A Study on Plant Variety Protection under Intellectual Property Rights in India: Current State, Emerging Concerns and Challenges

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Abstract

India has seen the sui generis regime of intellectual property protection rights for plant varieties being traded under the TRIPS agreement of the World Trade Organization (WTO). The issue of plant-variety patent system and the granting of intellectual property rights at both the local and international level has resulted in a number of challenges for the seed industry, including the effect of IPR at the legislative level and also how they interact with other legislations, IPR and the philosophy of competition, and that of IPR overlappings. India may unveil apendagian plans with foreign intellectual property models that protect plant variety.

Keywords: seed, access, innovative plant breeding methods, farmers' rights, intellectual property rights (IPR), plant variety protection (PVP), and initiatives.

INTRODUCTION

In the framework of the World Trade Organization (WTO) and the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS), it is compulsory for countries to provide a protection for plant varieties' intellectual property rights (IPR) through patents, the functional sui generis method or the combination of these two. All these make varietal development a sequential and cumulative process. Thus, crop variety IPR can play a key role in varietal development research. Seed Variety Protection via intellectual property rights (IPR) relates to seed prices, farmers' position as customers of seeds, breeders, and biological resources conservators, and ultimatelly, the global food safety and security. The author in this paper discusses the current IPR protection status for Indian Plant Varieties. Furthermore, it considers the issues that the seed industry is encountering with regard to the protection of plant kind in terms of intellectual property rights.

Plant variety protection via intellectual property rights (IPR) in India

In order to achieve the commitment it had assumed through the TRIPS agreement, India passed the Protection of Plant Varieties and Farmers' Rights Act (PPVFR Act) in 2001. For communication of plant varieties with intellectual property protection, PPVFRA was set up in India, like the Protection

of Plant Varieties and Farmers' Rights Authority. At the end of October 2023, it will be 156 notifications taken into PPVFRA for protection of agrarian species, since the first applications were accepted in 2007.

Plant varieties may be registered under the PPVFR Act in four different categories: directly or indirectly related variety (DERV), farmer's variety (one of existing variety), new variety, and existing variety. The existing varieties, as well as the known varieties (the VCK, i. e. the Varieties of common knowledge) are on both lists of registered varieties. In addition to the genetically modified plants that were approved by the Genetic Engineering Appraisal Committee as being eco-friendly, transgenic types might also be covered by the PPVFR Act

Local farmers, federal research offices, and private seed companies are sending forward their registration requisitions. Among the plant variety protection (PVP) characteristics that were provided to PPVFRA, by the 12th of January in the year 2023, 15,790 applications had been reached covering 107 species alone; Farmers comprised the 66% of these applications, private seed firms 23%, and public authority the rest thereof (Table 1). Net diversity in the PVP applications by sectors was measured using the Herfindahl index; the public sector had the highest sum diversity, followed by the private sector. In the commercial sections total application rice had 12% (this is the third biggest figure); meanwhile in the public domain the first rank belongs to it with 19%; and in the case of the farmer's variety this also ranks as the first one with 53%. This shows us that rice does not get as much attention as polypoid cotton and maize, which in turn means that sectors in the private industry are not focusing enough on rice in their agricultural research portfolios. Across all owner types, the top five crops (in terms of PVP applications) had two common crops: rice and maize are.

In 2023 by the end of the period about 3 thousand plant varieties were registered by the PPVFRA which appeared only recently (2015) and started to grant PVP certifications (See the Table 1). For farmers there were awards for 11 crops, for private companies the number was 23, and for the public sector there were 47 crops. Every year, a total of 338 plants were registered for protection, of which farmers were the most represented with 142, followed by the commercial assistance with 76, and finally the governmental department with 120. , 85% five thousand nine hundred and forty-eight (85%) of the 3,043 PVP regional government certificates are for the existing varieties, and only 15% two hundred and seventy-five (15%) of this new varieties! Concerning the new types, 73% was the portion owned by the private sector while 27% was that which was government owned, pressing home the fact that the private sector had the last say. The number of commercial sector varieties, on average, ranged between 37 and 13 commercial sector varieties, and public sector varieties ranged between 2015 and 2023; 13 new varieties.

