Chapter 6
Intellectual Property and the Governance of Plant Genetic Resources in Mexico: Trends and Implications for Research and Innovation

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Abstract This chapter explores how the regulation of plant genetic resources intersects with legal regimes granting intellectual property rights in Mexico. Our analysis is directed towards addressing the argument that regimes governing access to plant genetic resources and the sharing of benefits derived from their commercial exploitation could discourage research and innovation in fields that rely on such resources as inputs. To engage with this critique, we examine the relationship between plant genetic resources and intellectual property, because trends in intellectual property protection may elucidate research and innovation dynamics. Our findings surrounding applications for patents and plant breeders' rights in Mexico indicate that intellectual property activity related to plant genetic resources can intensify even as new frameworks for the governance of these resources are designed and popularized. However, it is important to note that it is still unknown whether the implementation of a national regime based on the Nagoya Protocol in Mexico might impact the activities of users and providers of genetic resources, including in relation to intellectual property protection.

Keywords Plant genetic resources · Intellectual property · Nagoya Protocol · Access and benefit sharing · Mexican native plants

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6.1 Introduction

Plant genetic resources are highly valuable, providing the foundation for knowledge development in a variety of scientific fields as well as the basis for important commercial products. At a more primordial level, these resources have intrinsic value related to the role that they play in both natural ecosystems and traditional communities. In recent years, several landmark international legal instruments have been developed to structure transactions centring on plant genetic resources. Such regimes attempt to consider the interests of a variety of stakeholders surrounding the uses of particular plants, as well as the knowledge or information associated with these resources.

The first and most prominent international framework for the governance of plant genetic resources is the Convention on Biological Diversity (CBD 1992), which entered into force in 1993. The CBD acknowledges that individual States have sovereign rights to regulate biological resources sourced from within their borders, as well as to stipulate how any benefits that users perceive from the exploitation of these resources should be shared with providers (Article 15.1 and 15.7). More recently, the Nagoya Protocol, a supplementary agreement to the CBD, established a comprehensive framework to regulate access to genetic resources and equitable benefit sharing between users and providers.[1]

As the international landscape for the governance of plant genetic resources has evolved, so too has the debate over how to regulate access and benefit sharing at the national level. It has been broadly acknowledged that the Nagoya Protocol did not fully address many stakeholders' concerns, and indeed the agreement requires national action to implement its substantive obligations (Nijar 2011). To date, few countries have enacted comprehensive access and benefit-sharing frameworks, though at the time of writing, the Nagoya Protocol had 100 members (CBD 2018). Nevertheless, some States are now beginning to implement national laws to give effect to the provisions of the Protocol. Thus, there exists a need to better understand how both users and providers of plant genetic resources might be impacted by these new regimes.

In the present chapter, we focus on elucidating how the regulation of plant genetic resources intersects with legal regimes granting intellectual property rights in Mexico. Our analysis is directed towards addressing the argument that regimes governing access to plant genetic resources and the sharing of benefits derived from their commercial exploitation could discourage research and innovation in fields

[1] Another international instrument that covers issues related to the governance of genetic resources is the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), which entered into force in 2004. The ITPGRFA is designed to recognize the enormous contribution of farmers to crop genetic diversity; create a global system to provide farmers, plant breeders, and scientists with access to plant genetic materials; and ensure that recipients share benefits that they derive from the use of genetic materials with the countries where they originated. While the ITPGRFA is a highly relevant treaty to the global governance of plant genetic resources, it is not covered in this chapter because at the time of writing, Mexico was not a contracting party.

that rely on such resources as inputs (e.g. Jinnah and Jungcurt 2009). In order to engage with this general critique, we examine the relationship between plant genetic resources and intellectual property.

The rationale for this focus is that trends in intellectual property protection may elucidate research and innovation dynamics. For instance, in some instances exclusive intellectual property rights may deter both upstream research and downstream product development (e.g. Heller and Eisenberg 1998), potentially affecting the institutional cultures of universities and public research centres (Lei et al. 2009). Yet at the same time, intellectual property in the form of patents or plant breeders' rights might act as indicators for the economic valuation of plant genetic resources (Lee and Sohn 2016), thereby facilitating negotiations towards benefit-sharing agreements by mitigating information asymmetries between users and providers (Nelliyat 2017). Thus, regimes regulating access to and intellectual property protection of plant genetic resources intersect in numerous ways, which in many instances remain to be researched.

The present chapter is structured as follows: in Sect. 6.2 we review the relevant national legal frameworks in Mexico. These include the emerging national system for the governance of genetic resources based on the Nagoya Protocol, as well as the country's laws granting intellectual property protection through patents and plant breeders' rights. Subsequently, we present data related to filings for plant breeders' rights and patents, both in Mexico and internationally, in relation to ten particular species of Mexican native plants. Our conclusions centre on the interrelationship between intellectual property and plant genetic resources in the Mexican context, focusing on implications for future research and innovation.

6.2 Legal Frameworks for the Regulation of Plant Genetic Resources in Mexico

Mexico is classified as one of the 17 "megadiverse" countries in the world, meaning that it belongs to a group of nations that house the majority of all species on Earth, in addition to having a large volume of endemic species (Mittermeier et al. 1997). The country is both a provider and a user of genetic resources, and Mexico is also home to numerous indigenous communities, which collectively represent nearly 10% of the total national population (CDI 2006). These communities possess important reserves of traditional knowledge surrounding the use of plant genetic resources, which in many instances would likely form part of the subject matter of access and benefit-sharing agreements. Given this national profile, it is perhaps unsurprising that Mexico was a major proponent of the Nagoya Protocol, which it signed in February 2011.

