process of selecting plants for their desirable traits and crossing them over generations to produce crops better suited to human needs.¹ This process has been around for thousands of years, used to develop crops with higher yields, greater drought tolerance, and stronger disease resistance. Historically, plant breeding required physical access to the plants themselves, whether through seeds, cuttings, or other reproductive materials. Genetic engineering has changed this process and allowed scientists to more readily develop plant varieties that may not occur naturally.²

Whether through conventional plant breeding or genetic engineering, plant breeding has created the foundation of our global food system.³ But the use of existing plant material, evolved over millennia and cultivated for countless generations, raises unsettled questions over ownership and compensation.⁴

In our current global food system, the people or companies that commercialize new plant varieties benefit financially from seed sale profits and intellectual property royalties.⁵ However, plant breeders often look to plants from around the world to find the traits they need, like resistance to pests and diseases, tolerance to drought or flooding, and better nutritional quality.⁶ The people who supply the initial material for these breeding projects—often Indigenous communities and smallholder farmers in biodiverse regions of Latin America, Africa, and Asia—typically see little economic benefit from the commercialization of varieties that draw on their stewardship work.⁷

The shift toward data-driven and, increasingly, automated breeding techniques has complicated this landscape by reducing the need for physical material.⁸ Genetic resources have been digitized, which makes them easier to distribute and more difficult to track.⁹ Because the relevant frameworks are housed in different international bodies with different memberships and enforcement mechanisms, there is no single forum with clear authority to resolve the questions around the fair exchange of digital sequence information. In this resource, we will define digital sequence information, identify the international bodies that have been involved in issues related to ownership and benefits, explain why digital sequence information is difficult to govern, and outline how these decisions affect researchers in the United States as these debates continue.



What is Digital Sequence Information and Why Does it Matter?



The first whole plant genome, *Arabidopsis thaliana*, was published in 2000 and took almost five years to produce.¹⁰ Just a quarter-century later, genomes have been published for more than 2,500 species. That number is increasing steadily as the process becomes faster and less expensive.¹¹ As genomic information gets processed, shared, and utilized in the development of new plant varieties, scientists and policymakers have questioned how to fairly govern a process that used to be wholly dependent on the exchange of seeds or other plant material. In these discussions, the type of information used in plant breeding that is *not* physical material is called *digital sequence information* (DSI). A place-holder term used by policymakers rather than a scientific term, DSI refers to the digitized form of a genetic sequence that has been uploaded into a database and is used by scientists to analyze, edit, engineer, and synthesize biological materials.¹² There are many different types of genetic sequencing, and the information associated with those sequences can be broadly or narrowly construed.

In 2018, the Convention on Biological Diversity (CBD) commissioned a report on the scope of digital sequence information, which outlined potential definitions for DSI, including:

- only DNA and RNA;
- DNA, RNA, and proteins;
- DNA, RNA, proteins and metabolites; and
- DNA, RNA, proteins, metabolites, traditional knowledge, and ecological interactions.¹³

Each of these categories expands outward from the genetic code itself. DNA, RNA, and proteins are identifiable by their molecular “sequence”; metabolites are small molecules identifiable by molecular formulas or models. All these forms of information can, to varying degrees, prove useful in developing commercially viable products, potentially without the need to access physical biological plant matter.¹⁴

Given these various definitions, there is still no consensus on what constitutes DSI from a policy perspective. Most researchers favor a definition somewhere within the first three definitions. Information like traditional knowledge or ecological relationships is unlikely to be included in any formal definition.¹⁵ Still, some communities that provide biological resources to researchers have argued that DSI is itself a form of traditional knowledge, reflecting a view that a genetic sequence cannot be separated from the living organism and its environmental and community relationships.¹⁶

Though decisions continue to be made regarding the governance of DSI without a formal definition, placing a boundary around what is and is not DSI is important. This is true both for those who provide materials and information, and for those who commercialize products derived from it and need clarity around what they owe in exchange.

