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Intellectual Property Rights protection for rice varieties - status - emerging issues and challenges-new initiatives

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ABSTRACT

Study of evolving landscape of Intellectual property right (IPR) protection to rice plant varieties in India, indicates dominance of private sector in hybrid research output. At global level, the issues associated with IPR protection to rice plant varieties are overlapping IPRs, increasing consolidation in seed sector, problems in exercising of farmers' rights. For addressing these issues, some "open source seed" type initiatives and "access to seed index" type incentive mechanisms are being tried out. In India, though Protection of plant varieties and Farmers Rights Act explicitly has some provisions for protecting farmers' rights, its effectiveness in empowering farmers at ground level is yet to be established.

Key words: *Intellectual Property rights, plant variety, rice, access to seeds, farmer's rights, competition*

INTRODUCTION

Under Trade Related Intellectual Property Rights (TRIPS) agreement of World Trade Organization (WTO), member countries have to provide Intellectual Property Rights (IPR) protection for plant varieties by patents or effective sui-generis system or by combination of both. IPR protection for crop varieties has important implications for research, as varietal development research is a cumulative technology development process. IPR protection to plant varieties also has implications for choice and affordability of seeds to farmers and exercise of farmer's rights and thereby global food security. The implications will be far reaching in the context of Rice crop which is not only an important staple food crop but also a source of livelihood in rural areas across several countries. In this backdrop this study examines the status of IPR protection to rice varieties and emerging issues and challenges.

The paper is presented in six sections. Following this introduction, in section two, status of IPR protection to rice varieties is presented. In section three emerging issues and challenges are discussed. In section four and five, innovative IP and non-IP initiatives across global countries, to address some of issues and challenges are discussed. In section six conclusions are presented.

Status of IP protection for rice varieties

To fulfil their obligation under WTO, 75 countries (as on 13-10-2017) ratified International Convention for the protection of new varieties of plants (UPOV) convention, a ready-made type of sui-generis system available for protecting their plant varieties. However, some countries like India, Thailand and Malaysia opted for their own sui-generis system of protection of plant varieties. India enacted Protection of Plant Varieties and Farmers Rights Act in 2001 and subsequently in 2005, constituted Protection of Plant Varieties and Framers Rights Authority (PPVFRA) to look after IPR protection for plant varieties through registration. India excludes plants from patentability (Indian Patent Act, 1970). However, a synthesized gene provided it is different from the natural gene, a vector and a method

of transformation of crop species are patentable (Ravi, 2013). Under Indian patent Act "no method of agriculture and horticulture " is patentable (Indian Patent Act, 1970).

PPVFRA started receiving applications from the year 2007. As of now 150 plant species are notified by PPVFRA for protection. Under PPVFR Act, four kinds of varieties can be registered, they are (i) extant variety (ii) new variety (iii) farmers variety (it is subset of extant varieties) and (iv) Essentially Derived variety (EDV). Transgenic plant varieties are also eligible for protection under PPVFR Act, subject to clearance from Genetic Engineering Approval Committee (GEAC) for environmental safety. Private sector, public sector and farmers are applying for registration. As on 12-01-2018, 15790 applications with respect to 107 crop species were received by PPVFRA. Out of these, 6280 applications (constituting 40 percent) are with respect to rice crop (Table 1).

Out of the 6280 rice applications, major chunk is with respect to farmers' varieties (87.7 percent). Private sector applications constituted 6.6 percent of rice applications and the rest applications (5.7 percent) are from public sector. Applications of rice varieties constituted 53 percent of total farmers' variety applications. In private sector applications portfolio rice varieties applications share stood at 11.6 percent (ranking third only), compared to 19.4 percent (ranking number 1) in the case of public sector. This indicates that in private sector crop research portfolio, still rice is of less importance compared to crops like tetraploid cotton and maize.

According to UPOV, at Global level, 6167 rice variety applications from 29 UPOV member countries/ country groups were received for registration under plant breeders' rights (Table 2). This indicates that rice applications received by Indian PPVFRA is almost equal to rice applications by PV rights authorities across different UPOV member countries. Among these countries, China and Japan together contributed about 40% of rice PVP applications. In India under PPVFR Act plant variety registration started from the year 2009 and the details of status of registration are presented in table 3.

Till the end of year 2017, totally 3043 plant

Table 2. Number of applications for Rice Plant Variety Protection received by PV authorities in different countries.

Country	Number of rice PVP applications	Share (%)
Argentina	108	1.75
Australia	10	0.16
Bulgaria	56	0.91
Brazil	130	2.11
Chile	5	0.08
China	1529	24.79
Colombia	76	1.23
Coasta Rica	3	0.05
Ecuador	12	0.19
Spain	249	4.04
France	104	1.69
Croatia	12	0.19
Hungary	29	0.47
Italy	478	7.75
Japan	993	16.10
Kenya	1	0.02
Korea	262	4.25
Mexico	50	0.81
Panama	18	0.29
Peru	10	0.16
Portugal	65	1.05
OECD	751	12.18
European union	748	12.13
Romania	19	0.31
Russian Federation	193	3.13
Turkey	86	1.39
Ukrain	4	0.06
USA	150	2.43
Uruguay	16	0.26
Total	6167	100

Source: https://www3.wipo.int/pluto/user/en/index.jsp as on 26-02-2018.

