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Plant Variety Rights in India: Progress, Sectoral Participation, and Certification Dynamics

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Plant Variety Rights (PVRs) stimulate agricultural innovation by incentivizing breeders with exclusive rights over their varieties. In India, the Protection of Plant Varieties and Farmers' Rights Act, 2001 provides dual benefits: encouraging breeders to develop new plant varieties and motivating farmers to conserve agro-biodiversity by protecting landraces. This study examines the Indian system of plant variety protection in terms of varietal registration progress, participation of public and private sectors as well as farming communities, portfolio diversity of public as well as private grantees, and their certification lags. Findings revealed that between 2009-10 and 2024-25, registrations grew from 170 to 1719 certificates with maximum rights in farmer varieties (54.6 %), followed by extant (30.4 %) and new varieties (14.8 %). Most rights were secured for cereals (64.2 %), fibres (9 %), and pulses & vegetables (7.5 % each), with highest registrations in rice, cotton, and maize. Private companies focused on commercial crops (tetraploid cotton, vegetables, and sunflower), whereas public institutions covered a broader spectrum of rights in crops. Registration diversified in crop species over time, especially among private companies and farmers. Typical varieties secured the highest protection (58.5%), followed by hybrids, parental inbred lines, and transgenic crops. Average certificate grant time increased from 1.6 years (2009) to 7.5 years (2023), with public institutions experiencing shorter lags (2.6 years) than private companies (6.5 years) in registration.

Keywords: Plant Variety Rights, PPVFRA, Portfolio Diversity, Hybrids, Parental Lines, Certification Lag

By improving productivity, resource-use efficiency, and competitiveness, innovations in and for agriculture play a vital role in fostering rapid agricultural growth and rural development, particularly in smallholder-dominated agrarian economies characterized by the high incidence of poverty and malnutrition. The evidence shows that innovation-led growth in agriculture has a larger effect on poverty reduction,[1-4] and nutritional outcomes than the growth in non-agricultural sectors.[5,6] Globally, the development of crop varieties for higher yields has been one of the most significant technological innovations in agricultural science. Besides yield improvement, agricultural research has also laid a significant emphasis on breeding crops for traits like resistance to insect pests and diseases, tolerance to droughts, floods, and heat stress, higher resource-use efficiency, and biofortification for micro and macro-nutrients.

Research involves significant fixed costs and a longer gestation period, and the innovators, including individuals and organizations, need to gain access to new markets for their innovations and making profit. Innovators are largely motivated by incentives due to the involvement of substantial time and expenses in conducting research and subsequent knowledge spillovers.[7] Thus, the probability of investment in research is higher if the innovations by the organizations and individuals are protected through intellectual property rights (IPR). By minimizing the problems of free-riding, the IPR can attract foreign and domestic investment in agriculture, further driving the innovations.

Intellectual Property Rights (IPRs) play a critical role in incentivizing innovators by enabling them to reap the benefits of innovation by ensuring monopoly rights over their innovation.[8] The landscape of plant breeding research has gradually been shifting from traditional low-cost breeding techniques to expensive marker-assisted and biotechnological approaches, including genetic engineering, genomics, etc. In the context of plant varieties, protecting, safeguarding, and acknowledging the rights of breeders have important implications for sustained varietal development and thereby sustained agricultural progress. Intellectual property rights serve to safeguard the rights of innovators, driving the development of technologically advanced varieties suitable for withstanding the existing biotic as well as abiotic challenges pertaining to

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agriculture. Thus, a robust plant variety protection system is essential to protect innovations, minimize the problem of free riding, and attract more investment in research.

In India, the process of evolving a system of protection of plant breeders' rights began in 1995 in line with International Union for the Protection of New Varieties of Plants (UPOV) model, leading to the enactment of Protection of Plant Varieties and Farmers' Rights Act in 2001. The Act allows for the registration and protection of new, extant, and essentially derived plant varieties, thereby incentivizing innovation in plant breeding and encouraging investment in agricultural research. The Act legally grants Indian farmers the right to save, use, sow, re-sow, exchange, share, and even sell farm-saved seeds of protected varieties (except branded seeds). Further, the act also enables farmers to register their own varieties developed through traditional knowledge and practices. Thus, by promoting agricultural innovation and safeguarding farmers' rights. The PPV&FR Act provides inclusive approach to intellectual property in agriculture, contributing to both technological advancement and socio-economic equity in the farming sector.

Unlike many countries following the UPOV model, which grants rights only to breeders for new varieties, India's system is more inclusive. It provides plant breeders exclusive rights on the varieties they have developed and also acknowledges the contributions of farmers in cultivating and preserving landraces and making these available for the development of new varieties. It provides for mechanisms of benefit-sharing in a fair manner in line with the basic theme of the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) and Convention on Biological Diversity (CBD). Additionally, the process of registration of farmers' variety has been made much simpler with fewer formalities than those required for new varieties. Further, unlike in other important varietal protection systems in the world that grant rights only for new varieties, the Indian system also provides rights for extant plant varieties.