The International Governance Landscape for Plant Genetic Resources

One of the primary questions around the regulation of DSI is who owns it, and how the benefits from its use should be distributed to the communities where the plant material originated. In developed countries, there is a presumption that anything not covered by a regulated system of intellectual property is a part of the public domain and should be freely accessible.¹⁷ Indigenous peoples and local communities in biodiverse regions, particularly in developing countries, have long challenged this presumption, arguing that even when their genetic resources and traditional knowledge are not covered by intellectual property, outside researchers and commercial enterprises should not be able to access or use them without prior informed consent and a fair share of any resulting benefits.¹⁸ This section describes the two international frameworks at the center of that debate: the intellectual property systems that determine ownership of genetic materials, and the access and benefit sharing agreements that define what benefits must be returned in exchange for their use.

The Intellectual Property Systems for Plant-Related Inventions

The **World Trade Organization (WTO)** is a group of sovereign states that operates a system of rules for trade between nations. Members the World Trade Organization must adhere to its **Agreement on the Trade-Related Aspects of Intellectual Property (TRIPS)**, which sets minimum standards for the regulation of intellectual property. In general, TRIPS requires countries to extend patent protection to most types of human inventions, and it specifically prohibits countries from advantaging or disadvantaging specific industries via the types of patent protection available to them.¹⁹ However, TRIPS allows countries to design their own system for plant varieties specifically.²⁰ Most use the system outlined by the **International Union for the Protection of New Varieties of Plants (UPOV)**, an older compromise system that lets plant breeders restrict commercial sale of their varieties while still allowing researchers and farmers to use and save seed, unlike patent systems that restrict the use of patented seeds in research and seed saving.²¹ A few countries, such as the U.S., Japan, and Australia, offer both a UPOV-style system of protection for plant varieties and broader patent protection.²² Other countries offer patent protection for certain plant-related inventions, like genetically engineered traits or genetic sequences, but do not offer patent protection for plant varieties.²³

The **World Intellectual Property Organization (WIPO)**, a specialized branch of the United Nations, promotes intellectual property legislation around the world, including by assisting with the development and administration of TRIPS. In 2024, WIPO adopted the Treaty on Intellectual Property, Genetic Resources and Associated Traditional Knowledge, which would require patent applicants to disclose the origin of genetic resources and associated traditional knowledge.²⁴ The purpose of the treaty, in part, is to “prevent patents from being granted erroneously for inventions that are not novel or inventive with regard to genetic resources and traditional knowledge associated with genetic resources.”²⁵ The treaty, not yet in force, will become effective when it has 15 ratifications.²⁶ Though 44 member countries have signed the treaty, only four have ratified it as of July 2026.²⁷