Table 1. Number of Applications received under PPVFRA as on 12-01-2018.

	Farmer	Individual breeder	Private	Public	Total
Total Number of applications	10356	2	3593	1839	15790
Number of Rice applications	5506	0	417	357	6280
Share of rice applications (%)	53.2	0.0	11.6	19.4	39.8
Share of different agencies in rice applications (%)	87.7	0.0	6.6	5.7	100.0

Source: computed using data of PPVFRA

Table 3. Status of plant varieties registered with PPVFRA in India.

Year	Total number of plant varieties registered	Number of Rice varieties registered	Number of new rice varieties registered	Number of Rice hybrids registered
2009	168	6	-	-
2010	49	5	-	-
2011	116	11	-	1
2012	212	40	1	4
2013	304	122	20	10
2014	833	531	26	19
2015	385	231	14	16
2016	605	349	21	16
2017	371	230	5	4
Total	3043	1525	87	70
Average	338	169	10	8

Source: data of PPVFRA

varieties constituting 19 percent of total applications (15787) received by that time were registered. Out of this 3043 varieties registered, 1525 varieties were rice varieties constituting 50 percent of the total varieties registered. Out of these 1525 rice varieties, 1234 varieties (81%) were farmer's varieties and 87 (6%) were new and rest were extant varieties. Farmers varieties registered were from different states of India. Odisha was the leading state with 58 percent of farmers varieties followed by Chhattisgarh (21%), West Bengal (12%) and Jharkhand (5%) . Till the end of year 2017, totally 70 hybrid rice varieties were registered with PPVFRA in India. On an average 338 plant varieties, 169 rice varieties, 10 new rice varieties and 8 hybrid rice varieties per annum were registered in India during the period 2009 to 2017 (Table 3).

As stated earlier, out of 1525 rice varieties registered, 1234 varieties were farmers' varieties. Ownership details of rest of the varieties are given in Table.4. Public sector contributed 11 percent of rice varieties registered. A perusal into details of distribution of ownership across hybrid and Non-hybrid rice varieties registered (Table 5) with PPVFRA revealed that private sector share was higher than public sector in new rice varieties, hybrids and new hybrids. "Value capture mechanism" associated with hybrid rice seeds as they cannot be reused by farmers and also high export potential of hybrid rice seeds could be reasons for private sector's lead in hybrid rice varieties development and registration. During 2016-17, India exported 14792.96 tons of (hybrid) rice seeds of value 19,187.28 lakh Rupees (DGCIS, APEDA). However hybrid rice area share in total rice area in India in year 2016 was below 10 % (USDA, 2017; Vadlamani,2016).

In India under PPVFR Act annual plant varieties are protected for 15 years. By 31-12-2017, for 63 rice varieties statutory protection period of 15 years was over and hence they are now under public domain. Out of these 63 varieties only one variety is of private sector. Only 3 out of these 63 rice varieties, are hybrids, one from private sector and 2 from public sector. Recently PPVFR Authority has extended time limit for registration of extant rice varieties upto 27-07-2020 and farmer's varieties upto 01-07-2024, through a notification.

In USA, 136 varieties of rice are registered for plant breeders rights and in European Union, 201 rice varieties are registered with Community plant variety office. In USA at present for rice varieties protection is being given for 20 years. So far in Philippines 43 rice varieties are registered for plant

Table 4. Progress and distribution of ownership of rice plant varieties registered with PPVFRA in India.

Year	Farmers	Private industry	Public Sector	Total
2009	3	1	2	6
2010	-	-	5	5
2011	-	1	10	11
2012	1	3	36	40
2013	46	31	45	122
2014	456	34	41	531
2015	191	28	12	231
2016	318	20	11	349
2017	219	6	5	230
Total	1234	124	167	1525
Average	137	14	19	169
Share(%) in total	81	8	11	100

Table 5. Distribution of ownership of hybrid rice varieties registered with PPVFR Authority in India as on 31-12-2017.

	Private	Public	Total	Share of private sector (%)
	Hybrids			
New Hybrids	33	1	34	97
Extant Hybrids	28	8	36	78
Total Hybrids	61	9	70	87
	Non-Hybrids			
New	39	14	53	74
Extant	24	144	168	14
Total	63	158	221	29
	All varieties			
New	72	15	87	83
Extant	52	152	204	25
All varieties	124	167	291	43
	Share of Hybrids in total rice varieties (%)			
New Hybrids	46	7	39	
Extant Hybrids	54	5	18	
Total hybrids	49	5	24	

variety protection and in Japan, 500 rice varieties (http://www.hinsyu.maff.go.jp/vips/cmm/apCMM110.aspx?MOSS=1). USDA (2014) reported that at the end of 2013, in China 1323 rice varieties received protection. Thus China has more number of registered rice varieties compared to India by the year 2013 itself.