Table 1 Status of PVP applications received by PPVFRA (12 January 2023) and PVP certificates issued (31 December 2023)

	Farmer	Individual breeder	Private	Public	Total
Total number of applications	10,356	2	3,593	1,839	15,790
Share of different category applicants in total applications (%)	66	0	23	12	100
Number of crops	98	1	40	78	107
Number of crops in which the category of applicant is major player	74 (69)		12 (11)	21 (20)	
Overall portfolio diversification (Herfindahl index)	0.290	1.000	0.127	0.068	0.173
Rank	Top five crops in number of PVP applications				
1	Rice (53)	Tetraploid cotton (100)	Tetraploid cotton (27)	Rice (19)	Rice (40)
2	Maize (4)		Maize (13)	Wheat (9)	Tetraploid cotton (7)
3	Pigeon pea (3)		Rice (12)	Maize (8)	Maize (7)
4	Mango (3)		Pearl millet (7)	Sorghum (6)	Brinjal (3)
5	Black gram (2)		Tomato (7)	Tetraploid cotton (5)	Pearl millet (2)
Share of top five crops in total PVP applications (%)	65	100	66	47	59
Total number of PVPs registered	1,277		685	1,081	3,043
Share of PVPs registered in total applications	12	0	19	59	19
Number of crops with respect to which PVPs were registered	11	1	23	47	49
Overall PVP certificates diversification(Herfindahl index)	0.934	1	0.147	0.071	0.270

Eleven percent of the PVP certificate portfolio was for the public sector, while 48 percent was for the private sector.

As shown in Table 3, only 523 types (17%) out of 3,043 registered for PVP were hybrids. Of all hybrids, private vehicles accounted for 70% of the market. Of existing hybrids and new hybrids, the private sector held 64% and 79% of the shares, respectively. Five-thirds of the PVP certifications held by the private sector were hybrids, compared to just fifteen percent in the public sector. Between the public and private sectors, there were on average 17 hybrids and 41 hybrids registered annually for PVP in the former. Within the private sector, the proportion of newly built hybrid vehicles was 42%, while in the public sector, the figure was 25%.

Table 2 PVP certificate portfolio by owner category (31 December 2023)

	Farmer	Individual breeder	Private	Public	Total
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Tetraploid cotton, maize, and rice crops had the highest number of PVP registrations, as shown in Table 3. The private sector had a stake of 52%, 89%, and 71% of the hybrid crop market, which included maize, pearl millet, and tetraploid cotton, the top three crops in terms of PVP registration.

Table 3 PVP certificates issued by crop (31 December 2023)

Crop	Total number of PVP certificates issued	Distribution of PVP certificates across different owners (number)			Crop	Total number of PVP certificates issued	Distribution of PVP certificates across different owners (number)		
		Farmer	Private	Public			Farmer	Private	Public
Amaranthus	1		0	1	Maize	221	6	110	105
Barley	9		0	9	Muskmelon	2		0	2
Black pepper	3	3	0	0	Okra	30		16	14
Black gram	17	1	1	15	Onion	6		0	6
Bottle gourd	3		1	2	Pearl millet	119		85	34
Brinjal	16		4	12	Pigeon pea	30	3	6	21
Cabbage	1		0	1	Potato	23		8	15
Castor	7		3	4	Pumpkin	2		0	2
Cauliflower	4		1	3	Rapeseed	17	5	1	11
Chickpea	46	2	0	44	Rice	1,525	1,234	124	167
Chilli	7		0	7	Ridge gourd	1		0	1
Coconut	6		0	6	Rose	1		1	0
Cucumber	2		0	2	Safflower	6		0	6
Diploid cotton	41		15	26	Sesamum	5		0	5
Field Pea	25		0	25	Small cardamom	7	6	0	1
Finger millet	5		0	5	Sorghum	134	4	47	83
Garden pea	2		0	2	Soybean	30		2	28
Garlic	6		0	6	Spinach	1		0	1
Green gram	31		1	30	Sugarcane	43		1	42
Groundnut	34		0	34	Sunflower	54		45	9
Indian mustard	64	2	15	47	Tetraploid cotton	216		169	47
Jute	17		0	17	Tomato	30		21	9
Kidney bean	10		0	10	Turmeric	4		0	4
Lentil	11		0	11	Wheat	163	11	8	144
Linseed	5		0	5	Total	3,043	1,277	685	1,081