The PPVFRA is responsible for the implementation of varietal protection system in India to provide a legal framework to protect IPRs and incentivize investment in research on breeding and development of crop varieties. A plant varieties registry has been established under the authority, and procedures are delineated or the registration of varieties with distinctness, uniformity, and stability (DUS) as criteria for protection.[9] New varieties need to pass the DUS criteria for two similar crop seasons at two locations, while farmers' and extant varieties that are in common knowledge (i.e., extant VCK) have to fulfil the criteria for only one crop season at two locations. No DUS test is required for notified extant varieties, while it is not mandatory for essentially derived varieties (EDVs). The differential procedural requirements for various categories of varieties contribute to temporal disparities in the granting of rights across varietal classifications. Further, the protection is granted for 15 years for crops and 18 years for trees and vines.

While a majority of the existing IPR literature in agriculture focuses on legal frameworks and varietal protection trends, there is a lack of literature on the varietal certification lags and the crop/applicant specific factors influencing the speed of the certification process. Moreover, only a few studies explored the area of sector-wise participation (public, private, farmers) in varietal certification and their focus crops, which has crucial implications for developing necessary steps in incentivizing varietal development and their subsequent protection in less prioritized crops/crop species.

In this context, this paper examines (I) the progress of variety registration, and the response of public and private sectors to the plant varietal protection system, (ii) trends in PVRs under different varietal classifications, (iii) the speed of varietal certification process i.e. certification lag, and (iv) sectoral participation in plant variety protection and their varietal portfolio. Understanding these processes is vital for optimizing the timeliness of protection, enhancing participation from both public and private sectors, promoting genetic resource conservation, and providing data-driven recommendations for refining regulatory policies to improve the overall effectiveness of the varietal protection system.

Data and Methods

Data

To achieve the intended objectives, the study sources secondary data from the Protection of Plant Varieties and Farmers' Rights Authority (PPVFRA). As the process for registration of plant variety was initiated in 2007 with the first varietal registration in 2009, the data pertaining to various parameters related to varietal registrations was collected for the period 2009-10 to 2024-25 from the website of PPVFRA. The passport data of varieties was taken from the plant variety journal released by the authority for the period 2009-2023 to

obtain information on the major variety classification (i.e., typical varieties, parental lines, hybrids, transgenic crops, and variety ownership) by public and private sectors, and also by crop species.

Exploratory Data Analysis

A comprehensive exploratory analysis was conducted to assess the status of registration in extant, new, and farmers' varieties, crop-wise focus, and patterns of rights granted to major public and private sectors. Further, the effectiveness of the system was examined in terms of coverage of crop species, speediness of registration process (i.e. certification lag), and diversity in varietal rights.

Certification Lag

Certification lag indicates not only the timeliness of the registration process but also the existing disparity in certificate grant time across crop groups and applicants.

Herfindahl-Hirschman Index (HHI)

The diversity in plant variety rights reflects the overtime expansion of varietal/species coverage to see whether the rights are concentrated in a few crops or diversified across different crops and crop groups. The diversification in varietal rights was assessed using the Herfindahl-Hirschman Index (HHI),

$$HHI = \sum s_i^2$$

where s is the share of i^{th} crop in the total certificates issued.

Results and Discussion

Status of Varietal Rights in India

There has been a significant increase in number of plant varieties registered, from 170 in 2009-10 to 1719 in 2024-25 (Fig. 1). Of the total varieties registered, the farmers' varieties comprised nearly 54.6%, followed by the extant varieties (30.4%) and new varieties (14.8%). The share of rights granted in EDVs was negligible (0.2%), which were given in tetraploid cotton. By applicants, farmers obtained more than half rights in total varieties registered under the authority (54.6%), followed by private (24.6%) and public sector (20.8%) till 2024-25 (Table 1).

Public sector has a dominant share in the registration of extant varieties registered (89.2%), while private sector companies have a slightly higher share in the registration of new varieties (51.2%). Initially, the extant varieties dominated the total registrations, whereas the share of new and farmers' varieties was negligible. However, in later years, there was a rapid rise in the number of farmers' varieties registered due to a rise in farmers' applications for varietal protection under the authority. It was mainly due to the protective role of the authority in planning mass awareness and capacity building programmes to create wider publicity by involving ICAR institutes, SAUs, KVKs, NGOs, and many other agencies.[10] The number of registrations of new varieties also gradually increased. At the same time, there was a rapid rise in the coverage of crop species notified by the authority from 12 in 2007 to 197 species in 2024. Government initiatives towards the implementation of the international standards also played a key role in promoting legal protection and encouraging innovations.