Although Mexico was the sixth country in the world to adhere to the Nagoya Protocol, the country still does not have a comprehensive, binding national law that would implement the Protocol. Instead, Mexico has outlined a series of actions as

part of its National Strategy on Biodiversity ("ENBioMex") 2016–2030. This guidance document establishes a set of key elements for the sustainable conservation, restauration, and management of Mexican biodiversity. Furthermore, the ENBioMex plan is based on 14 governing principles along 6 strategic axes, which include (1) knowledge governance; (2) conservation and restauration; (3) sustainable use and management; (4) prevention and control; (5) environmental education, communication, and culture; and (6) integration and governance (ENBioMex 2016). Although the National Strategy on Biodiversity is nonbinding, it is ambitious in scope and demonstrates the commitment of the Mexican federal government to substantiate the aspirations of the CBD and Nagoya Protocol through domestic legislation.

More recently, in October 2017 a new policy entered into force under the jurisdiction of the Mexican Secretary of Agriculture (SAGARPA), which acts as an interim mechanism for the review of applications for access to plant genetic resources for food and agriculture. This policy is legally binding, and it establishes the steps that SAGARPA and the National Service for Seed Inspection and Certification (SNICS) must follow to evaluate permit applications to access plant genetic resources for uses in the food and agricultural contexts. The document is intended to serve as a transitional measure until a comprehensive national framework to implement the Nagoya Protocol is enacted.

The SAGARPA policy outlines procedures for the submission and evaluation of permit applications for access to plant genetic resources, the emission of permitting decisions by the Mexican federal government, how to deal with commercial uses of plant genetic resources, and guidelines for how to negotiate and execute benefit-sharing agreements with genetic resource providers (SAGARPA & SNICS 2017). Furthermore, as part of the interim policy and in order to facilitate negotiations between providers and users, the Secretary of Agriculture has published template agreements for prior informed consent and equitable benefit sharing.

While the national framework for the governance of plant genetic resources continues to evolve in Mexico, the country has firmly established intellectual property laws. Although the country offers a variety of mechanisms to protect intellectual property rights, the systems that are most relevant to plant genetic resources are plant breeders' rights and patents (e.g. Raustiala and Victor 2004). The former system confers exclusive yet temporary rights to the developers of new varieties of plants (i.e. breeders) in relation to the commercial use of these varieties. Plant breeders' rights laws interrelate with regimes governing genetic resources where breeding material sourced from native or local plants is used to develop new, commercially viable varieties. Meanwhile, patents are a form of intellectual property designed to reward the creators of novel, inventive, and useful products and processes. Plant genetic resources provide important inputs to a wide array of patentable subject matter, including research tools used to develop genetically modified organisms, biofuels, medications, and cosmetics, among many other types of products.

The Mexican system for plant breeders' rights is based on the 1978 version of the Convention of the International Union for the Protection of New Varieties of Plants (UPOV 1978), to which Mexico adhered in 1997. The prior year, the Federal Law on Plant Varieties was enacted, and this legislation was subsequently reformed in

2012. The Federal Law on Plant Varieties grants plant breeders the right to utilize and exploit – for a period of 15–18 years, depending on the species – plant varieties and associated propagating material, in relation to the production, reproduction, distribution, and sale thereof (LFVV 1996).

Meanwhile, the system for patent protection in Mexico dates to 1942 when the country's first Patent and Trademark Law was enacted. This regime was reformed in 1991 to become a comprehensive Industrial Property Law (Ley de Propiedad Industrial 1991), at which time the Mexican Intellectual Property Institute (IMPI) was created to review applications for patents and other forms of intellectual property. The Industrial Property Law has been reformed several times since 1991, most recently in 2012. These newer iterations of the Mexican Industrial Property Law have gradually expanded the scope of patentable subject matter. Until 1994, several classes of inventions related to plant genetic resources were not considered patentable, including biotechnological processes; medications in general; animal feed; fertilizers, pesticides, herbicides, and fungicides with biological activity; genetic processes to obtain plant or animal species; and plant varieties and animal breeds (Carrasco 2012).

The 1994 reform to the Industrial Property Law eliminated several of these restrictions. As a result, classes of products including biotechnological processes, medications, and agricultural inputs such as fertilizers and pesticides are now patentable. Yet even today many types of inventions related to the use of plant genetic resources are excluded from patent protection. For instance, non-patentable subject matter in the current (2012) version of the Mexican Industrial Property Law includes essentially biological processes for the production, reproduction, and propagation of plants and animals; biological and genetic material as found in nature; animal breeds; and plant varieties (LPI, Article 16).

One general feature of the Mexican intellectual property system is that the plant breeders' rights and patent laws do not permit the granting of exclusive rights over naturally occurring plant genetic resources. Nevertheless, these regimes do allow for intellectual property rights to be obtained for derivatives of such resources, such as improved plant varieties using native or local plants as parental lines (plant breeders' rights) or compositions made from plant materials (patents). In the following section, we examine how these regimes have operated in practice to grant intellectual property rights over subject matter derived from ten native Mexican plant species. We also review how these same species have been protected with intellectual property internationally.

6.3 Trends Related to the Protection of Mexican Plant Genetic Resources with Intellectual Property

Since the 1980s, intellectual property protection in the form of plant breeders' rights and patents has become increasingly important for scientific research on plant genetic resources, as well as for the utilization and commercialization of research results. This trend is evidenced in changes to patentability requirements in multiple

territories to permit the protection of living forms, the execution of the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) in 1995, and the subsequent burgeoning of UPOV membership (Correa 1995). The negotiation and execution of the CBD and the Nagoya Protocol have occurred concurrent with these developments. Today, laws providing for the protection of plant genetic resources with intellectual property interrelate with access and benefit-sharing regimes in multiple ways.