Emerging issues and challenges

Overlapping IPRs

As mentioned in previous paragraphs, in India plant varieties are not patentable. But in some countries dual protection system is in operation *i.e.,* same plant variety is protected under two IPR systems like Patents and PVP (Plant Variety Protection) rights concurrently. For example in some countries (like USA) several herbicide tolerant rice varieties are protected both under Patents (for their specific traits) and PVP rights simultaneously. Further in Countries like USA patents are granted for plant as a whole (plant patent) and patent for trait (plant related invention). In recent years UPOV has also accepted double protection. South Korea, Japan and Australia also endorsed dual protection (Campi and Nuvolari, 2015). Patent granting for a plant variety removes the exemptions/exceptions offered under PVP viz; research/breeders exemption and farmers exemption/rights. Thus it is expected that these kinds of overlapping IPRs will affect breeding programs by creating asymmetric power relations and increasing licensing/ transaction cost in arriving at contractual solutions. In such cases the issue of primacy of law becomes important.

The overlapping of patents and PV rights also emerges as a consequence and development of "New Plant Breeding Techniques" like development of transgenic crops. In countries of Europe and South Africa, Patents are not excluded on plants produced using "non-biological process" and " microbiological process". Accordingly in EU Biotechnology Directive, a provision is made for compulsory cross licensing in contexts where exploitation of one type of IPR (PV right or patent) is impossible without infringing other IPR (Patent or PV right) subject to unsuccessful application for a contractual licence (Markus, 2006). Further, the applicant has to show that his right constitutes significant technical progress of considerable economic interest compared with the hindering right (Markus, 2006). Another alternative identified for handling this kind of situation is provision that "creation of a prior right may exclude the subsequent creation of another right" (Bedasie, 2012).

Overlapping IPRs can also occur due to overlapping of process and product patents. Product Patents on plants created using conventional breeding techniques (granted by EPO prior to amendments of some of its patent rules in June 2017) was not in accordance with TRIPs agreement and can also create some problems (Correa, 2014). As per TRIPS agreements patents on Products (plants) is applicable only if the Products (plants) are produced using patented process (Correa, 2014). As per the EPO amendments in June 2017, the products (plants, or animals) obtained exclusively from essential biological process are excluded from patentability. Such amendment was made in German patent law in 2013. But the issue is that, product patents may also limit/hinder the exercising of breeder's rights and farmer's rights. Thus there is need for explicit "breeder's exception" and "farmer's exception" in crop/animal related product patents.

In India, Patent Act 1970 was amended in 2005 for introducing patents for products. Overlapping of IPRs was observed in recent past in India in the case

Table 6. Transgenic rice field trails in India.

S.no	Year	Organization	Trait
		Private Sector	
1	2010	BASF India Ltd	Yield enhancement
2	2011	BASF India Ltd	Yield enhancement
3	2008	Bayer Bioscience Pvt Ltd	Insect Resistance
4	2009	Bayer Bioscience Pvt Ltd	Insect Resistance
5	2010	Bayer Bioscience Pvt Ltd	Insect Resistance and Herbicide tolerance
6	2011	Bayer Bioscience Pvt Ltd	Insect Resistance and Herbicide tolerance
7	2010	E.I.Dupont India Pvt Ltd	Hybrid Rice SPT maintainer
8	2011	E.I.Dupont India Pvt Ltd	Male sterile female inbred rice line
9	2011	E.I.Dupont India Pvt Ltd	Insect Resistance
10	2011	E.I.Dupont India Pvt Ltd	Insect Resistance
11	2011	E.I.Dupont India Pvt Ltd	Insect Resistance
12	2012	E.I.Dupont India Pvt Ltd	Herbicide tolerance
13	2012	E.I.Dupont India Pvt Ltd	Herbicide tolerance
14	2012	E.I.Dupont India Pvt Ltd	Herbicide tolerance
15	2012	E.I.Dupont India Pvt Ltd	Herbicide tolerance
16	2006	Mahyco	Insect Resistance
17	2007	Mahyco	Insect Resistance
18	2010	Metahelix Life Sciences Pvt Ltd	Insect Resistance
		Public sector	
1	2011	Department of Botany, University of Calcutta	Abiotic stress tolerance
2	2006	IARI, NewDelhi	Insect Resistance
3	2006	TNAU, Coimbatore	Rice Chitinase.

Source: www.igmoris.nic.in

of Bt cotton varieties affecting affordability of seed to farmers. The full details of the case, complex web of regulations in the case are reported by Singh (2016). On 11-04-2018, Delhi High Court pronounced its judgement regarding a patent infringement suit filed by Monsanto, stating that Monsanto's patent "subject" falls within the exclusion spelt out by section 3(j) of the patents Act. It also stated that Monsanto can apply for registration under PPVFR Act within 3 months so as to get the benefit of its previous patent in terms of determination of prior publication provision requirement and benefit sharing. Further cotton seed being essential commodity, the Delhi High Court pronounced that Monsanto is obliged to maintain the supplies to facilitate production of Nuziveedu seed company's varieties for onward sale to farmers. The case has been appealed to and admitted by the Supreme Court. However, the Supreme Court has rejected the plea by Monsanto to stay the Delhi High Court Order, on May 7th, 2018. The next hearing is scheduled for July, 2018.