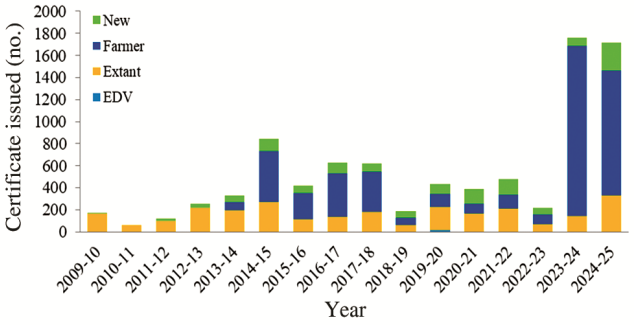

Fig. 1 — Registration certificates issued (2009-10 to 2024-25) under PPV & FRA

Table 1 — Applicant-wise registration under PPVFRA (2009-10 to 2024-25)

Applicant	New varieties	Extant varieties	EDV	Farmers' varieties	Total	Share of applicant in total rights (%)
Public	194 (10.8%)	1598 (89.2%)	0 (0.0%)	0	1792	20.8
Private	1084 (51.2%)	1018 (48.1%)	14 (0.7%)	0	2116	24.6
Farmer	-	-	-	4708 (100%)	4708	54.6
Overall	1278 (14.8%)	2616 (30.4%)	14 (0.2%)	4708 (54.6%)	8616	100.0

Table 2 — Certificates issued in major crop groups under PPV & FR during 2009-10 to 2024-25

Crop Group/Crop	Public			Private			Farmer	Total varieties registered
	New	Extant	Total Public	New	Extant	Total Private		
Cereals	*126*	*823*	*949*	*580*	*366*	*946*	*3680*	*5575*
Rice	29	286	315	205	116	321	3295	3931
Wheat	23	205	228	18	12	30	107	365
Maize	43	161	204	217	143	360	44	608
Sorghum	31	87	118	44	15	59	59	236
Pearl millet	0	46	46	95	79	174	8	228
Barley	0	19	19	1	1	2	27	48
Ragi & other millets	0	17	17	0	0	0	140	157
Pulses	*5*	*243*	*248*	*14*	*6*	*20*	*375*	*643*
Chick pea	2	64	66	0	1	1	51	118
Pigeon pea	2	34	36	14	2	16	157	209
Green gram	0	40	40	0	1	1	18	59
Black gram	1	38	39	0	0	0	53	92
Oilseeds	*2*	*186*	*188*	*58*	*46*	*104*	*187*	*479*
Rapeseed & Mustard	1	68	69	5	18	23	85	177
Sunflower	0	12	12	44	22	66	0	78
Soybean	0	36	36	5	1	6	18	60
Groundnut	0	39	39	1	1	2	14	55
Fibre Crops	*17*	*118*	*135*	*270*	*352*	*636*	*1*	*772*
Diploid cotton	4	36	40	9	10	19	0	59
Tetraploid cotton	4	67	71	258	342	614	1	686
Cotton	8	103	111	267	352	633	1	745
Jute	9	15	24	3	0	3	0	27
Sugarcane	*13*	*47*	*60*	*0*	*1*	*1*	*5*	66
Vegetables	*3*	*119*	*122*	*160*	*135*	*395*	*125*	*642*
Brinjal	1	16	17	49	106	155	38	210
Tomato	0	18	18	49	59	108	18	144
Okra	0	16	16	20	29	49	13	78
Potato	2	15	17	18	7	25	1	43
Cauliflower	0	3	3	17	9	26	4	33
Fruits	*16*	*15*	*31*	*2*	*10*	*12*	*230*	*273*
Apricot	0	0	0	0	0	0	30	30
Mango	0	2	2	0	0	0	130	132
Grapes	2	2	4	2	4	6	16	26
Spices	*1*	*30*	*31*	*0*	*0*	*0*	*93*	*124*
Turmeric	1	9	10	0	0	0	19	29
Black pepper	0	4	4	0	0	0	11	15
Small cardamom	0	3	3	0	0	0	10	13
Coriander	0	2	2	0	0	0	27	29
Flowers	*1*	*4*	*5*	*0*	*2*	*2*	*7*	*14*
Rose	1	1	2	0	2	2	0	4
Orchid	0	0	0	0	0	0	5	5
Tree, forest and plantation crop	*9*	*12*	*21*	*0*	*0*	*0*	*2*	*23*
Medicinal and Aromatic plants	*0*	*1*	*1*	*0*	*0*	*0*	*1*	*2*

Crop-wise Varieties Registered

The Authority provides protection to a wide range of crops, and the number of crops registered has increased considerably over time. Currently, varietal rights are granted for cereals, pulses, oilseeds, fibres, vegetables, fruits, spices, flowers, sugar crops, medicinal and aromatic plants, and trees, forest and plantation crops. Cereals dominate the registration. Table 2 shows that of the total 8616 varieties registered till 2024-25, about 65% belong to cereal crops, followed by fibres (9%) and

pulses and vegetables (each at 7.5%). Amongst cereals, rice has the highest varietal registration (70.5% of certified cereal varieties), and 84% of these are farmers' varieties. Maize, wheat, sorghum, and pearl millet were next in the order. Amongst other field crops, tetraploid cotton, chickpea, pigeon pea, and mustard received maximum varietal protection.