Below, we demonstrate how the plant breeders' rights and patent regimes are increasingly utilized in Mexico and internationally to protect subject matter derived from Mexican plant genetic resources. We particularly focus on instances in which rights have been granted in relation to ten native Mexican plant species. The species that we selected are *Agave tequilana* (blue agave), *Gossypium hirsutum* (cotton), *Opuntia ficus-indica* (nopal), *Physalis ixocarpa* (husk tomato), *Simmondsia chinensis* (jojoba), *Sechium edule* (chayote), *Solanum lycopersicum* (tomato), *Theobroma cacao* (cacao), *Turnera diffusa* (damiana), and *Zea mays* (maize or corn).

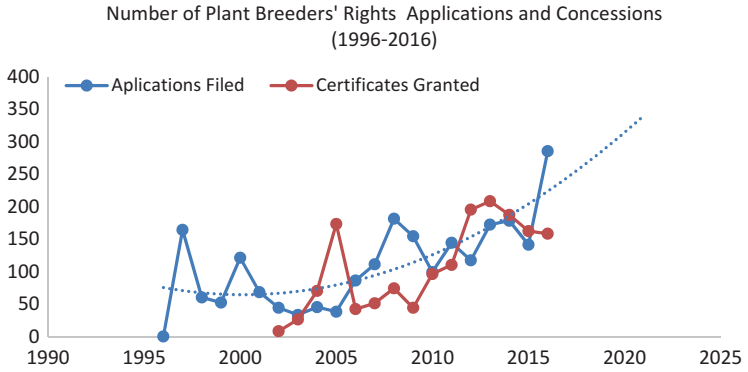
We chose these particular species for several reasons. All are considered to be native to Mesoamerica, a region that today partially falls within the borders of Mexico. The selection represents a range of plant types covering a variety of uses, including the generation of numerous agricultural, chemical, food, textile, and pharmaceutical products. Finally, we intentionally selected plant species that are both popularly cultivated throughout the world and those which are relatively unknown outside of Mexico, in order to highlight different issues related to the intersection between intellectual property laws and regimes governing access to genetic resources.

6.3.1 Protection via Plant Breeders' Rights

Since the Federal Law on Plant Varieties was enacted in 1996, the number of applications filed for plant breeders' rights in Mexico has steadily increased. This trend is illustrated in Fig. 6.1.

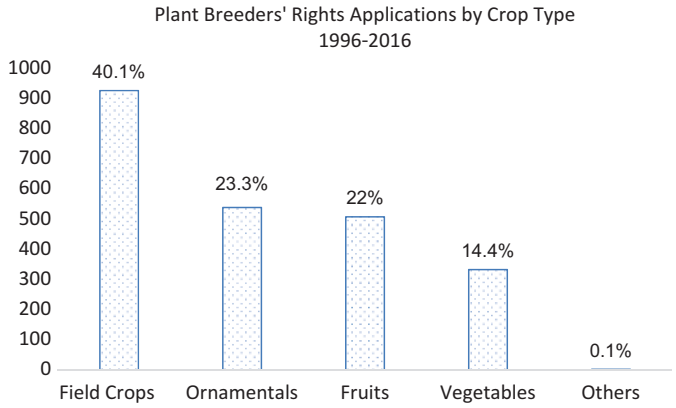
Figure 6.1 demonstrates increases in both plant breeders' rights applications and granted breeders' rights certificates during the period of 1996–2016. The total number of applications reached 2314 by 2016 and covered 123 crop species. Meanwhile, of the total number of applications, as of 2016 1619 breeders' rights certificates had been granted. Of the total number of granted certificates, 84.3% were active at the time of writing, highlighting the increase in activity in recent years.

The number of plant breeders' rights applications by type of crop can be seen in Fig. 6.2. Clearly, domestic Mexican and international institutions and firms were most interested in obtaining protection for plant varieties that are cultivated as large-scale commercial field crops. Meanwhile, nearly equal proportions of applications claimed fruit and ornamental varieties, while relatively less activity was associated with the registration of vegetable varieties.



Source: Authors' elaboration based on data from the Official Plant Breeders' Rights Gazette from SAGARPA.

Fig. 6.1 Number of plant breeders' rights applications and concessions (1996–2016). (Source: Authors' elaboration based on data from the official plant breeders' rights gazette from SAGARPA)



Source: Authors' elaboration based on data from the Official Plant Breeders' Rights Gazette from SAGARPA.

Fig. 6.2 Plant breeders' rights applications by crop type 1996–2016. (Source: Authors' elaboration based on data from the official plant breeders' rights gazette from SAGARPA)

Within these broad categories of crop type are several plant species that would likely be understood as Mexican plant genetic resources under the terms of the forthcoming national access and benefit-sharing regime, due to their common designation as native crops and the fact that they are likely to be sourced in Mexico. For instance, in recent years applications have been filed for varieties of crops that are popularly cultivated worldwide, some species of which were domesticated in Mexico. These include varieties of grains, pulses, tubers, and fibre crops such as amaranth, beans, cotton, maize, potato, and sorghum, as well as fruit and vegetable crops such as avocado, cacao, chili pepper, papaya, and tomato. Plant breeders' rights have also been sought for varieties of relatively less common food and ornamental plants that were

domesticated in Mexico, including agave, chayote, chia, dahlia, husk tomato, and nopal, among others (SNICS 2016).