In India, some genetically modified rice varieties were approved for limited field trails as shown in table 6 and still some GM rice developmental research is going on (Warrier and Pande, 2016). Thus, the decision regarding primacy of PPVFR Act over patent Act will have implications in rice crop also in case GM rice is permitted for cultivation in India in future. Further, this may discourage participation of Multi National Corporations (MNCs) in Indian seed sector, limiting technology options available in India.

Role of IPR and other regulations in increasing consolidation in rice seed sector

At global level in 1997 top 10 companies accounted for about 30% of the estimated global seed market and 82 % of global agrochemical market. Accordingly, Srinivasan (2005) reported that there was no empirical evidence to suggest that PVP has contributed significantly to the consolidation of the seed industry as PVP provides farmers exemption and researchers' exemption. He opined that when PVPs are strengthened by way of Essentially Derived varieties (EDV) clause, concentration in PVP may have more impact on seed market consolidation and concentration. PPVFRA's recent guidelines in India (Plant variety journal, July 2018) makes it mandatory to protect parents of hybrids also together with hybrid (as package) irrespective of whether the hybrid is new or Essentially Derived Hybrid

(EDH). This may have implications in increasing consolidation in seed sector. In recent years it is estimated that Six big companies *viz.*, Monsanto, Syngenta, Dupont, BASF, Bayer and Dow collectively, controlled more than 75% of agrochemical market and 63% of the commercial seed market (ETC, 2015).

As discussed in previous paragraphs, in private sector PVP portfolio in India, Rice ranks third only. However over the years, the number of private companies participating in rice varietal development research is increasing. The number of private companies which got PVP registration certificates for their rice varieties and rice hybrids increased to 25 and 21 respectively by the year 2017 (Table 7). This trend lends some support to the proposition that IPR creation stimulates private sector participation in self-pollinated crops (like rice) research also. However when compared to number of private companies participated in all crop PVP registration, share of companies participated in rice varieties registration, constitutes around 46% only. When compared to number of companies participating in seed market in India, this share becomes further low.

C4 ratio (*i.e.,* share of top 4 companies) with respect to rice PVP certificates declined from 56 percent to 48 percent, during 2014 to 2017 (Table 7). In the case of rice new varieties and new hybrids C4 ratio declined continuously during the period 2014 to 2017. In other cases the trend was not consistent. At the end of year 2017, C4 ratio stood at 58 and 42 percent in the case of rice new varieties and new hybrids PVP certificates respectively. Venkatesh and Pal (2013) reported that protected rice varieties had a premium price of 11.6 percent compared to unprotected varieties. Higher price of protected varieties can be due to seed company pricing strategy to recover protection costs as well as due to changing seed market structure.

The details of top 4 companies with respect to rice PVP in India are presented in Table.8. Will this concentration in PVP certificates lead to concentration in seed market? There is some evidence of concentration in hybrid rice seed market in India as is evidenced in table 9.

It is observed that in 2017, top 4 companies in rice hybrid seed market controlled 66 percent of quantity of seeds sold and 66 percent of revenue from seed sale. Bayer and Dupont pioneer (which are involved in recent cases of mergers) are included in this top 4 seed companies and Bayer and Dupont pioneer are in top 4companies group with respect to ownership of PV rights of rice hybrids also. This is indicating correlation between IPR and seed market concentration in case of rice hybrid where farmers right to reuse seed stands irrelevant. Further in India, among approved transgenic rice field trails 50 % of trails in private sector pertains to EI Dupont and 22% trails pertain to Bayer Biosciences Pvt Ltd (Table 6). These trends indicate concentration in rice hybrid PVP certificates, rice hybrid seed market, rice GM field trails in India.

At Global level *viz.,* Bayer crop Science and Syngenta are among top 5 assignees with respect to rice sequence patents in USA, the top most assignee being Dupont (Cambia, 2010). Globally so far 8 GM events are approved in rice crop, out of which three are developed by Bayer crop Sciences (ISAAA website accessed on 07-05-2018). Earlier in September 2017 Dow Dupont merger came into effect, later followed

Table 7. Concentration of rice PVP certificates in Private industry in India.

	All				New				Extant			
	2014	2015	2016	2017	2014	2015	2016	2017	2014	2015	2016	2017
Number of companies	18	22	24	25	13	16	16	18	14	18	20	20
Number of varieties	70	98	118	124	41	55	69	72	29	43	49	52
C4 ratio (%)	56	50	47	48	68	62	59	58	59	47	43	44
	All Hybrids				New Hybrids				Extant Hybrids			
	2014	2015	2016	2017	2014	2015	2016	2017	2014	2015	2016	2017
Number of companies	14	18	20	21	11	13	15	17	8	12	13	13
Number of varieties	30	45	57	61	18	24	31	33	12	21	26	28
C4 ratio (%)	50	38	39	39	61	50	45	42	67	52	58	61

Source : Data of PPVFRA

Table 8. Top 4 companies in rice PVP registration as on 31-12-2017.