Corn was the most common crop, ranking among the top three crops for various types of hybrid PVP

certificate holders. The public sector registered hybrids for 18 crops, while the private sector registered hybrids for 16 crops, for a total of 22 crops. The table provides information on the dominance of various owners in each category of cultivars. A total of 55 firms secured five PVP certifications for their crop types were secured by a total of 55 firms. Just eight of these enterprises had more than five crops in their PVP certificate portfolios, whereas 29 of them only had one crop (Table 4).

Table 4 Frequency distribution of private companies based on number of varieties registered under PPVFRA for crops (31 December 2023)

Range of number of crops	Number of companies	Total number of varieties registered for PVP	Share in total PVP registrations of private sector (%)
1	29	102	15
2–4	18	186	27
5–10	6	324	47
>10	2	73	11
	55	685	100

Range of number of companies	Number of crops	Total number of varieties registered for PVP	Share in PVP registrations (%)
1	11	14	2
2–4	6	42	6
5–10	5	143	21
>10	4	486	71
Total	26	685	100

A total of 58% of PVP variant registration was provided by these 8 businesses. Tetraploid cotton, pearl millet, and maize were the next most popular crops among the corporations that registered their rice varieties. These four crops accounted for a total of 71% of the PVP certifications in the private sector. The top four corporations held between 48% and 100% of PVP certifications across all crops (C4 ratio). The C4 ratio varied from 35% to 100% across distinct crops; from 39% to 100% in the case of hybrids of diverse crops; and from 53% to 88% for crops in which private enterprises' PVP certifications surpassed those of the public sector.

Each company's PVP certifications are examined (Table 5). The businesses that came in first and second place for the quantity of crops (for which they registered plant types) did not place first or second for the overall quantity of PVP certificates.

Table 5 PVP certificates concentration and distribution across private companies

		Type of variety					
		All	Extant	New	EDV	Hybrid	Typical varieties
Total PVP certificates		685	355	329	1	366	319
Total number of companies		55	48	39	1	45	31
Number of PVP certificates of	Top most company	134	95	87	1	45	89
	Top 4 companies	312	163	165	1	122	210
Share of PVP certificates (%)	Topmost company	20	27	26	100	12	28
	Top 4 companies	46	46	50	100	33	66
	Equal distribution	2	2	3	100	2	3
Number of PVP certificates		Number of companies					
1–10		39	39	31	1	34	25
11–20		8	6	6		6	3
21–30		2	2			4	1
31–40		4	-	1		1	
41–50		-	-				
>50		2	1	1			2
All		55	48	39	1	45	31

This demonstrates that firms use various crop portfolio diversification strategies in their research. Compared with existing kinds, the new cultivars had a higher C4 ratio.

When compared to conventional kinds, hybrids' C4 ratio was 50% lower, suggesting more competition. This is also indicated by the fact that there are 45 hybrid enterprises registered compared to 31 normal types.

Vegetable varieties and tree species are protected in India for 15 and 18 years, respectively, under the PPVFR Act. 318 varieties—all now in use and representing 10% of PVP certifications issued—had their statutory protection term expire on December 31, 2023. Only 57 of these 318 varieties—or 17% of all currently recognized hybrids—were hybrid. As of December 31, 2023, 72% of registered public sector varieties were protected, but only 98% of registered private enterprise variations. The highest number of varieties (63), followed by wheat (39), and maize (60), were among the 318 types for which the protection period ended on December 31, 2023. In corn, tetraploid cotton, and pearl millet, the highest number of hybrids for which protection expired was reached.

Recall that the PPVFRA has extended the deadline for registering farmers' varieties of various crops and existing crops.

Emerging issues and challenges

The relationship between competitiveness and intellectual property rights

The economic rationale for granting IPRs is to draw private developers into plant improvement research, by presenting them with an inviting incentive of exclusive control for a certain time period, allowing them to recoup their research costs. India has around 400 seed companies with different features, but there are only 55 companies with PVP certificates among them. This implies that the seed industry in India along with upstream research is competitive which can be associated with IPR.