The ten species of interest for the present analysis have interacted with the plant breeders' rights system in Mexico in diverse ways. Perhaps unsurprisingly given the global importance of maize as an important source of food, feed, and fuel, more breeders' rights applications were lodged in Mexico for *Zea mays* than for any other plant species. Specifically, as of 2016, a total of 422 applications had been filed, representing 19% of all breeders' rights applications from 1996 to 2016 (SNICS 2016). Similarly, *Gossypium hirsutum* (cotton) appeared in seventh place for the total number of applications from 1996 to 2016, with 68 filings or 3% of the total. A relatively high amount of activity also surrounded *Solanum lycopersicum* (tomato), with 42 applications lodged over the 20-year period, for approximately 2% of the total.

Meanwhile, far fewer applications had been filed to claim rights over new varieties of the other species of interest. Ten applications were filed to claim new varieties of *Physalis ixocarpa* (husk tomato; 0.44% of the total), while five applications were filed for *Opuntia ficus-indica* (nopal; 0.22% of the total). Other species were even less likely to be protected with breeders' rights in Mexico. Four applications were filed from 1996 to 2016 for *Sechium edule* (chayote; 0.2% of the total), and only one application was filed for a variety of *Theobroma cacao* (cacao; 0.04% of the total). No applications were filed in Mexico for varieties of *Agave tequilana* (blue agave), *Simmondsia chinensis* (jojoba), or *Turnera diffusa* (damiana).

While these findings illustrate the commercial value of native species within Mexico, it is important to note that the Nagoya Protocol was primarily designed to address concerns over international rather than national uses of plant genetic resources (Kamau et al. 2010). For this reason, it is important to examine instances in which rights have been granted over the ten Mexican native species of interest in other territories. In order to gather these data, we conducted searches in the PLUTO Plant Variety Database, which is administered by UPOV. We conducted searches by botanical name for the ten species of interest and discovered that in many cases, plant breeders' rights have been granted for new varieties of these species.

Unsurprisingly, an enormous volume of plant breeders' rights applications has been filed for varieties of *Zea mays* (maize). Including hybrid varieties, 119,016 filings were located for maize in the PLUTO database, in dozens of territories throughout the world. A large number of breeders' rights applications have also been lodged for *Gossypium hirsutum* (cotton; 3401), likewise in numerous countries. Significant activity also surrounded *Solanum lycopersicum* (tomato), with a total of 961 applications filed in 14 countries.

The remaining seven plant species were less commonly protected with plant breeders' rights. We located 29 filings through the PLUTO database covering *Theobroma cacao* (cacao), which were lodged in four countries. For *Physalis ixocarpa* (husk tomato), we found 28 applications in four countries, while 20 filings were encountered in relation to *Opuntia ficus-indica* (nopal), in three territories. Eleven applications had been filed for *Simmondsia chinensis* (jojoba) in three coun-

tries, while for *Sechium edule* (chayote), the only filings that appeared in the PLUTO database were made in Mexico (4). Finally, no records were found for *Agave tequilana* (agave) or *Turnera diffusa* (damiana).

The results demonstrate that in many instances, Mexican native plant species have been protected with plant breeders' rights, both in Mexico and in other territories. These data illustrate the fact that plant varieties derived from Mexican plant genetic resources may have commercial value in numerous world regions. In the future, if germplasm is obtained from within Mexico, whether in situ or from ex situ collections, the emerging legal framework for plant genetic resources governance will be implicated.

6.3.2 Protection via Patents

To elucidate the interrelationship between patenting and issues surrounding access to plant genetic resources in Mexico, we searched for patent documents published by the Mexican Intellectual Property Institute that included claims covering the ten plant species described above. Our searches were limited to patent applications and granted patents published since 1993, the date on which the CBD entered into force.

As demonstrated in Table 6.1, multiple patent applications have been filed since 1993 claiming the ten plant species of interest, and many of these applications have also resulted in granted patents. Meanwhile, Fig. 6.3 displays the number of patent applications filed by species, illustrating the fact that in general, the number of applications filed in relation to the ten species of interest has increased noticeably beginning in 2012. Figure 6.4 presents the number of granted patents by species since 1993. In comparison to the number of patent applications filed, relatively few patents have been granted for the ten species of interest since 2012. However, it is likely that their corresponding applications are still undergoing prosecution in the Mexican Intellectual Property Institute, and as such it is likely that the number of patents granted in relation to these five species will increase in the near future.

The overall trends in patenting activity in Mexico surrounding the ten species of interest are demonstrated in Fig. 6.5. This graph reveals a general increase in the number of patent applications with claims covering these species since 1993. Patenting activity has increased steadily over this period, and it is notable that the filing of patent applications appears to not have been negatively impacted by Mexico's signing of the Nagoya Protocol in 2014. In other words, these data suggest that to date, the country's adherence to the Nagoya Protocol has not impacted patenting activity in Mexico, in relation to Mexican plant genetic resources. Such a finding is not necessarily surprising, given that the interim permitting policy for access to plant genetic resources for uses in the food and agricultural contexts – the first legally binding framework in Mexico to cover such subject matter – was only enacted in October 2017. It remains to be seen whether this new regime might affect patenting activity in the future.