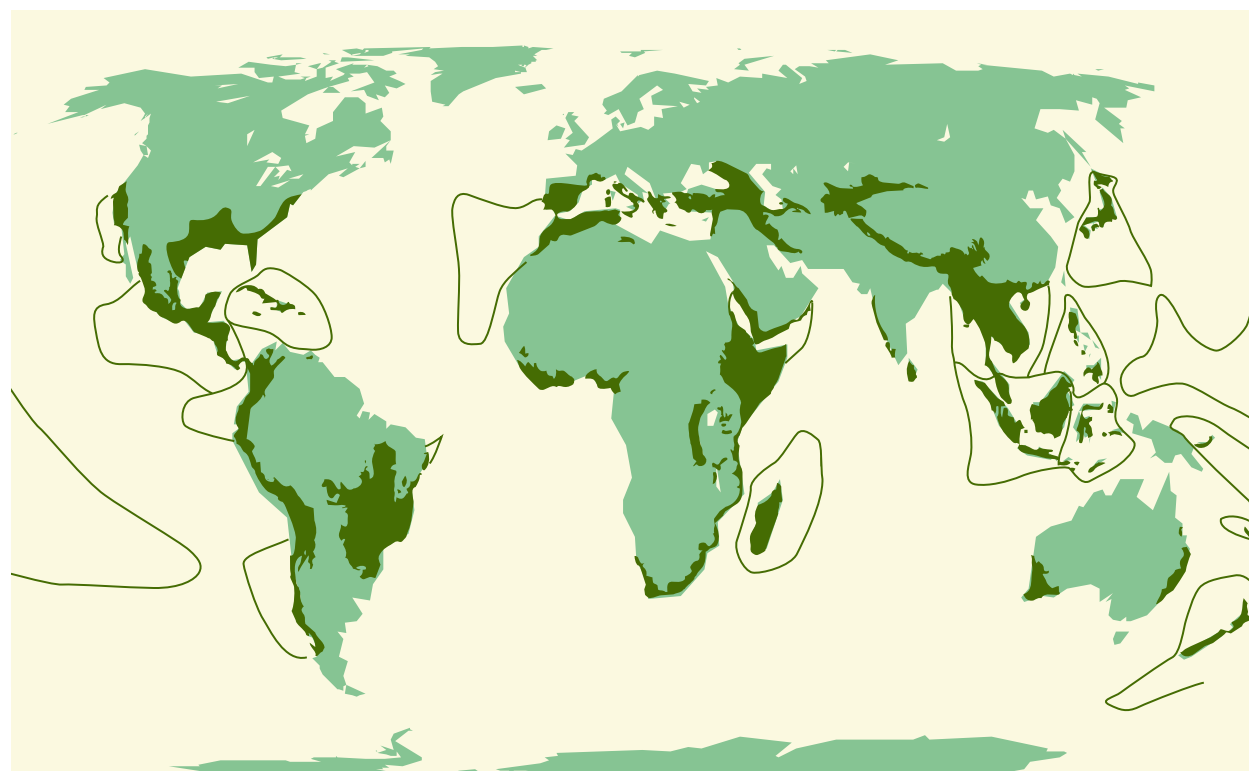
Access and Benefit Sharing Frameworks

The global expansion of intellectual property law to plant-related inventions, and the growing recognition that the people living in some of the world's most important biodiverse areas lacked resources to protect them, led to the creation of the **Convention on Biological Diversity (CBD)** in 1992.²⁸ The convention has three major objectives: (1) to support the conservation of biological diversity; (2) to support the sustainable use of the components of biological diversity; and (3) to support the fair and equitable sharing of benefits arising from the use of genetic resources.²⁹ The third objective has been implemented through the **Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization (Nagoya Protocol)**. The Nagoya Protocol requires that anyone seeking access to genetic resources for any purpose must obtain prior informed consent from the country providing the resources, and it requires that both sides agree on the terms of use before access is granted.³⁰ Additionally, researchers that use genetic resources have to share benefits (both monetary and non-monetary) that come out of their research back with the communities that provided the genetic resources.³¹ Those benefits include data results, co-authorship for publications, or jobs or research positions for members of the originating community.³² It is up to each country to set their own laws for implementing these requirements, and many agreements are established on a case-by-case basis. Every country in the world has ratified the CBD except for the United States and the Holy See.³³ The Nagoya Protocol has been ratified by 142 countries.³⁴

Critics of the Nagoya Protocol were concerned that the decentralized, piecemeal nature of these arrangements could slow innovation. To address these concerns, the **United Nations Food and Agriculture Organization (FAO)** established the **International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA)**. The ITPGRFA creates a shared, multilateral system of access and benefit sharing for a specific list of crops when used specifically for food and agriculture research. Defined in Annex 1 of the treaty, these crops are now broadly known as “Annex 1 crops.” This list includes important staples like maize and wheat but not major commodities like sugar and soybeans or vegetables such as tomatoes, peppers, and cucurbits.³⁵ Materials in the system are exchanged under a **Standard Material Transfer Agreement (SMTA)**, which avoids the lengthy negotiation and approval process which can sometimes arise when accessing plant material under the Nagoya Protocol. The SMTA prohibits recipients from restricting others from accessing the same materials for research and breeding; however, it permits researchers to obtain intellectual property rights on commercial products developed from those materials.³⁶ If those intellectual property rights restrict others from conducting research or breeding on the protected material, the owner must pay 0.77 percent of sales of the product into a fund.³⁷ If products are made available without restriction, users may voluntarily contribute to the fund.³⁸ All resources that are both Annex 1 crops and in the public domain are subject to the SMTA, but individuals who hold private collections can choose whether to put their materials in the system.