The seed industry's upstream research sector, downstream seed market, and the intermediate technology commercialization (IPR licensing market) have now been essentially defined in terms of IPR. According to the last assessment performed on December 31, 2017, Bayer was positioned among the top four companies in the Indian market regarding the PVPs in the rice, sorghum, and pearl millet categories; Monsanto was named among the top four companies for the tomato crop; and Syngenta was among the top four companies in the Indian market regarding the PVPs in the maize and

Farmers and researchers are given freedom under the PVP system. Hence, that PVP is less efficient than IPR, is one argument. This test case, though, is only relevant in the case of hybrid vehicles (Bhutani, 2011). Thus, to regulate PVP upstream (particularly hybrids royalty), downstream seed market and the licensing of technologies and traits, this is a critical thing to monitor. Providing an edge in one strata of seed industry will be consequential for the more advanced strata. Some seed businesses indicted the Competition Commission of India (CCI) of predominance abuses on the part of the licensing and sublicensing of transgenic cotton seeds by a small number of seed companies. The case is being investigated by the CCI (CCI (2016)).

Operational change in the seed industry, e. g. takeovers occurs, and market concentration shows another way the development of IPR (intellectual property right) in the plant variety sector might influence competition. Agrigate PVP can possibly be more impactful in terms of seeds market merge and consolidation when it is compounded by the EDV clause (Srinivasan 2005). Regulatory agencies and policy makers should also ensure the parents of hybrids are protected as a package under the most recent PPVFRA guidelines. This is applicable to both brand new or brown (EDV) stock.

Only six companies with the most sales on the market, the "Big Six", held the monopoly over the agrochemical industry, controlling over 75% of global sales. However, that monopoly has been progressively losing its power due to the presence of other market actors and is now down to 63% control of the global commercial seed market. They were Dow, Monsanto, Syngenta, DuPont, BASF, Bayer, and alike. (ETC 2015). The Big Six that was have become now the "Mighty Four" after a series of deals that currently are on going, such as: DowDuPont, Bayer-Monsanto and Syngenta-Chemchina. Economic size and scope along with complementary IPRs certainly account for the reasons which trigger mergers and acquisitions.

Global seed chemical giants create listings out of the land quickly because of alliance of patent and IPRs (Lianos et al. , 2016). This industrial concentration has been achieved, in part, by the reduction of the number of businesses in the seed and agrochemical industrial field, as a result of mergers and

acquisitions.

Many of the companies involved own intellectual property rights for various instruments of genomic selection, owned gene sequence patents, and their most important genetically engineered features (ISAAA 2018). Both of the broad institutes in Massachusetts Institute of Technology (MIT) and the University of California, Berkeley have given permission to Corteva Agriscience, the corporate entity that resulted from the DowDuPont's merger in the crop section (Deering 2018). Innovation market fosters the development of new varieties of plants, furthermore, licensing technology contributes to technology development, and seed markets (Maisashvilli et al. 2016; Manne and Gibby 2017) are in turn affected by these company mergers. In contrast with this, a lot of regulatory bodies around the glob have either vetoed these mergers or allowed them subject to some conditions. The Indian CCI too offered conditional clearance for the merger of Bayer with Monsanto.

The cost of all types of seeds produced by the PPVFR right holders who own the plant variety rights will now be fixed under Sec. 29 of the Act by the right holder or their assignee's permission in the way of agreement of terms and conditions between the right holder and other concerned staff. A PPVFRA notification dated January 23, 2019, includes the information. Section 92 of the PPVFR Act on the other hand, states that in relation to the prescribed trait values and fixing of prices of the variety, the Act may only be done in accordance with the provisions of the Act and the Act shall have precedence for the duration of variety in question's protection period. As a result, there will be two price regimes: first for varieties that are covered by the PPV & F Requirement Act, and then for varieties that are registered under the PPV & F Requirement Act or protection term has ended (for 192 varieties, the protection period ended on December 31, 2023). It has been mentioned that seeds of protected nutrient varieties were more expensive before this announcement (Venkatesh and Pal 2013).

Although it is unclear how the PPVFRA would determine if a price is "unreasonably high," the PPVFR Act mandates that a registered breeder must get a license if they charge a variety at an "unreasonably high sale price."