Protection in pulses was granted mainly to farmers (375 certified varieties) and public applicants (248 varieties). The private sector held less than $1/10^{th}$ rights of varieties in pulses as compared to public sector institutions. The limited number of rights of private sector in pulses is caused by the economic nature of the crop, such as less economies of scale, lack of hybrids (except pigeon-pea), and high logistics for marginal, scattered farms, which leads to a refrainment of private companies from varietal/hybrid development in pulses.

Protection under millets increased particularly in recent years, with maximum hold of farmers' varieties securing PVRs in millet crops. Out of 157 certified millet varieties in India, farmers hold rights to 140 millet varieties (89% of certified millet varieties), whereas rest of the 17 varieties were secured by the public sector. Among millet crops, highest protection was granted in little millets (62 varieties), followed by kodo millet (49 varieties) and finger millet (30 varieties).

While varietal protection in the vegetable was gradually increased over time, varietal certification surged in spices in recent years, particularly by farmers. Turmeric and black pepper received maximum certifications in spices group, whereas brinjal and tomato received maximum certification among vegetables.

Farmers' varieties have a major share in total varietal registration. Private companies have secured more varietal rights for commercial crops like sunflower, tetraploid cotton, pearl millet, and vegetables. Public sector institutions have a dominant share of varietal rights in those crops which are comparatively less remunerative but crucial for food security aspects of the country, namely, cereals, pulses, oilseeds, sugarcane, jute, cotton, plantations, and also in medicinal & aromatic crops. Varietal registration of extant varieties of different crops (except maize, fruits, and plantation crops) is concentrated in the public sector. On the contrary, private sector secured maximum varietal protection in new crop varieties, except of pearl millet, cotton, brinjal, tomato, and okra.

Extent of Diversification in Varietal Protection

The diversification in the portfolio of variety registration among applicants' category as well as within major crop groups was examined using the Herfindahl-Hirschman Index (HHI) in two periods: Period I (2009-2014) which was the period of inception and implementation, and Period II (2019-2024), representing the recent period, to identify the growth in varietal spectrum of public and private grantees as well as of farmers in a 10 year gap. A lower value of HHI indicates a higher level of diversification in the crop coverage of varietal rights, and vice versa. During the initial period (2009-2014), the farmers exhibited the highest HHI values (0.98), indicating a higher concentration on selected crops, while the public and private sectors, with significantly low HHI values of 0.07 and 0.16, had comparatively diverse rights over various crops (Table 3).

During the latest period (2019-2024), the HHI values were improved noticeably in farmers' varieties to 0.36, i.e. more than half of the previous period, reflecting expansion of varietal rights in pulses, species, fruits, and oilseeds besides rice which still hold a principal share in total certified varieties of farmers. Within major crop groups, cereals, pulses, and fibre crops witnessed a decrease in portfolio diversity due to an increase in focus towards rice, pigeon pea & tetraploid cotton, respectively, whereas the vegetables and spices groups indicated an increase in varietal portfolio diversity. Overall, the spread of varietal protection was enhanced marginally among the notified crop species between period I (2009-2014) and period II (2019-2024) as indicated by a reduction in HHI values from 0.21 to 0.20.

Table 3 — Diversity in varietal coverage through Herfindahl-Hirschman Index (HHI)

Category	Period I 2009-2014	Period II 2019-2024
Applicants		
Public	0.07	0.09
Private	0.16	0.16
Farmers	0.98	0.36
Within major crop groups		
Cereals	0.43	0.50
Pulses	0.18	0.25
Oilseeds	0.20	0.14
Fibres	0.56	0.88
Vegetables	0.37	0.19
Spices	0.38	0.19
Fruits	-	0.20
Flowers	-	0.28
Overall	0.21	0.20

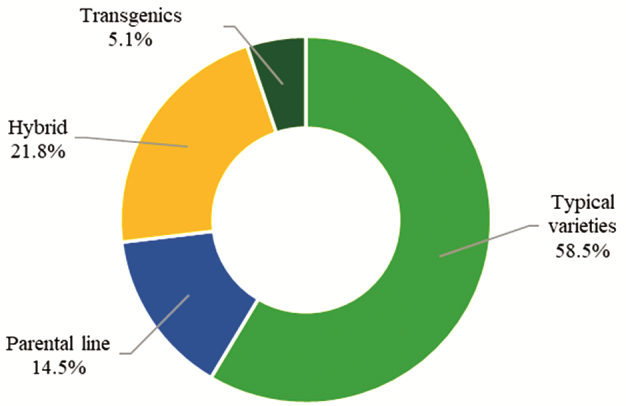

Fig. 2 — Varietal registrations in major crop classification in public and private sector (2009-2023)

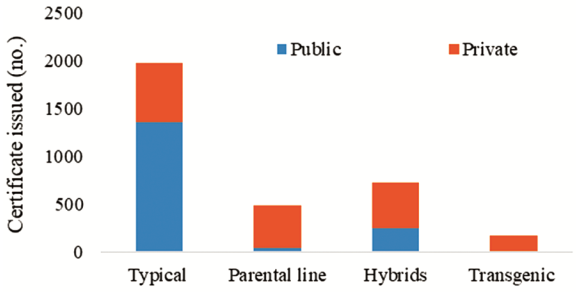

Fig. 3 — Varietal registration by public and private sectors in major crop classification