There are 155 contracting parties to the ITPGRFA, including the United States.³⁹ The ITPGRFA satisfies the requirements of the Nagoya Protocol for researchers in countries that have ratified both agreements.⁴⁰ Where a country is not a party to the ITPGRFA but is a party to the Nagoya Protocol, researchers must negotiate and share benefits directly on a case-by-case basis with providers of genetic resources.⁴¹

FIGURE 1.
GLOBAL BIODIVERSITY HOTSPOTS⁴²



Declarations of Human Rights

The United Nations system has adopted several declarations on human rights, including rights related to seed stewardship. The **United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP)** enshrines the right of Indigenous people to retain ownership of and control over their seeds.⁴³ The **United Nations Declaration on the Rights of Peasants and Other People Working in Rural Areas (UNDROP)** strengthens these rights, affirming that the right to save, use, exchange, and sell seeds is fundamental to the realization of farmers' rights.⁴⁴ The FAO, which also oversees the ITPGRFA, actively participated in the negotiations of UNDROP.⁴⁵ On one hand, the ITPGRFA and the UN's work on human rights can be seen as complementary; they both protect farmers' rights to save, use, exchange, and sell seeds.⁴⁶ At the same time, encouraging the open sharing of plant material and related data might conflict with the right of Indigenous people to ban the collection and use of such information that originates in their territories.⁴⁷ Put a different way, TRIPS, CBD, and UNDRIP reflect values that can be in tension: TRIPS treats unprotected knowledge as freely available; the CBD regulates access to biological resources; and UNDRIP protects the right of Indigenous communities to decide on their own whether and how to grant access to genetic resources.⁴⁸ While the international intellectual property regime aims to protect innovation, the goal of access and benefit sharing frameworks is to protect the resources from which that innovation is derived.⁴⁹

These discussions, contentious in the context of plant material, become even more difficult to resolve when it comes to designing the rules that govern the use of digital sequence information derived from plant material.

Core Challenges

Why is Digital Sequence Information Difficult to Govern?

Once a plant's genetic information has been separated from the physical seed, that digital sequence information becomes much more difficult to trace as it is shared.⁵⁰ This is especially true for DSI deposited in open-access repositories such as GenBank, the European Nucleotide Archive, and the DNA Data Bank of Japan, the three databases that make up the International Nucleotide Sequence Database Collaboration (INSDC).⁵¹ The INSDC was founded in the 1980s to provide free and open access to genetic sequence data. Unlike physical material, which is usually shared by mail under a material transfer agreement, these databases generally do not require users to register, so there is often no record of who accessed the data or how it was used.

In this way, it is also much more difficult to assign value to DSI than to plant material. Unlike other physical goods, the “supply” of a piece of genetic information does not diminish as researchers use it.⁵² In addition, the use of DSI occurs very early in the value chain, and there is no way to calculate the importance of the DSI's contribution to a final commercial product.⁵³ Finally, sequence data derives its value by comparison with other sequences.⁵⁴ Treating all DSI as equally valuable will tend to undervalue some sequences and overvalue others; yet, assigning value to each sequence individually would be virtually impossible.⁵⁵

Should DSI be Subject to Access and Benefit Sharing Agreements?