Conflicting rights to intellectual property

Plant varieties are not patented in India.

For those countries with dual protection, whenever the same plant variety is protected under more than one intellectual property right, nations with dual protection systems will apply different systems, such as patents and PVP right, which constitute a dual protection system. Such overlap not only gives IPR owners more power but also poses challenges to the public in balanced protection and fair usage. With plant variety patenting what is obtained is the PVP regime's exclusions and exceptions kind. That is farmers' rights and research or breeders' exemption are eliminated as well. The intrusion of "modern plant breeding techniques" like genome editing and transgenics into PVP laws further makes the patent system overlap with PVP. Therefore, intra-European licensing should be cross-licensing to deal with the situation (Lenßen 2006). Another way of putting it is "when a thing belong to someone, by the consequence other things of a kind should be excluded" or when

"two clones meet up, there should be an exclusion of someone, so it becomes a question of priority" (Bedasie 2012). Commentary provision is embodied in the patent regulations of some countries, being Germany and France in the first place (Smith et al. 2016).

However, some are implying that even in countries with exceptions of researcher from patent law, different perceptions of how patent ownership is allowed in the variation of countries from each other might lead to not getting the exception (Tomkowicz 2011).

The presence of both process and product patents in a single process may create overlay of IPRs. In India the patent product was inserted in 2005, and 1970 act of the patent was amended. As reported by the latest review, the overlapping of the intellectual property rights to Bt cotton varieties affected the farmers capacity to purchase seeds; however, the governing body which effort was aimed at controlling the price of transgenic cotton through the licensing laws failed (Singh 2016). On 11 April 2018, an Indian High Court in New Delhi took a patent infringement suit filed by Monsanto. The court asserted that the "subject" of Monsanto's patent is indeed under the exception specified in section 3(j) of Patent Act. As a result, the court determined that the PPVFR Act provisions require registration of the application within a three-month period.

The Delhi High Court also confirmed that the seed of the cotton which will be now provided by Monsanto as it a staple commodity and helps the Nuzeedu Seed Company to produce their own varieties of seed for the farmers. SCC held on January 8, 2019 (SC case no 16059-2018) that process implemented in which the patent of Monsanto was "annulled" is neither desired, encouragable or permissible. "The Supreme Court, due to this problem, forwarded the investigation with extensive evidence to be used in a proper trial. "Moreover, at the trial hearing, it was also required to look at the matter on whether the DNA sequence was part of a plant or the best part of it, and whether the genomic sequence trait could be isolated from the variety once it was inserted. "

Sequential overlap of IPRs

In the beginning, according to the PPVFRA, these parental lines of the existing hybrids notified under the Seeds Act, 1966, were not declared specifically and, hence, those lines could not be considered as having been caught up in the Seeds Act, 1966.

In such case, it could be worth noting that they would be listed as an entry under a different category than existent notified keys (extant VCK). Yet, such an outcome pointed to the possibility of "evergreen" patent expiration dates for hybrids by registering each of these – the hybrid, the parental line one, and the parental line two, consecutively. For verification of the caliber of current hybrids, it has been notified under the Seeds Act, 1966 that the present pedigree of the parental seeds for the existing hybrids shall fall in the category of the existing varieties notified under the Act, dated December 5, 2018, pursuant to the order issued by the PPVFRA. Pheromone protection is granted to the paternal line and also to its surviving hybrid and remains continuous for 15 years after the bond had been officially formed.

"A consideration to put under the category of the new varieties notified under the Act of the parental lines of new hybrids notified under the Seed Act, 1966, provided they are being filed within a year

from the date of commercialization of the earliest or first hybrid should be made" - this decision specifies. However, situations are not going to be all smiley as the evolution of new hybrid will also be seen which will include both the existing parental line as well as new one. Holding the line as to the further developments anticipated in this respect granted the current state of only the turning point of the plant's IPR law in India.