Varietal Registration in Various Crop Classifications

The pattern of varietal certificates granted to the public and private sector shown in Fig. 2 reflects that the typical crop varieties secured the highest protection (58.5%) under the Act followed by hybrids (21.8%), parental inbred lines (14.5%), and transgenic crops (5.1%). A clear difference was seen in the varietal focus of public and private sector in the certificate secured under major variety classes (Fig. 3). Public sector institutes obtained a dominant share in the rights of typical varieties viz. self/open pollinated varieties (69% of the total), on the other hand, private sector companies secured the varietal rights in majority of the hybrids (64.9%), inbred parental lines (90.6%) and the transgenic crops (100%) (Fig. 3). The major reason for high interest of private sector in obtaining plant variety rights in hybrids are: i) fresh purchase of hybrid seeds in each season by farmers as there is no possibility of re-sowing or reuse of the seed due to the inability of hybrids to maintain true to type plant in the subsequent seasons, ii) difficulties in identifying the parental lines of hybrids by competitive companies

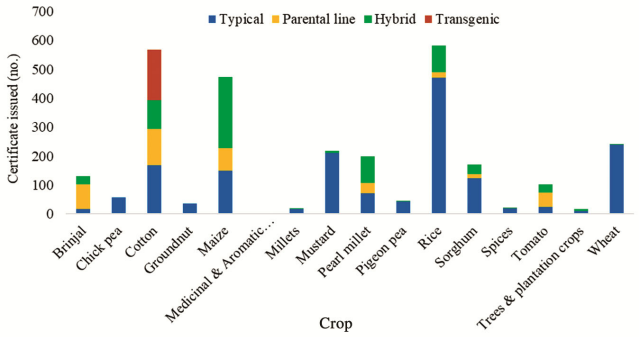

Fig. 4 — Crop-wise varieties registered by variety type (2009-2023)

Note: Figure shows data for public and private players only, as farmers' varieties are, by and large, typical varieties.

thereby narrowing market competition and ensuring a regular market.[11] Additionally, higher returns from the cultivation of hybrids due to their biological features provide the necessary incentives to attract private sector participation in hybrid breeding, production, and their subsequent protection.[12]

Besides obtaining varietal rights of hybrids, there is active engagement of private sector in securing the rights over the parental lines that are used for development of hybrids. Because to protect the hybrids which is developed by two parental lines, it is also necessary to sought protection for the corresponding parental lines as it is not uncommon for seed varieties to become known to competitors by either accidental mixing of parental line seeds in DUS testing bag or through relocation of breeders from one company to another.[11]

Further exploration of the crop-wise certificates issued in different types of varieties reveals that the rights over typical crop varieties were mostly concentrated in cereal crops-rice, wheat, maize, and sorghum (Fig. 4). Conversely, rights in the hybrids and parental lines were obtained in commercial crops including brinjal, cotton, maize, tomato, rice, sorghum and pearl millet. Lastly, rights of the transgenic varieties were obtained in cotton (tetraploid), which covered 34% of the total varietal rights of the crop.

Interestingly, the varietal protection secured in the parental lines of cotton, tomato, and brinjal was much higher than the protection obtained in hybrids of these crops, indicating the fierce competition in development and easy replication of varieties in these three crops. Further, economic incentive of gaining better market share also compels seed companies to protect their parental line in the first place to secure

proprietary rights over their germplasm and rule out or limit the competition.

The pattern of varietal rights in pulses indicates dominance of PVRs in typical crop varieties but a dearth of rights in hybrids or parent lines in this group. Similar is the case of wheat, where most of the varietal rights were granted in the typical crop varieties coming particularly from the public sector, and hybrids are largely missing which due to a lack of interest from the private companies in hybrid development and thereby their subsequent protection in case of less remunerative crop species. Private sector participation in securing varietal protection is 1/10th of the public sector in the case of pulses (Table 2).

Certification Delays

The certification lag, defined as the time passed between filing the application for plant variety protection and its final issuance of PVR certificate, has significant implications for the economic viability and the subsequent survival of a varietal right. Longer lags in the grant of protective rights lead to the delayed entry of the variety in the market, making it less relevant, especially when the market is already taken over by other advanced varieties, which ultimately leads to poor survival of its protective right as it no longer remains profitable to invest in its renewal.[13] As indicated by Fig. 5 (a), the certification lag has notably increased from 1.6 years in 2009 to 7.5 years in 2023, indicating a growing delay in the certification process. This may be due to increasing application load, incomplete and poorly filled applications coupled with delayed response from the applicants, inadequate manpower mainly due to lack of creation of technical positions, and complexities in the executing DUS procedure (including field testing, analysis, and maintenance of varieties as well as their records) in various crop species.[14]