Table 6.1 Patenting trends for Mexican native plants in Mexico

		1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Simmondsia chinensis	PA	–	–	–	–	3	1	1	1	2	2	3		1	2	3		1	–	1	2	1	2	6	1	1
	GP	2	–	–	1	–	–	1	–	1	–	1	–	–	–	–	–	1	–	1	1	–	–	–	–	–
Sechium edule	PA	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–	–	–	2	2	1	–	–	–
	GP	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	–	–	–	–
Agave tequilana	PA	–	2	1	–	–	–	–	–	2	3	3	1	2	–	–	1	4	4	4	2	7	3	3	6	1
	GP	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	–	1	–	–	–	–	–
Zea mays	PA	–	–	–	–	–	2	5	6	14	10	6	7	6	5	10	7	8	12	11	12	14	6	9	20	5
	GP	1	1	–	2	1	1	2	3	4	3	4	4	7	2	7	5	4	7	4	7	6	2	–	–	–
Turnera diffusa	PA	1	–	–	–	–	–	–	1	1	–	–	–	–	1		3	1	1	–	–	1	2	2	1	–
	GP	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
Gossypium hirsutum	PA	–	–	–	–	–	–	1	1	1	2	–	1	–	2	3	2	2	3	2	5	3	5	3	6	-
	GP	–	–	–	–	–	–	-	1	1	–	–	–	–	–	1	2	-	2	1	4	1	1	–	–	–
Opuntia ficus-indica	PA	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	2	2	1	2	5	5	6	2	–	–
	GP	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	–	–	2	2	–	–	–	–
Physalis ixocarpa	PA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	–	–	–	–	–
	GP	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	–	–
Theobroma cacao	PA	–	–	–	–	–	1	–	–	1	-	1	1	1	2	2	2	–	5	2	4	1	7	3	2	2
	GP	–	–	–	–	–		–	–	1	–	–	–	–	–	–	1	–	1	-	3	-	-	–	-	-
Solanum lycopersicum	PA	–	–	–	–	–	1	2	1	–	–	–	–	1	1	1	3	3	5	8	6	2	9	7	3	6
	GP	–	–	–	–	–		1	1	–	–	–	–		1	1	2	1	3	3	3	–	–	–	–	–

Source: Authors' elaboration based on data from the Official SIGA database of the Mexican Intellectual Property Institute (IMPI)
PA patent application, *GP* granted patent

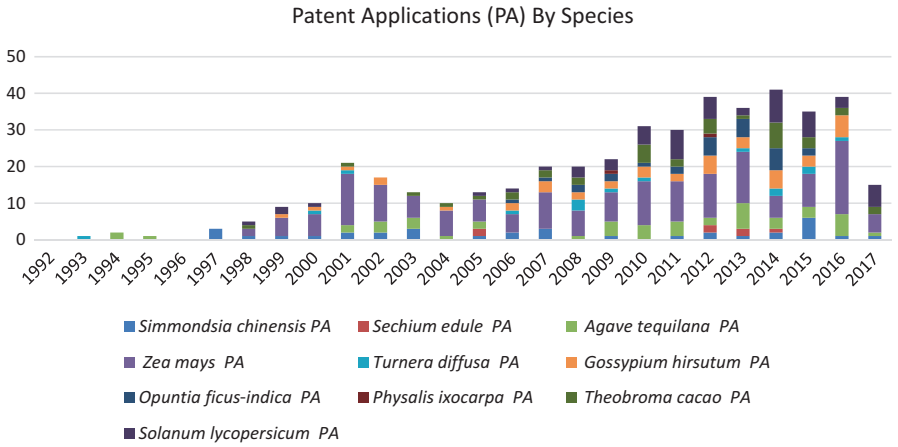


Fig. 6.3 Patent applications (PA) by species

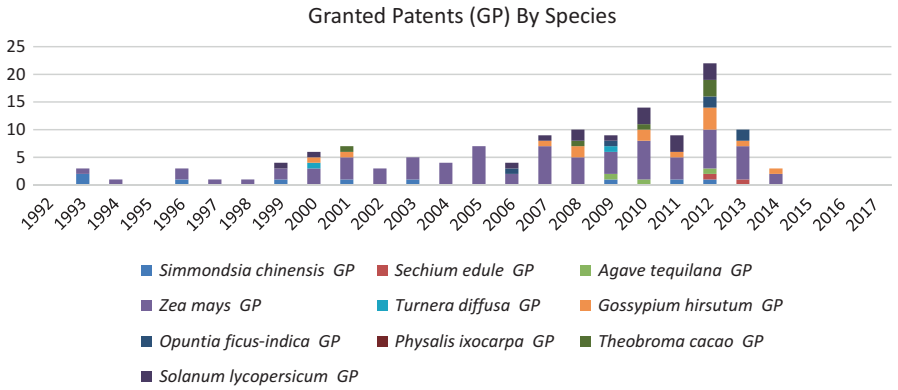


Fig. 6.4 Granted patents (GP) by species

To gain a broader understanding of the relevance of intellectual property protection to Mexican plant genetic resources, we decided to delve more deeply into international patent filings related to three of the ten species of interest. We selected *Turnera diffusa, Agave tequilana,* and *Sechium edule* for further analysis. Our selection was based on the fact that these plants are less widely known internationally than other Mexican plants such as *Zea mays* or *Gossypium hirsutum*, and because these three species have seldom been protected with plant breeders' rights, as discussed above.

The common name of *Turnera diffusa* is damiana. This plant is a diminutive, woody shrub that produces small, aromatic flowers. Damiana is native to southern Texas in the United States, parts of Central America, South America, and the