Many users of DSI feel they should not be obligated to access and benefit sharing agreements for several reasons.⁵⁶ One argument is that an open access system provides opportunities for both industry and public interest plant breeders, so placing conditions on DSI access would unnecessarily slow scientific progress.⁵⁷ Some plant breeders, primarily representing industry, argue that plant breeding often involves the integration of data and germplasm from many individual plants, thus creating a complex web of contractual obligations that would be difficult to untangle, especially as the value chain becomes increasingly long, under an access and benefit sharing system.⁵⁸ Another argument against access and benefit sharing for DSI is that some research projects involve large amounts of sampling across multiple countries; obtaining agreements for each sequence could become onerous, especially for projects that



have little profit potential or for researchers working at institutions with low administrative capacity.⁵⁸ In addition, public funding sources often require researchers to openly share their research results, which may conflict with the terms of access and benefit sharing agreements that grant the originating country or community ownership over data.⁶⁰

At the same time, others argue that access and benefit sharing governance of DSI is essential, considering DSI's potential to replace physical germplasm and become a revenue-generating asset in plant breeding projects. Proponents of access and benefit sharing frameworks for DSI argue that researchers' ability to bypass current benefit sharing responsibilities by accessing germplasm sequences instead of physical material undermines the mechanisms that can bring revenue to owners of genetic resources.⁶¹ These proponents also point out that because research funding is finite, access to DSI without benefit sharing requirements could redirect already-limited investments toward digital infrastructure at the expense of physical ecosystem conservation and *ex situ* seed banks.⁶²

Lastly, some people argue that DSI should be considered a benefit in and of itself arising from the use of physical germplasm. Existing access and benefit sharing agreements encourage the sharing of research and development results as a form of non-monetary benefit.⁶³ However, calling DSI a benefit assumes that the recipient community has the technology, infrastructure, and expertise necessary to make use of it, which is often not the case.⁶⁴ Even when lower income countries have some scientific capacity, they may lack the economic infrastructure needed to convert knowledge into value, such as capital, pathways to commercialization, and entrepreneurial support.⁶⁵

Global Tensions in Access and Benefit Sharing Debates

The idea behind access and benefit sharing is to rebalance the capacity for biological conservation from places with high levels of technical capacity but low levels of biodiversity to places with low levels of technical capacity but high levels of biodiversity.⁶⁶ Most of the world's biodiversity is located in tropical and lower-income countries, yet wealthier, more industrialized nations have historically captured most of its value.⁶⁷ This has created a perceived binary that runs beneath all negotiations on the topic between “users” (wealthy, industrialized nations) and “providers” (low and middle income biodiverse nations, including most countries in Africa, Asia, Latin America, and Oceania) of biological resources. The “users” generally argue that open access to DSI is essential to solving urgent problems like food security and disease, and that the resulting information is the product of human ingenuity. The “providers” generally argue that open access undermines any real attempt to compensate the communities that safeguard these resources.

This framing may be a useful shorthand, but it tends to oversimplify reality.⁶⁸ Research shows that most DSI originates in countries that are generally characterized as “users” and that “provider” countries can still be “scientifically productive.”⁶⁹ Industrialized “user” countries are home to Indigenous communities that are also subject to biopiracy, and biodiverse “provider” countries have national private interests that may encourage intranational bioprospecting.⁷⁰ Therefore, while creating financial obligations for large multinational corporations that have historically exploited biodiverse communities may seem necessary and even justifiable, applying too broad a standard may require under-resourced enterprises in low and middle income countries to unfairly face the same obligations.⁷¹ Understanding these arguments and their limitations helps explain why consensus has proven so difficult to achieve.