The crop-wise pattern reveals that the highest lags in the certification of varietal rights were in vegetable crops viz., brinjal (7.21 years), tomato (6.64 years), okra (5.15 years), and also in cotton (6.61 years) and pigeon pea (5.96 years). In contrast, the shortest lag in the issuance of varietal rights was observed in sugarcane (1.98 years). Wheat, groundnut, and soybean also reflected shorter lag as compared to other crops in their respective crop groups (Fig.5 (b)). Further, Table 4 indicates that typical varieties took considerably less time to get their registration approval (3.7 years) as compared to hybrids (4.6 years), parental lines (7.1 years), and transgenic crops (7.7 years). However, looking into the varietal registration of public and private sectors, a converse pattern was observed with public sector varieties, which secured faster certification of PVR in parental lines (2 years), followed by hybrids (2.6 years) and typical varieties (2.7 years). Private companies received faster

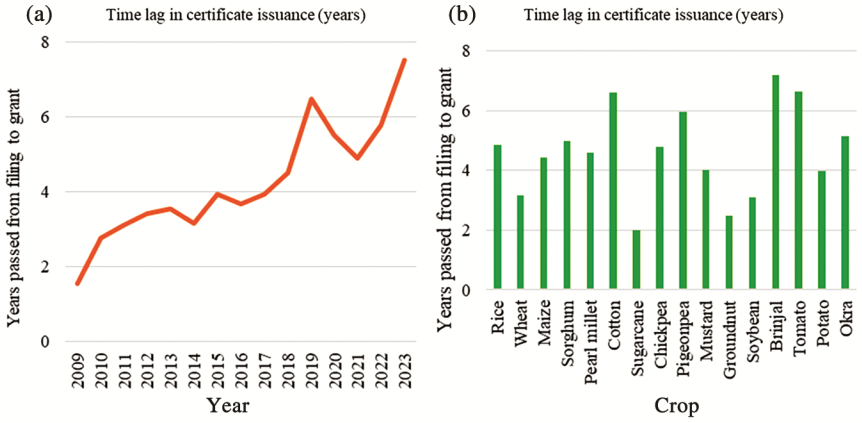

Fig. 5 — Certification lag in varietal registration under PPVFRA (2009-23)

Table 4 — Certification lag in major crop classifications

Crop classification	Certification lag (in years)		
	Public sector	Private sector	Overall
Typical	2.7	6.1	3.7
Parent line	2.0	7.6	7.1
Hybrids	2.6	5.7	4.6
Transgenic	-	7.7	7.7
Overall	2.6	6.5	4.6

certification for their applications in hybrids (5.7 years) and typical varieties (6.1 years) as compared to parental lines (7.6 years) and transgenic varieties (7.7 years).

While transgenic crops tend to have a longer lag in PVR certificate grant due to required approval from regulatory bodies including Institutional Biosafety Committee (IBSC), the Review Committee on Genetic Manipulation (RCGM), and Genetic Engineering Approval Committee (GEAC), the parental lines suffer from delay in grant which is attributed to the complex and extensive requirements involved in their registration process. Moreover, Indian plant protection system does not recognize the parental line as a new variety but as an extant variety. Overall, public sector applications face less delay (2.6 years) in granting their varietal rights certificate as compared to private sector applicants (6.5 years).

In India, there exists a vast network of public institutions comprising ICAR and SAUs that play a predominant role in the development and release of plant varieties in the country. The varieties from the public sector get released only after showing satisfactory performance in multi-location all-India coordinated varietal trials and have longer establishment periods before DUS trials, making them better equipped for the rigorous requirements of DUS examination. Conversely, private companies are mainly profit-driven and often prioritize faster variety development due to economic pressures.[13] Furthermore, public institutions generally face fewer intellectual property (IP) disputes and legal challenges compared to private entities, reducing delays caused by the resolution of these issues. The well-established system of field trial sites in public research organizations across different agro-climatic zones also enables faster and more consistent DUS testing.

Trends in Sectoral Participation

The private sector brings innovation, investment, and market-driven research to crop variety development, while the public sector focuses on accessibility, equity, and conservation of genetic resources, fostering diversity and food security. Both sectors are of great importance in plant variety development and protection. Major private and public sector stakeholders engaged in securing varietal rights over their developed varieties were explored in terms of their major crop focus, diversity of rights in their varietal portfolio, and existing lag in securing these rights.

Among the private sector entities, the maximum PVR certificates were obtained by *Nuziveedu Seeds Ltd*. (384), having a 25% share in the total varietal rights provided to the private sector, followed by Kaveri Seeds (184), Mahyco (108), and Pioneer (106) (Table 5). These four companies accounted for more than half of the plant variety rights given in the private sector, indicating a highly concentrated market power of these companies in the Indian seed industry. The major R&D focus of top private companies was in tetraploid cotton, rice, maize, pearl millet, sunflower, and vegetables (brinjal, tomato & cauliflower) as reflected by their PVR portfolios. Though the top three companies showed a relatively diversified portfolio of PVRs, some major companies like Pioneer Overseas Corporation, Sungro Seeds, and Prabhat Agri Biotech reflected the concentration of their varietal rights in maize, brinjal, and tetraploid cotton, respectively. The length of time between application filing and certificate grant for these major companies ranged between 5.09 years (in Bayers) to 8.48 years (in Mahyco).