Regulatory network

In addition to the regulations that detail issues of seed quality, environment and biosafety as well as to the guidelines for seed commercialization such as mandatory registration or minimum standards, IPR's such as patents and PV rights are also important in understanding how nation's plant varieties are developed and how the market is regulated. By setting up the World Seed Partnership, seed industries in participating countries would be helped to expand, given that it facilitates the formulation of a robust global seed regulatory framework. Members of UPOV, which stands for the International Union for the Protection of New Varieties of Plants (UPOV), have the intellectual property rights (IPR) for plant species. The International Seed Testing Association is in the front to ensure the quality of destined to be harvested seeds. The organization responsible for the seed variety certification system is OECD or Organisation for Economic Cooperation and Development. The International Seed Federation is responsible for developing seed industries in the regions where there is lack of seed arable production.

Transgenic plants like transgenic plants are protected by intellectual property rights under India's PVP regime; however, this does not make getting clearance for the cultivation of a transgenic crop any cheaper or quicker, as access to private records still is heavily dependent on secure financial consideration. These acts together setting up of obstacles for new companies entering the industry could bring rise to a situation of increased concentration in the seed industry. For this reason, the simplicity in which the approval authorities function undoubtedly needs to be thought over more. In addition, the ambiguity over the kind of intellectual property rights (IPR) that will be accorded for synthetic plants which are developed with the help of these advanced technologies such as genome editing and synthetic biology, as well as their regulation in the Indian context clouds the scenario further.

Certain researchers contend that copyright laws apply to DNA sequences, including modified DNA sequences made using synthetic biology. Technology transfer via "generic seeds" may be impeded in the case of transgenic crops during the post-patent or PVP regime, as well as during the PVP regime, by export-import laws and permissions from the biosafety regulatory body. In the USA, there have been some efforts to address situations of this kind using contractual solutions such as AgAccord (see Prasanna (2018) and Prasanna et al. (2018) for a thorough examination of these agreements).

Farmers' rights: effectiveness

Farmers' access to seeds may be hampered by stringent IPR laws for plant varieties; however, some nations have included provisions for farmers' privileges or rights in their PVP laws. Under the Indian PPVFR Act, farmers' rights as breeders, conservators of plant genetic resources, and consumers—that

is, as seed users—are protected. The homogeneity requirements for farmers' varieties under the PPVFR Act in India are loosened, allowing twice as many off-types as would normally be allowed for other categories of varieties.

Farmers' rights, regardless of farm size, apply to all crops announced by the PPVFRA and to all farmer categories. Farmers' varieties do not need a fee for registration or renewal.

Despite these beneficial measures, it is still unclear how farmers would benefit as breeders on the ground (apart from the increased number of farmers registering varieties); see Prasanna et al. (2018) for a thorough discussion on this topic. Furthermore, there are growing concerns about farmers' rights as customers. PVP filings with the PPVFRA make it clear that the private sector is creating more hybrids than varieties. The ability of hybrids to generate "true-to-type plants" renders farmers' rights to repurpose their harvest's seeds obsolete.

PepsiCo India recently sued a few Gujarati farmers, claiming that they were infringing on their PVP rights over a certain potato type that was meant to be used to make chips. Following talks with the government, it dropped the lawsuit; nonetheless, some opponents maintain that this withdrawal does not represent a victory for the PPVFR Act (EPW Editorial 2019).

New initiatives

IPR is seen by innovators as an incentive mechanism, but from the perspective of consumers, it defines the conditions under which people and businesses may obtain knowledge or information commodities (anything that can be digitalized) (Hemel and Ouellette 2019). Assuring access to customers is not the same as offering incentives, and both goals may be addressed independently (Hemel and Ouellette 2019). One such option is to provide seeds at subsidized costs; however, this increases public budgetary costs and denies researchers access to existing kinds that they may use to create new ones.

Therefore, efforts are being made to solve the access problem by implementing various adjustments to IPR regimes and developing new incentive systems. A few of these projects are briefly discussed here.

Open-source projects

The Open Source Seed Initiative (OSSI) was started in the US based on lessons learned from open source development in the software sector, the copyleft license in the field of copyrights, and the management of the commons (Ostrom 1990). OSSI employs a hybrid strategy that combines non-market and market components. The Open Source Seed License (OSSL) proposal, which is protected by German civil law, has been taken up by the non-profit Association for Agriculture Ecology (AGRECOL). While the OSSL initiative is founded on an enforceable licensing mechanism, the OSSI depends on the pledge mechanism, or a moral responsibility approach (for a further explanation of these two systems, see Prasanna (2018) and Prasanna et al. (2018)).