Current Approaches

Both the Convention on Biological Diversity and the International Treaty on Plant Genetic Resources for Food and Agriculture were designed well before researchers had the ability to quickly digitally sequence plant material. Now, each is separately attempting to determine whether using DSI should trigger the same obligations that apply to physical germplasm. While the two treaties have some overlap in the crops they cover, they have employed diverging approaches and are governed by entirely separate bodies. These approaches are explained further in the sections below. The outcome of these discussions has potential to further fragment these frameworks and create confusing or conflicting obligations. At the same time, these discussions also create opportunity for a coordinated approach.⁷² For example, an existing institution could claim governance, a new organization or convention could be created, or existing bodies could agree to a new, shared structure.⁷³

Convention on Biological Diversity

In 2024, the parties to the Convention on Biological Diversity endorsed a non-binding decision to establish a multilateral system, charging only profitable users of specific sectors that benefit directly or indirectly from DSI, known as the “Cali Fund.”⁷⁴ The Cali Fund is designed to preserve open access to data and, recognizing that tracking is impractical, does not link benefit sharing obligations to specific sequences. Qualifying companies contribute a share of profits or revenue to a fund.⁷⁵ All users, including non-commercial users, are required to share non-monetary benefits as well.⁷⁶ The Cali Fund generates legal certainty, but it might also foreclose the interests of Indigenous peoples, especially their right to determine whether and on which terms to share information and their ability to identify and track traditionally important DSI. The decision provides that at least 50 percent of resources must be dedicated to supporting Indigenous peoples and local communities.⁷⁷ Currently, contributions to the Cali Fund are still voluntary,⁷⁸ though a mandatory requirement is slated for discussion at the biannual Conference of Parties in Armenia in October 2026.

International Treaty on Plant Genetic Resources for Food and Agriculture

If the ITPGRFA institutes its own system for access and benefit sharing for DSI, the system will likely operate in place of the mechanisms constructed by the CBD, in the same way the ITPGRFA’s multilateral system for Annex 1 crops currently operates in place of Nagoya Protocol’s bilateral system.⁷⁹ The ITPGRFA could also choose to support the Cali Fund and any model implemented by the CBD. Despite more than 10 years of debate on these topics and preparation for decision making, the most recent meeting in 2025 ended in a stalemate and was adjourned without reaching consensus, at which point the secretary postponed the decision to the autumn of 2027.⁸⁰