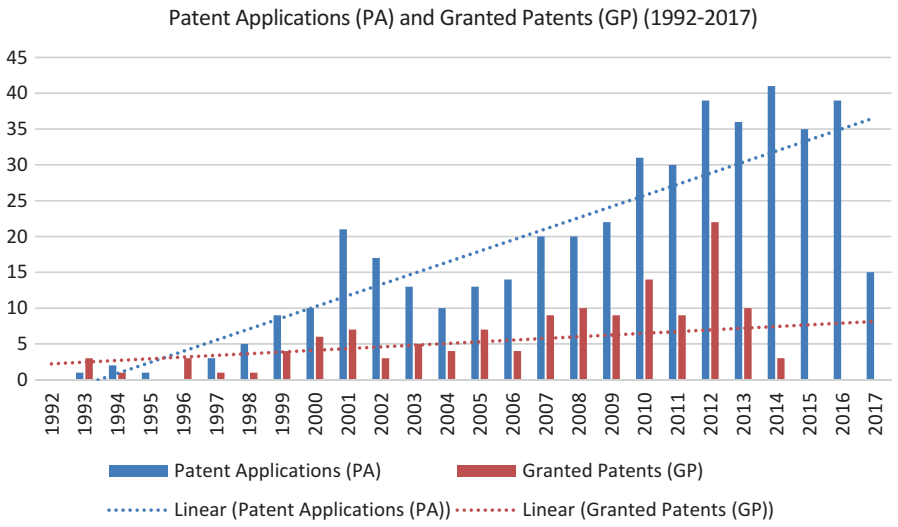


Fig. 6.5 Patent applications (PA) and granted patents (GP) (1992–2017)

Caribbean, and arid regions of Mexico. *Turnera diffusa* has been used in numerous commercial products since at least the nineteenth century, especially in the food and pharmaceutical industries. The essential oils derived from Damiana have been reported to have stimulant, diuretic, and aphrodisiac effects, among others (Martín-Martínez 2013).

As discussed above, searches conducted in the database of the Mexican Intellectual Property Institute revealed only five patent applications and zero granted patents claiming products or processes related to *Turnera diffusa*, for the period of 1993–2017. However, searches in the international patent database administered by Derwent Innovation® encountered a significantly larger number of records. Specifically, 131 patent documents were found in 55 patent families covering compositions used to stimulate weight loss, produce food products, and treat a variety of medical disorders. The territories with the greatest number of patent families related to *Turnera diffusa* were the United States (ten families), Canada (six families), Australia (four families), Morocco (four families), Japan (three families), Germany (three families), European Patent Office (two families), Mexico (two families), and South Korea (two families) (Fig. 6.6). Patenting activity related to *Turnera diffusa* appears to have remained relatively consistent over time, while the greatest number of documents was published in 2016 (Fig. 6.7).

Similar results were found in relation to *Agave tequilana*. This plant is commonly known as blue agave or tequila agave, and its most widespread commercial application has been in the form of the distilled, alcoholic beverage tequila. The high production of sugars, mainly fructose, in the core of the blue agave plant renders it useful for tequila production, as well as for food and other products, including paper (Iñiguez-Covarrubias et al. 2001).

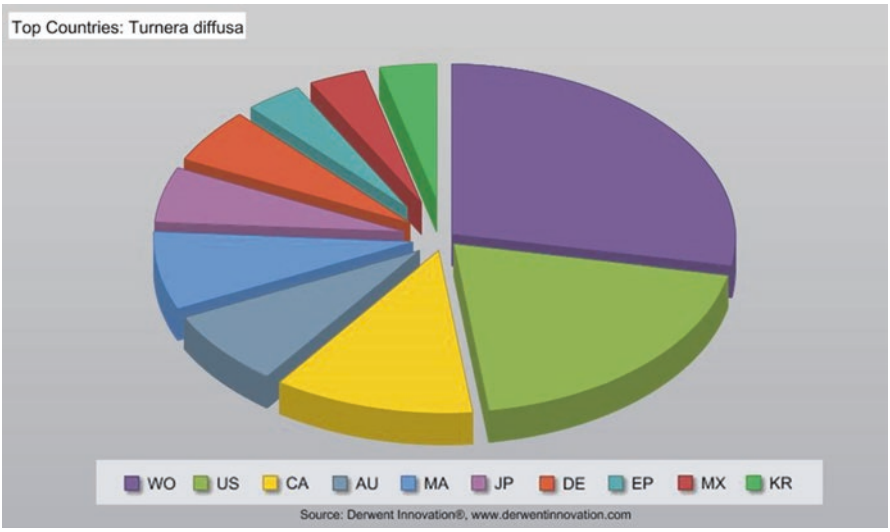


Fig. 6.6 *Turnera diffusa* countries

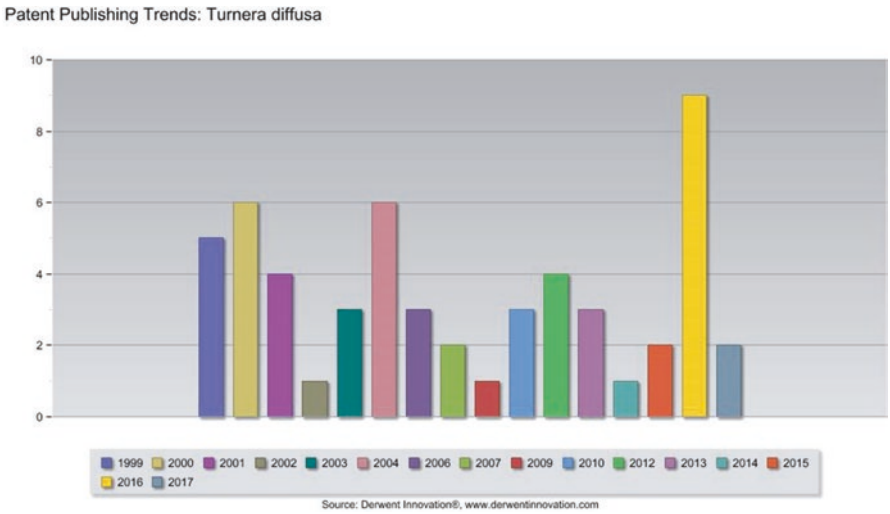


Fig. 6.7 *Turnera diffusa* patenting trends

At the international level, 57 patent documents were located in 38 families with claims covering *Agave tequilana* (Fig. 6.8). The inventions claimed relate to the use of polyfructans sourced from blue agave to treat inflammatory diseases, the production of ethanol, and the creation of probiotic nutritional supplements, in addition to the distillation of alcoholic beverages. Interestingly, the greatest number of patent documents encountered through searches in Derwent Innovation®