Rank	All varieties	New Varieties	Extant Varieties
1	Nuziveedu (30)	Nuziveedu (22)	Nuziveedu (8)
2	Syngenta India (Ltd)/Pioneer (10)	Syngenta India Ltd(9)	Pioneer Overseas(7)
3	Nirmal seeds (9)	Krishidhan Seeds(6)	Advanta India Ltd/ Indo American Hybrid Seeds/ Nirmal seeds(4)
4	-	Nirmal seeds(5)	
Rank	Hybrids	New Hybrids	Extant Hybrids
1	Pioneer Overseas (10)	Nuziveedu (5)	Pioneer Overseas (7)
2	Nuziveedu (6)	Krishidhan / Nirmal Seeds/ Pioneer Overseas (3)	Advanta India Ltd (4)
3	Advanta/ Bayer Cop Science/ Devgen N.V/Indo Amercian Hybrid Seeds /Seed work International (4)		Bayer Crop Science (Ag)/ Seed works international (3)

*Figures in parentheses indicate number of PVP certificates.

by acquisition of Syngenta by Chemchina. Currently proposal of acquisition of Monsanto by Bayer crop science is under progress and is being examined by competition authorities of different countries. Bayer got approval for acquisition of Monsanto from more than half of the 30 competitions authorities. The major countries that approved the acquisition are EU, Brazil and China. Several competition authorities have given conditional approval. The conditions are divesting for removing overlaps in seeds, pesticides and digital agricultural markets. Bayer gave consent to give some of its corporate secret data to Russian Federal Antitrust Authority. Bayer also signed an agreement to sell its further crop science business (which includes global vegetable seed business, certain seed treatment products, research platform for wheat hybrids and certain glyphosate based herbicides) to BASF. Besides these, three research projects in the field of total herbicides and Bayer's digital farming business will also be transferred to BASF and will receive a back licence for certain digital farming applications (seedworld, 27-04-2018).

Table 9. Private companies in Indian Hybrid rice seed market in 2017.

S.No.	Company	Quantity of Hybrid Rice seed sold (Tonnes)	Revenue from hybrid rice seed sales (million US dollars)
1	Bayer	17696	112.81
2	Dupont Pioneer	4261	26.4
3	Syngenta	2979	18.5
4	Kaveri	2363	16.39
5	Panseeds	1578	9.89
6	Rasi seeds	1546	10.41
7	Advanta	1285	7.75
8	Mahyco	1236	8.45
9	Nirmal Seeds	976	6.09
10	Nuziveedu	211	1.22
11	Others	7493	45.55
	Total	41624	263.46

Source: LP information

Competition Commission of India (CCI) has also given conditional approval for the acquisition of Monsanto by Bayer, vide its order dated 14-06-2018. Salient conditions are (i) divestment of business of Glufosinate Ammonium (a non-selective herbicide), crop traits of cotton and corn and hybrid seeds of vegetables (ii) Divestment of the shareholdings of Monsanto in Maharashtra Hybrid Seed Company (iii) for 7 years, follow a policy of non-exclusive licensing of traits, non-selective herbicides and their active ingredients, and existing agro-climatic data owned by the combined entity for its digital applications on FRAND (Fair, Reasonable And Non-discriminatory) terms. CCI also proposed appointment of a independent "Monitoring Agency" to monitor the compliance.

Economies of scale, economies of scope and accessing complementary IPRs appears to be the major motives behind ongoing mergers and consolidation. According to Lionos et al., (2016) IP rights and patent alliances are accelerating merger of global seed-chemical companies. Halpert and Chappell (2017) also expressed similar opinion. The issue is that concentration of power resulting from mergers can cause problems due to exercise of market power. Manne and Gibby (2017) opined that there is need for considering not only likely harmful effects but also beneficial effects in agricultural biotech industry

mergers. Further they opined that merger will increase innovations because of efficient use of complementary skills and resources of merging firms. The main issue is that the effects of mergers of agro-biochemical industries on competition needs to be evaluated in (i) research (investment) market (ii) Technology and IPR arena (ownership of product and process patents/pv rights/traits and their licensing) (iii) different product markets (seeds, agro-chemicals) (iv) different levels of geographic markets. Thus, assessing the beneficial and harmful effects of merger of agro-biochemical companies correctly in ex-ante framework is becoming a challenge to economists. This is the reason underlying wider adoption of "conditional approval" of mergers and acquisitions with follow up monitoring. It is pertinent to note here that while IPR applicability is territorial, competition authorities can address anti-competitive issues due to across nations action of firms.

In India competition in rice seed market is becoming further complex as there are (i) a group of companies which are owning their own rice varieties (ii) companies which do not own any rice variety but licensee of some public sector rice varieties (iii) companies which not only own their varieties but are also licensee of some public sector rice varieties/hybrids. These different groups of companies may have different strategies in competing with other companies making the situation very complex.