TABLE 1.
CBD AND ITPGRFA APPROACHES TO DSI

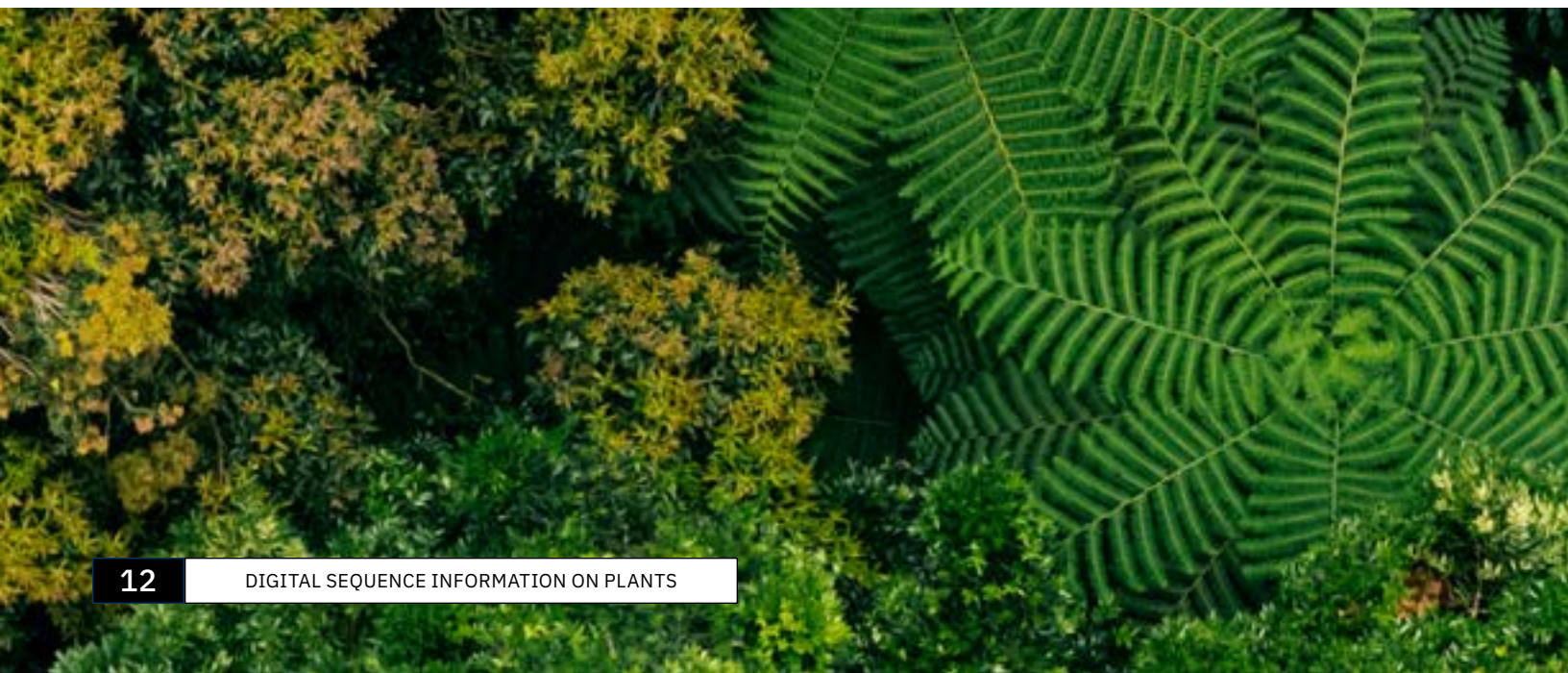
	CONVENTION ON BIOLOGICAL DIVERSITY (AND THE NAGOYA PROTOCOL)	INTERNATIONAL TREATY ON PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE
SUBJECT MATTER AND GEOGRAPHIC SCOPE	Covers all genetic resources covered by the CBD (not limited to plant material); ratified by every country except the U.S. and the Holy See (Vatican City).	Applies to a defined list of “Annex 1” crops (35 crop genera and 29 forage species) in 155 contracting parties, including the U.S.
APPROACH TO PLANT GENETIC RESOURCES	Requires prior informed consent and negotiated benefit sharing terms for access to genetic resources.	Requires a Standard Material Transfer Agreement (SMTA) to access a defined list of agricultural crops. Protects use for research and breeding, with a share of commercial revenue owed back to a shared fund.
HOW BENEFIT SHARING IS DETERMINED	Bilateral agreements; researchers and providers negotiate on a case-by-case basis.	Multilateral system; the Standard Material Transfer Agreement cannot be altered or amended.
AGREEMENT TRACKING AND ENFORCEMENT	Implemented through national legislation, with no mechanism for tracking how countries have implemented legislation or individual agreements.	No mechanism for verifying SMTA compliance. SMTA payments are made into a shared fund with public reporting.
WHAT’S BEEN DONE SO FAR	COP 14 (2018) commissioned a scoping report on DSI’s definition (none has yet been widely accepted); COP 15 (2022) agreed to establish a multilateral benefit sharing mechanism.	A working group formed in 2023 to enhance the multilateral system, with DSI as a priority alongside crop list expansion and payment structure reforms.
CURRENT APPROACH TO DSI	COP 16 (2024) adopted the operating modalities for the Cali Fund. Companies meeting two of three financial thresholds (\$20M in assets, \$50M in sales, or \$5M in profit) contribute 1 percent of profits or 0.1 percent of revenue. Contributions are currently voluntary, and at least 50 percent of resources are reserved for Indigenous peoples and local communities.	The November 2025 meeting considered an annual subscription fee triggered by a crop’s first accession into the multilateral system, and a seed-sales tax reflecting DSI’s value. No consensus was reached; the decision was postponed to the Governing Body’s next session.
NEXT OPPORTUNITY TO ADDRESS DSI AND LIKELY QUESTIONS TO ADDRESS	COP 17 in Armenia, October 2026. Should Cali Fund contributions be mandatory rather than voluntary? How will funds be distributed to countries and communities of origin?	12th Session of the Governing Body in Italy, November 2027. Will the Governing Body revisit the unresolved DSI questions from November 2025? Will the ITPGRFA adopt a model similar to the Cali Fund? If so, how would it avoid creating overlapping obligations?