In addition to breeding and sharing eight types of rice, wheat, and pulses, the Centre for Sustainable

Agriculture, Hyderabad, India, established an open source network (Lucas 2017). The Apna Beej program in India is supported by Hivos, an international organization that backs national efforts for the open source system. Twenty types of rice, vegetables, and pulses have been registered under this initiative, which began in 2015. Farmers and seed firms. It is predicted that there would be little to no germplasm interaction between the two domains, with open source seed systems functioning as a parallel system to commercial seed systems (OECD 2018).

In the meantime, there are a few open-access-style synthetic biology projects. Using open source principles, the BioBricks Foundation (BBF), an informal consortium of top synthetic biologists in the United States, promotes the democratization of synthetic biology research (Torrance 2017). A conventional continuous DNA sequence that represents a fundamental biological function is called a BioBrick. Because BioBrick designs are standardized, connecting different BioBrick components together is very simple. The BBF drafted and carried out an open material transfer agreement with Open Plant, a collaborative project of the University of Cambridge, the John Innes Center, and the Earlham Institute.

Creative licensing programs

The International Licensing Platform (ILP) Vegetables was founded in November 2014 by eleven seed firms from Switzerland, Germany, Japan, France, and the Netherlands, with assistance from the Dutch government (OECD 2018). All interested parties, patent holders or not, are welcome to join.

Under the terms of the ILP, members provide other members with access to all of their patents pertaining to vegetable traits. On April 6, 2018, the ILP guidelines were amended to include that patents that cover qualities created by novel breeding techniques, such as genome editing, are also eligible for licensing through the ILP, "so long as these traits are not regulated as genetically modified." There were 13 members of ILP Vegetables as of December 10, 2018, ILP Vegetables had 13 members.

Alternative systems of reward

An independent non-profit organization with its headquarters in the Netherlands, the Access to Seeds Foundation, publishes the Access to Seeds Index, a relative ranking of businesses using an integrated seed business model that spans the entire seed value chain, from R&D to seed distribution, based on a number of parameters (ASF 2019). This index aims to motivate the seed business to support smallholder growth through positive reinforcement. The index is issued on a worldwide and regional scale, with specific attention to vegetable and field crops.

The inaugural Access to Seeds Index for Southeast and South Asia was just released. It found that out of the 24 firms that were rated, just 20% of smallholder farmers were reached by them all together. Global seed firms serve just 10% of smallholders worldwide (ASF 2019). Only 11 of the 55 Indian firms that were seen in the PVP ownership study could be indexed, as only these companies provided the data required for the analysis. An in-depth analysis of the competition is hampered by the paucity

of information about the Indian seed industry. Transparency is encouraged by mechanisms like the Access to Seeds Index, which aims to improve the situation for seed firms.

Conclusion

TRIPS dictated that the members of this Union had to put into have place at least one IPR protection system on plant varieties which was in progress during a heated argument of the necessity and desirability of putting such a system into place. Nevertheless, any undue IPR protected competition in seed layers and levels of market is capturing the agency of antitrust authorities. The industry structure, seed quality & biodiversity regulation policies in conjunction with competition & antitrust policies, and access regulation policies shape up how affordable seed costs are. Among the policy tools available to the seed sector in achieving the goals of affordable seed, more varieties accessible to farmers, and appropriate incentives for the development of new varieties, in this scenario, the balance is the crucial element. Additionally, TRIPS members are therefore expected to implement at least a framework for intellectual property rights in their nations for plant varieties, though it is optional for each nation within a nation.

The only entities that utilize IPRs to outsmart the rest are the ones that come up with variations. Advanced licensing strategies are at the center of the IP protection system, as by-passing transaction costs, either during the IP protection stage (like PVPP) or subsequent to this stage (like AC). Some stakeholders utilize non-proprietary patent systems which the open-source seeds use to ward off germplasm accessibility which could reduce varietal advancement in the future. The efforts should also have the support of individuals to be effective. Corresponding, the Governments must direct programmes like the Access to Seeds Index towards the facilitation of private sector participation in the seed marketing and research.

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