In India, based on Delhi High court judgement with respect to transgenic cotton, it can be inferred that transgenic plants also will be protected through PV rights only. But access to proprietary bio-safety/ environmental safety/food safety data for getting approval for cultivating a transgenic crop may still be an issue involving cost both in terms of money and time. This can also aid in increasing consolidation in seed sector. Hence, there is need for relook into these approval issues. So far no transgenic food crop is permitted for commercial cultivation in India (This is not only due to delay in getting safety approvals but also due to strong opposition from NGOs, biodiversity conserving organizations, farmers and consumers). In addition to this some uncertainty prevails regarding how frontier technologies like Genome editing, synthetic biology, etc will be regulated in India and which type of IPRs will be provided for plants produced using these technologies. Researchers from USA developed rice resistant to bacterial blight using genome editing. USA made it clear that plants produced through genome editing will not be regulated as there is no use of pathogen in the process. On the other hand EU decided that crops created using genome editing technologies such as CRISPR-Cas9 will be subject to same stringent regulations as conventional GM crops (Callaway, 2018). Such clarification is yet due from India. India also has no policy on synthetic biology.

In case of transgenic crop in post-patent regime/ PV regime and during PV regime also, these regulations (such as getting clearance from bio-safety regulatory authority, export import regulation authority) can come in the way of technology transfer through " generic seeds". There are some attempts in USA to handle this kind of situation through contractual solutions like "AgAccord". The effectiveness of this mechanism is not yet established.

IPR and farmers rights

Ensuring that IPR doesn't hinder farmer's access to seed is one argument against strong IPR for plant varieties. Accordingly, in PVP legislation of several countries, there is a provision for farmers' privilege or right. Indian PPVFR Act protects rights of farmers as (i) breeders (ii) plant genetic resource conservators and (iii) as consumers i.e users of seeds. For registering farmer's varieties under PPVFR Act in India the criteria of uniformity is relaxed allowing double the number of off-types as otherwise permitted for other categories of varieties. With respect to farmers privilege, Indian PPVFR Act is broader compared to CPVR (Community Plant Variety Rights) of European Union. Under PPVFR farmers rights are applicable to all crops notified by PPVFR and applicable to all category of farmers irrespective of farm size.

Comparing farmers rights implementation in Brazil and India Peschard (2016) differentiates between 'ownership' and 'stewardship' approach of farmers' rights. The goals under "ownership" and "stewardship" approach are different (Andersen,2016). Under ownership approach granting breeders rights to farmers is the proposition and this is the approach followed in India. However a view is there that this ownership approach could provide disincentive to sharing knowledge between farmers and among farmers as was observed in Peru with respect to potato (Andersen,

2016). Under stewardship approach, the objective is to protect farmer's knowledge from extinction and thus to encourage its future use. Presently in India farmers who registered their varieties are not getting any financial benefit (Kaye, 2012). They are not receiving any state assistance for developing and introducing these varieties in formal seed supply system (Shalini, 2015). There is no condition parallel to "working of patent" condition in Patent law. Thus, there is no guarantee that "farmers varieties" will be cultivated regularly. Under PPVFR Act farmers get financial benefit and their right as breeder becomes effective, only when their varieties are used in breeding and results in development of new varieties. This is being viewed as a sort of double speak of PPVFR Act (Kochupillai, 2018) as it is lending support to formal innovation only. Farmers will not have marketing skills like private industry, to publicise about their variety so as to commercialize their varieties as such or as a breeding material. This aspect need to be looked into in depth and some effective mechanism need to be designed so that farmers right as breeders become really effective. As of now farmers varieties registration can be thought of as a defensive mechanism against piracy but given the Indian farmer's (more particularly farmers from the states from which these farmers' varieties are registered) limited literacy in general and literacy regarding IPR law in particular raises doubt about this effect also. The state Government Agencies and NGOs which registered these varieties on behalf of farmers have to play active role in checking bio-piracy and marketing these varieties for their desired traits. Creation of national level register of farmers varieties with detailed description of varieties (not only DUS but also other values, traits etc as reported by Noreiga (2016) in the case of Peru) will serve more effectively the purpose of registering for defence. It can serve not only defensive purpose but also publicity purpose, creating demand for these varieties (both from breeders and other farmers).

Besides in IPR framework, in some international conventions also there is emphasis on farmer's rights. These are FAO's 1983 International Undertaking on Plant Genetic Resources for Food and Agriculture, United Nations Convention on Biological Diversity (CBD,1992) and 2001, International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA). These treaties emphasize access to plant genetic resources and equitable benefit sharing (Oguamanam, 2014). Accordingly, some view the Indian PPVFR Act as an amalgam of IPR and Access and Benefit sharing (Halewood and Lapena, 2016). However complex nuances involved in deciding about benefit sharing under PPVFR Act was described in case of "HMT" rice by Kochupillai (2015) and Peschard (2016). It is being felt that Public sector's promotional policies for improved varieties leading to farmers adoption of improved varieties may result in short time gain at the cost of long term benefit of conserving biodiversity *i.e.,* a "new market failure" (Kochupillai,2018). It is being opined that small number of plant genome saviour awards given by PPVFRA for incentivizing biodiversity conservation will not be able to address this "new market failure".