Implications for U.S. Researchers



As a member of the WTO, the U.S. served as a leading architect of the TRIPS agreement and often supports strong intellectual property rights in the international arena.⁸¹ The U.S. is also a party to the ITPGRFA but has not ratified the CBD and the Nagoya Protocol on the grounds that the treaty undermines research and innovation and should not weigh in on issues of intellectual property.⁸² Still, some institutions and universities in the U.S. have voluntarily instituted access and benefit sharing obligations via their own material transfer agreements.⁸³ This creates a confusing scenario both for researchers in other countries conducting research with materials derived from the U.S. and for plant breeders conducting research within the U.S. with materials derived from other countries.

The National Plant Germplasm System (NPGS), which is the primary public gene bank for plant materials in the United States, has added the majority of its collection to the ITPGRFA multilateral system with the exception of a few collections.⁸⁴ Requests for germplasm made from outside the U.S. are fulfilled under an SMTA.⁸⁵ Researchers requesting germplasm from inside the U.S. are required to accept the SMTA only if the material they are requesting was acquired by the NPGS under the same SMTA.⁸⁶ Researchers in the U.S. acquiring germplasm from other countries may need to determine whether an access and benefit sharing agreement needs to be negotiated under either the ITPGRFA or the Nagoya Protocol.⁸⁷ Gene banks and *ex situ* collections often hold a mix of accessions governed by each framework, requiring case-by-case evaluation.⁸⁸ There is no mechanism for verifying that researchers who have accepted the terms of the SMTA comply with the access and benefit sharing obligations it contains, and the U.S. does not appear to have made any contributions to the ITPGRFA fund.⁸⁹ At COP 17, parties are expected to finalize the Cali Fund's thresholds and contribution rates, which currently apply to large companies based on size and revenue rather than nationality, meaning that companies operating in the United States that meet these thresholds may be required to contribute, despite the fact that the U.S. has not ratified the CBD. Parties are also expected to finalize the formula governing how Cali Fund resources are distributed. Public researchers in the U.S. are already exempt from monetary obligations, though institutions may adopt voluntary contribution guidelines.



Conclusion

The debate over digital sequence information is a debate about who benefits most from the accumulated biological wealth of the planet and who bears the cost of conserving it. The governance frameworks described in this issue brief—the WIPO intellectual property system, the UNDROP’s resolution on human rights, the FAO’s ITPGRFA, and the CBD’s Nagoya Protocol—were all designed for a world in which questions around ownership and control were largely dictated by access to physical materials, and they were already struggling to deliver on their goals of advancing innovation, promoting fairness, and conserving biological diversity before the digital transformation of plant breeding. The emergence of DSI has accelerated existing disagreements between open science and sovereign control, between the interests of providers and users, and between the promise of multilateral solutions and the difficulties in achieving consensus for their management. The Cali Fund represents a step toward resolving some of these tensions, but many of the most difficult questions, including whether to mandate participation, how to distribute funds, and how important agricultural crops will be included, remain open. Although U.S. institutions are major users of plant genetic resources from all over the world, the country’s continued refusal to ratify the CBD means that its researchers operate largely removed from the frameworks the rest of the world is actively debating. Still, understanding where these debates stand, where they are headed, and the underlying motivations behind various approaches, is essential to navigating the rapidly changing global regulatory landscape.



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