In the public sector, the Indian Council of Agricultural Research (ICAR) held a dominant share of plant variety rights, accounting for 68% of total public sector protected varieties (Table 6). A total of 1145 certificates were granted to ICAR with a major focus on maize (157), wheat (153), and rice (145) crops (Table 6). Interestingly, all the major public sector institutes showed shorter Certification lag as compared to the

Table 5 — Top 10 private companies in PVR certificates issued (2009-2023)

Private Companies	Certificate issued	Major crop	HHI	Certification lag
Nuziveedu Seeds Ltd.	384	Tetraploid Cotton (115), Rice (84), Brinjal (40)	0.18	7.25
Kaveri Seed Company Ltd.	184	Maize (35), Tetraploid Cotton (32), Sunflower (31)	0.15	5.83
Mahyco Ltd.	108	Tetraploid Cotton (34), Brinjal (25), Tomato (14)	0.19	8.48
Pioneer Overseas Corporation	106	Maize (65), Rice (20), Pearl Millet (18)	0.50	5.28
Bayer Private Ltd.	98	Rice (31), Pearl Millet (24), Maize (25)	0.24	5.09
JK Agri Genetics Ltd.	72	Tetraploid Cotton (31), Pearl Millet (12), Maize (9)	0.24	7.21
Sungro Seeds Private Ltd.	52	Brinjal (32), Tetraploid Cotton (9), Cauliflower (9)	0.44	8.12
Nirmal Seeds Private Ltd.	50	Rice (11), Tetraploid Cotton (5), Pigeon Pea (5)	0.10	5.39
Syngenta India Ltd.	46	Tomato (12), Rice (10), Maize (9)	0.19	5.64
Prabhat Agri Biotech Ltd.	46	Tetraploid Cotton (45), Rice (1)	0.96	7.47

Table 6 — Top public sector grantees of PVR certificates (2009-2023)

Public Institutes	Certificate issued	Major certified crops	HHI	Certification lag
Indian Council of Agricultural Research	1145	Maize (157), Wheat (153), Rice (145)	0.08	2.80
Tamil Nadu Agricultural University	73	Rice (27), Tetraploid Cotton (13), Sorghum (9)	0.20	1.62
University of Agricultural Sciences	64	Rice (11), Wheat (8), Tetraploid Cotton (6)	0.08	1.47
Mahatma Phule Krishi Vidyapeeth	61	Sorghum (12), Tetraploid Cotton (7), Groundnut (7)	0.09	2.40
Dr. Panjabrao Deshmukh Krishi Vidyapeeth	44	Sorghum (6), Rice (5), Wheat (5)	0.08	3.19
Punjab Agricultural University	36	Wheat (5), Black Gram (4), Tetraploid Cotton (3), Indian Mustard (3)	0.07	2.53
Navsari Agricultural University	30	Rice (8), Sugarcane (5), Diploid Cotton (4)	0.15	2.03
Orissa University of Agriculture & Technology	23	Rice (15), Sesame (3), Black Gram (2), Rapeseed (2)	0.46	2.37
Acharya N.G. Ranga Agricultural University	19	Rice (10), Sorghum (3), Tetraploid cotton (3)	0.34	3.40
CCS Haryana Agricultural University	18	Tetraploid Cotton (8), Wheat (6), Diploid Cotton (4)	0.29	1.61

major private sector companies in obtaining varietal rights. The length of lag ranged from as small as 1.47 years in Tamil Nadu Agricultural University to 3.4 years in Acharya N.G. Ranga Agricultural University. Besides, the portfolio diversity was also found to be comparatively high in the top public sector grantees.

Farmers' Participation in Varietal Protection in India and Existing Challenges

Indian plant variety protection system provides a unique opportunity for farmers to have the right to their variety and helps them in seeking opportunities for access and benefit sharing. Farmers hold the maximum share in seeking (64%) as well as securing (49%) varietal protection in India. However, the turnover rate, i.e., actual registrations out of the total number of applications filed, is lowest (32%) in farmers' varieties in comparison to the turnover rate of public (82%) and private sector varieties (41%). The low success rate of farmers' applications for variety protection is likely due to inadequate variety verification and poor record-keeping by the farmers, in addition to technical issues such as incomplete application forms.

As indicated in Fig. 6, a majority of the farmers' rights were concentrated in rice, which accounted for close to 90% of the total certified varieties of farmers. Moreover, pigeon pea (3.3%), millets (3.0%), mango (2.8%), wheat (2.7%), and rapeseed & mustard (1.8%) also had a sizable share in total varietal rights obtained by farmers. In spices, the majority of the farmers' rights were given in coriander, black pepper,