For ensuring the benefit sharing component under PPVFR Act, the authority publishes details of registered varieties, inviting claims for benefit sharing. On the contrary, in Thailand the law mandates that applications for new plant variety protection to include details about the origin of the genetic material used for breeding and a proof of profit sharing agreement when general domestic or wild plant varieties have been used for developing a new variety (Gagne and Ratanasatien, 2016). Further the benefit need not be in monetary terms only but can be other means also like capacity building and technology transfer. Further under Thai PVP act, community registration of "local domestic varieties" is facilitated. Under this Act PVP application of Somchai Asaiboom for " Homhuang Chaiya" rice variety was rejected because Asiaboom was a family not community (Gagne and Ratanasatien, 2016). Thus, under Thai PVP both "new" and "local domestic varieties" are registerable, but not "general domestic and wild plants". Benefit sharing under registration of local domestic varieties is, targeted at the particular community. Benefit sharing when general domestic or wild plants are used in breeding is, targeted at wider community (Gagne and Ratanasatien, 2016). It is reported that these benefit sharing provisions discouraged foreign investment in seed R&D. Consequently Thai government proposed an amendment for "exempting new plant varieties which are not based on previous Thai plant varieties from the revenue sharing requirements" (USDA, 2017).

As stated in previous paragraphs, in India, in

rice crop, farmers have highest number of registered varieties as breeders. Some varieties were registered by individual farmers and some by farmers' groups or farmers' communities. But it is found that some of the farmers from Odisha state who had registered their varieties with PPVFRA were not aware of what exactly registration means and the benefits of registration (Authors' interaction with farmers in 2016). Further some of these farmers' rice varieties are not high yielding varieties but have specific traits like flood tolerance/pest resistance/salinity tolerance/suitable for making special products from rice. Deb (2011) reported some "folk varieties" of rice with not only higher yields higher but also perfectly suitable to marginal conditions (zero agrochemical inputs and long term yield stability). However these features are not made public in documented form so that they can serve as base material for breeding work. In Nepal a rice variety ' Pokhareli Jethobudho" developed from a landrace through Participatory Breeding (PB) was registered for joint ownership, and the farmers and the concerned organizations got rights to produce and market the seeds (Shrestha, 2016). In Vietnam a rice variety " Tamxoan Haihau rice" developed from local variety " Tamxoan" by an association comprising farmers and some research and development organizations was registered under Geographical Indication" in 2008 (Hue Nguyen Thi et al., 2016). Such initiatives in India, utilizing farmers' rice varieties will yield benefits to both owner farmers and also larger society.

Regarding farmers right as consumers, certain issues are emerging. As observed in the case of rice, private sector is developing more hybrids compared to varieties in India. As hybrids do not reproduce "true to type plants", farmers rights to reuse seeds from their harvest becomes irrelevant. Shalini (2011) argued that all the freedoms/rights granted under Indian PPVFR act are rendered ineffective due to hybrid seeds.

Emerging alternative IPR regimes in plant variety protection and access

In the backdrop of intensive debate regarding effect of IPR on farmers control over plant germplasm, crop diversity, seed market structure, innovation and seed prices in agriculture, there have been some initiatives to address/prevent some of negative effects through alternative IPR regime. These initiatives targeted 'taking repossession' of germplasm and seeds (Archana et al., 2017), by 'beating bounds' (Maywa, 2017).

Open source seed initiative

A non-profit organization consisting of a group of plant breeders, farmers, non-profit agencies, policy makers etc was created with the name "Open Source Seed Initiative (OSSI)" in May, 2012 in Minneapolis, Minnesota. This initiative was aimed at creating and ensuring access to "protected common genetic resources" for fostering development of new plant varieties (Luby and Goldman, 2016). This initiative was based on insights drawn from "open source" development in software industry, "copy left licence" in the area of copy rights and management of commons (Ostrom, 1990). For accessing seeds under OSSI, one has to sign a pledge, which reads " You have the freedom to use these OSSI - pledged seeds in any way you choose. In return, you pledge not to restrict other's use of these seeds or their derivatives by patents or other means and to include this pledge with any transfer of these seeds or their derivatives". Breeders who want to contribute their cultivars under OSSI-Pledged varieties are able to submit their varieties to OSSI. OSSI has been partnering with seed companies for selling seeds of OSSI-Pledged varieties. Thus, OSSI is using a hybrid approach having market and non-market components. Under OSSI, developer of an OSSI pledged variety retains the right to distribute or not distribute seeds as per his choice. But once the seeds are distributed, OSSI pledge becomes binding on both donor and recipient. OSSI as of now is not accepting material containing transgenic component.