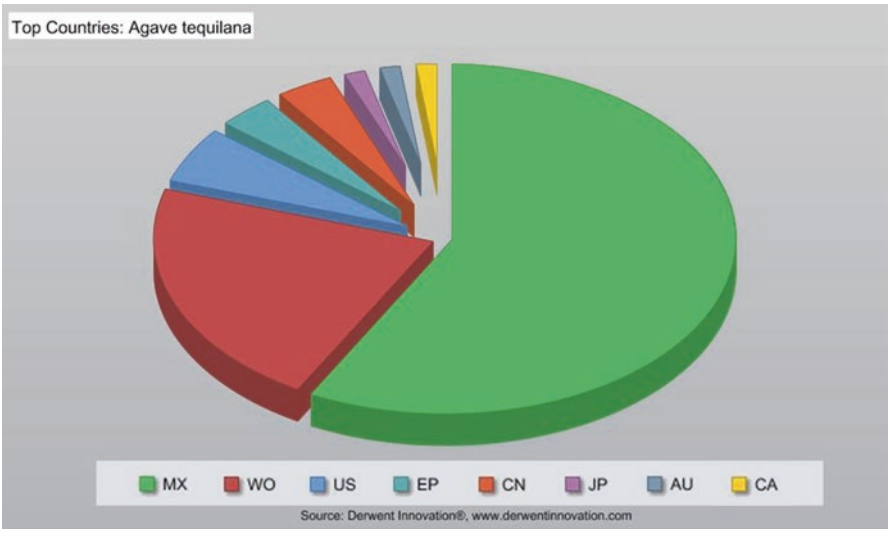


Fig. 6.8 *Agave tequilana* countries

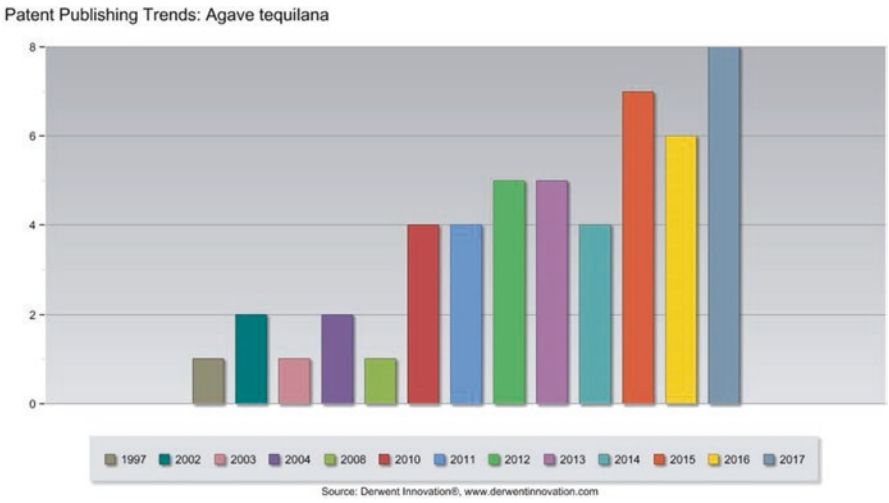


Fig. 6.9 *Agave tequilana* patenting trends

related to filings made in Mexico, with 26 total families in that territory (Fig. 6.9). This number was larger than the number of filings revealed through searches in the Mexican Intellectual Property Institute database. The discrepancy is likely due to the fact that many of the documents found through Derwent Innovation® were published in the past 3 years, and it is possible that these records have not yet appeared in the national database. The results demonstrated a clear increase in the number of filings over time in relation to *Agave tequilana*, suggesting that the entry

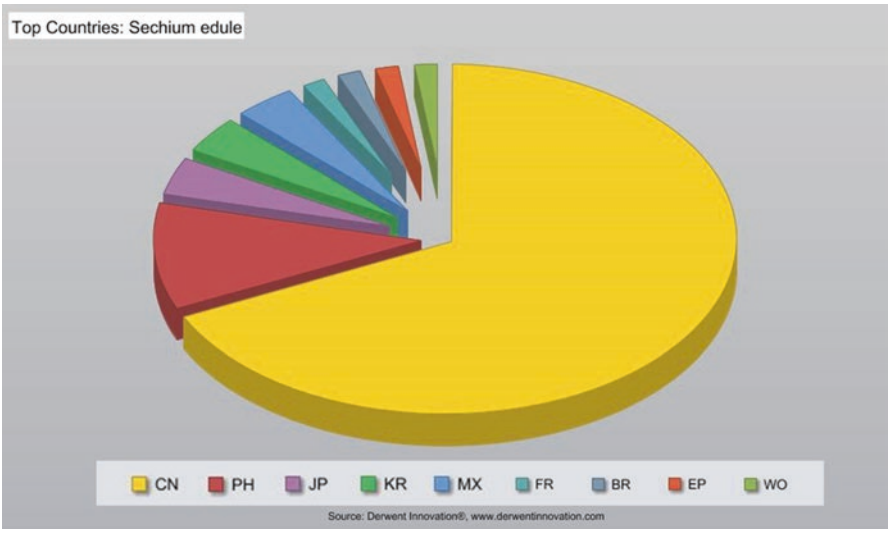


Fig. 6.10 Sechium edule countries

into force of the Nagoya Protocol – without the attendant national legislation to implement its provisions – has had little impact on intellectual property protection activity related to this plant species.