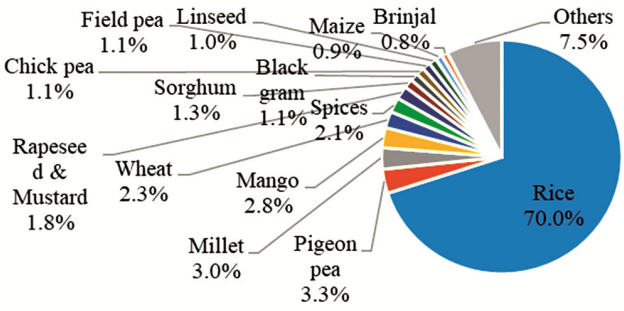

Fig. 6 — Farmers' rights secured in major crops/crop groups (%)

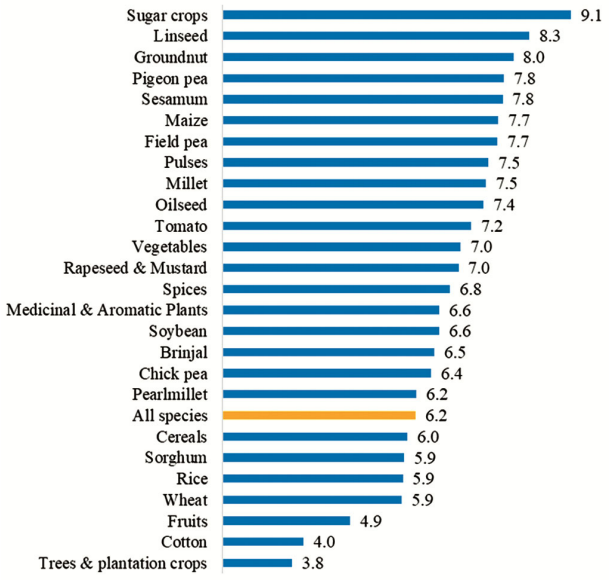

Fig. 7 — Certification lag faced by farmers' varieties in varietal registration

and turmeric, while in millets maximum number of rights were obtained in little millets (42%), followed by kodo millet (35%), and finger millet (14%) by farmers. In vegetables, maximum farmers' rights were secured in brinjal, tomato, okra, and chilli by the farmers.

The certificate lag in obtaining PVR by farmers was in the range of 3.8 to 9.1 years, averaging around 6.2 years. While only a small number of crop species had smaller lags in varietal certification process than the average delay faced by farmers' varieties namely, tree & plantation, cotton, fruits, rice, wheat, sorghum, cereals, majority of species/crop groups faced longer grants, especially, sugar crops, groundnut and linseed with a lag of more than 8 years between filing and actual registration.

Though farmers' participation was widely promoted and encouraged by the authority, there are many challenges that affect the filing process of farmers' varieties and thereby affect their conversion rate into final acceptance of rights. Key issues include inconsistent terminology regarding farming communities,[15] the absence of clear definitions for "group" and "community of farmers" in the Act, lack of technical expertise to validate conservation claims, and challenges in certifying such claims by specific groups or individuals[16].

Conclusion

The study examined the progress of the plant variety registration system in India, with a focus on the participation of the public and private sectors in securing rights across specific crops, type of variety protected, diversity in PVR portfolios, and the delay faced in the issuance of PVR certificates. Results revealed that there has been significant progress in the varietal registrations under the PPV&FR authority, as the number of certificates issued grew significantly from 170 in 2009 to 1,719 by 2024. A significant rise in applications from farmers and farming communities was observed within four years of implementation, due to extensive awareness campaigns by the authority. As a result, farmers' varieties accounted for the largest share of total registrations (54.6%). Additionally, extant and new varieties also showed decent growth, contributing 30.4% and 14.8% to total registrations, respectively. Among crop groups, cereals dominated with 65% of total registrations, followed by fibres and vegetables. Rice, in particular, accounted for the highest varietal registrations, with almost half of the total registrations, predominantly from farmers' varieties. Private companies mainly focused on commercial crops, while public institutions obtained a broader spectrum of varietal rights in crops. Furthermore, private players showed more keenness in securing the rights over the parental lines used for hybrid development, which consequently faced longer delays in their registration process compared with the hybrids.

Overall, increasing registrations, particularly in farmer varieties and cereals, highlight the inclusivity of the varietal protection system in India and its relevance to both breeders and farmers. However, the growing lag in granting certificates, especially for farmers and private companies, poses a significant challenge to the efficiency of the system. Addressing these delays while fostering balanced participation across public and private sectors, as well as farmers, is essential for ensuring the varietal protection system to stimulate innovation, conserve genetic diversity, and support sustainable agricultural growth in India. Streamlining procedural requirements could significantly reduce registration lags and ensure timely protection of innovations. Implementing a more differentiated approach to variety testing based on crop type and applicant, especially for farmers' varieties, may also expedite the process. Additionally, strengthening collaboration between public institutions, private companies, and farming communities is crucial for promoting innovation across a broader range of crops, particularly underrepresented varieties like transgenic and hybrid crops. Furthermore, policy reforms that incentivize private sector participation in a wider portfolio of crops, economic incentives in the form of subsidy or shared seed distribution costs in case of less economic crops such as pulses and cereals alongside continued support for farmer-led conservation efforts, will ensure a balanced and robust varietal protection system that fosters both innovation and agro-biodiversity conservation.

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