As on 03-08-2018, OSSI has 415 varieties of 59 crops (most of them are horticultural crops), contributed by 40 plant breeders and sold by 56 companies from different countries. Out of these 415varieties, 350 varieties are available for commercialization. Under OSSI initiative, breeders contributing their variety as OSSI-Pledged varieties can enter into royalty like agreements with seed companies for selling their varieties, there is no restriction on it. Only thing is that the agreement should not impose any restriction on ultimate recipient of the seed in any way. Thus OSSI is focusing on fostering a decentralised and innovative plant breeding system, respecting the rights and sovereignty of indigenous communities over their

seeds and genetic resources (Kloppenburg, 2014).

Open source seed licence (OSSL)

This initiative is taken up by AGRECOL (Association for Agriculture Ecology) a non-profit entity in Germany. Under this, licensee will be granted the right to use seeds for any purpose (propagation, enhancement) and pass on the seeds to others, disseminate propagated or enhanced seeds (Kotschi and Rapf, 2016). Open Source Seed Licence and is covered under German Civil Law. OSSI is initiative is relying on "pledge" mechanism i.e. a moral obligation approach , on the contrary OSSL is an initiative based on enforceable "Licence" mechanism. As on 03-08-2018, one sweet corn variety, three tomato varieties and three wheat varieties are available under OSSL.

Open source model initiatives in Indian plant varieties sector

In India some efforts to conserve rice varieties were initiated prior to enactment of PPVFR Act. "Vrihi" rice seed bank was established by Deb in 1997 in West Bengal and was later shifted to Odisha. Under this initiative, in order to receive seeds from the seed bank, a farmer must give in exchange one kg of seeds of at least one folk variety or return after harvest, two kgs of seed of rice variety he received.

In the context of pending seed bill (with focus on regulating seed quality) enactment with some provisions diluting PPVFRA, as precautionary measures some more initiatives have been taken up to address the issues of control over germplasm/seeds, seed quality and seed price. Centre for Sustainable Agriculture, Hyderabad by organizing an open source network, bred and shared eight varieties of rice, wheat and pulses (Lucas, 2017). Hivos, an international organization, supporting national initiatives for open source system, is supporting "Apna Beej" program in India. Under this program which started in 2015, so far 20 varieties of rice, vegetables and pulses were registered which remain available for breeding purpose for farmers and seed companies.

Archana et al. (2017) investigating various practices of the repossession of seeds in order to conserve agro-biodiversity and ecosystem, reported two cases of NGO led control and conservation of seeds of land races in the state of Odisha in India. Loka Samabaya Pratisthan (LSP) and Sambhav are the two NGOs, having their own seed banks and practicing organic farming. High chemical input usage in modern varieties cultivation leading to ecological damage motivated the initiation of seed bank program of LSP. Sambhav seed bank program was started with the objective of protecting environment by conserving agro-biodiversity. LSP conserves rice germplasm only, on the other hand Sambhav conserves germplasm of rice (400 varieties), millets, pigeon pea (300 varieties) and fruits. Seed banks are managed by organizations but not by communities both in the case of LSP and Sambhav. But under Sambhav seed bank program, seed conservation takes place at organizational level as well as at farmers group level. Both the NGOs do not support farmers financially but only provides them training for cultivating the land race varieties. Both LSP and Sambhav, followed a strategy of collecting and expanding their germplasm collection using informal networks. Under Sambhav an initiative has been taken up in which farmers are encouraged to 'adopt a seed' by signing a two page document containing vow to take care of seeds of a particular variety. Both LSP and Sambhav are sharing the conserved varieties with interested farmers for cultivation.

Non-IP initiatives

Hemel and Ouellette (2018) clarified that from the innovator perspective IPR is an incentive mechanism but from the consumers perspective IPR establishes the terms under which individuals and firms can gain access to knowledge goods. The two objectives i.e providing incentives and ensuring access to consumers are separate and can be handled separately. In India the policy option of subsidy to hybrid rice seeds is being used for improving access. At global level also some non-IP initiatives are being taken up to handle the seed affordability issue. One such initiative is "access to seed index". This index is published by Access to seeds Foundation, an independent non-profit organization based in Netherlands. The exercise attempts to use positive reinforcement approach for encouraging participation of seed industry in smallholders' development. The index is a relative ranking of companies with an integrated seed business model covering the full seed value chain starting from

Research and Development to seed distribution, based on some parameters. DuPont Pioneer topped in 2016 access to seed index at global level with respect to field crops. It was followed by Syngenta and Bayer.

CONCLUSION

IPR for plant varieties is affecting access to two key resources *i.e.,* germplasm for further future development and seeds for immediate use. For addressing these issues several IP and Non-IPR policy initiatives, some initiatives from Non-Government sector are being tried out across different countries. IPR and other regulatory aspects for some plant breeding technologies together with IPR for plant varieties is not only leading to several uncertainties but also adding to some concerns as discussed in previous paragraphs. Hence, it is crucial that for harnessing the potential of dynamic frontier plant-breeding technologies, there is need for laws and policies addressing these uncertainties by becoming more dynamic. Indian PPVFR Act though a well planned legislation, its effectiveness in empowering farmers at ground level is yet to be established. Further there is a need for in-depth study of IPR and competition interface in rice seed sector, by looking into pricing behaviour of private seed industry and seed value chain.

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