Finally, we examined international patenting trends related to *Sechium edule*, commonly known as chayote. This species is an edible plant belonging to the gourd family *Cucurbitaceae*, in which melons, cucumbers, and squash are also members. Chayote may be eaten cooked and served in a variety of dishes, and its fruit and seeds are rich in amino acids and vitamin C. The tuberous part of the chayote root is starchy, and it can be used as animal feed. Additionally, the leaves and fruit of *Sechium edule* have diuretic, cardiovascular, and anti-inflammatory properties, and tea made from its leaves has been used to treat arteriosclerosis and hypertension and to dissolve kidney stones (Aung et al. 1990).

Searches in Derwent Innovation® located 54 patent documents in 47 families with claims covering *Sechium edule* (Fig. 6.10). These documents related to the application of chayote for the treatment of a variety of ailments including diseases associated with endothelial dysfunction and hypertension, as well as constipation and acne, in addition to a variety of food-related uses. In contrast to the other two plant species that we examined, the majority of patent filings (32 families) related to chayote were made in China, while the second largest number of documents was found in the Philippines (5 families). Similar to the case of blue agave, the trends demonstrated a marked increase in the number of patent filings related to *Sechium edule* since 2013 (Fig. 6.11).

The results of the patent database searches that we conducted reveal that patenting activity in relation to the ten plant species of interest has tended to increase over time, both in Mexico and internationally. Assuming that the number of patent filings

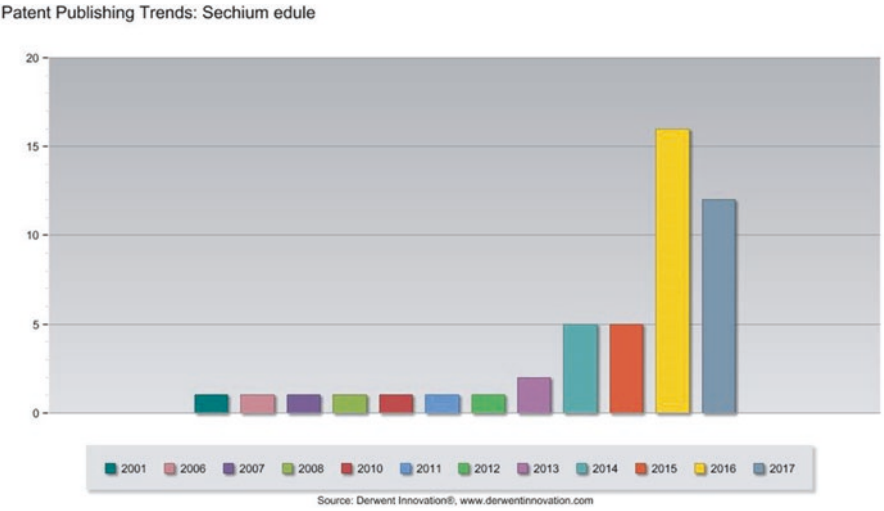


Fig. 6.11 Sechium edule patenting trends

related to such subject matter will continue to grow, inventors who utilize Mexican plant genetic resources as research inputs will need to remain vigilant about forthcoming changes to the legal framework for access and benefit sharing in Mexico. Additionally, while it is not the focus of this chapter, our findings indicate that patents may offer an effective means for the ex ante valuation of Mexican plant genetic resources, given the fact that multiple patent families exist across an array of technological sectors. Future research could develop valuation case studies based on the Mexican native plant species discussed in the present chapter, which in turn could inform prospective benefit-sharing agreements.

6.4 Conclusions

In this chapter, we have demonstrated that intellectual property rights in the form of plant breeders' rights and patents have been claimed in relation to a variety of Mexican plant genetic resources, both within the country and internationally. The data indicate that in general, applications for both plant breeders' rights and patents claiming subject matter derived from native Mexican plants have tended to increase over time. Yet it is still unknown whether increases in applications for intellectual property protection would actually correlate with a rise in the number of access permits applied for under national regimes based on the Nagoya Protocol or in the number of benefit-sharing agreements executed.

To date, only three permits granting access to genetic resources in Mexico have been made available to the Access and Benefit-Sharing Clearing-House administered by the CBD. This fact demonstrates that access and benefit sharing remains a

nascent issue in Mexico but that the government is taking the implementation of the Nagoya Protocol seriously. The three permits were issued in July 2015, November 2016, and August 2017 to researchers located in the United States, Japan, and Spain, respectively. All were granted prior to the entry into force of the SAGARPA interim policy for the review of applications for access to plant genetic resources for food and agriculture. In the context of this new framework – and given the likelihood that Mexico will enact comprehensive and legally binding access and benefit-sharing legislation in the near future – researchers should take into account the need to comply with new, still-evolving regulatory procedures.

However, requirements to obtain an access permit or to negotiate prior informed consent or benefit-sharing agreements should not be considered impediments to the research process. As the data reported in the present chapter demonstrate, intellectual property activity related to plant genetic resources can intensify even as new frameworks for the governance of these resources are designed and popularized. Yet it remains to be seen whether the implementation of a national regime based on the Nagoya Protocol in Mexico might impact the activities of users and providers of genetic resources, including in relation to intellectual property protection. In the future, permit applications could serve as indicators of research trends, signalling areas of interest to potential collaborators or competitors. Meanwhile, intellectual property protections – in the form of plant breeders' rights or patents – could be used as proxies for the valuation of plant genetic resources. Then as now, Mexico will likely represent an important site in which the various dynamics related to the use of these resources may be unravelled.

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