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The Indian PPV&FR Act, 2001: Historical and Implementation Perspectives*

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This paper examines the objectives of the PPV&FR Act in the light of history and current state of Indian agriculture, drawing comparisons with approaches adopted by developed countries and/or the international community in the early days of plant variety protection where relevant. The analysis has been done with a view to determining the problems faced by Indian agriculture that the government seeks to resolve with the help of the PPV&FR Act. It provides a statistical analysis of plant variety application trends under the PPV&FR Act to determine whether the Act is 'effective' in the light of the objectives that it seeks to accomplish as per its statement of objects and reasons. Need and suggestions to make the Indian law more effective from a national interest perspective and also strengthening India's stand before the international community where Article 27.3(b) of the TRIPS Agreement continues to be under review are highlighted.

Keywords: PPV&FR Act, *sui generis* system, TRIPS Agreement

Despite India's adoption of a *sui generis* system for the protection of plant varieties ten years ago, academic and sponsored reviews of the functioning of the Indian Protection of Plant Varieties and Farmers' Rights Act, 2001 (PPV&FR Act) are scant.[1] Although a few analytical reviews are notable, a comprehensive statistical review of the Indian plant variety registration regime has so far not been undertaken.[2] A review of this nature is particularly relevant to determine the 'effectiveness' of the decade long regime, both from an international perspective (TRIPS compliance) and national interest.[3] This article, (i) traces the evolution of Indian agriculture since Indian independence in 1947, till the enactment of the PPV&FR Act, highlighting the specific objectives that the Act sought to accomplish; (ii) studies the filing trends under the PPV&FR Act with a view to determining whether the Act will likely achieve its stated objectives under the current framework of law; and (iii) studies the 'effectiveness' of the Indian regime from a national interest perspective. The study focuses on the seed sector for important staple or cereal crops for which registration information has already been published under the PPV&FR Act.[4]

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The PPV&FR Act: Background and Objectives from an International and Historical Perspective

The Indian Patents Act, 1970 (as amended in 1999, 2002 and 2005) excludes 'plants and animals in whole or any part thereof other than microorganisms but including seeds, varieties and species and essentially biological processes for production or propagation of plants and animals' from patentability.[5] Given the express exclusion of plant varieties from the scope of patentable subject matter, India was obliged to protect these under a *sui generis* system as per the mandates of Article 27.3(b) of TRIPS. In furtherance of its obligations under Article 27.3(b), India enacted the PPV&FR Act (or 'the Act') in 2001 (ref. 6).

However, environmental and public interest concerns (including the fear of monopolies in the field of life sustaining essential food) ensured that the Indian law did not just blindly copy the model laws under the International Convention for the Protection of New Varieties of Plants (UPOV 1978 and UPOV 1991). In fact, similar concerns also affected the enactment of plant variety protection laws in developed countries such as the United States. A look at the history of the US Plant Patents Act, 1930 reveals the caution with which legislators in the US adopted the system of proprietary rights in relation to sexually propagated crops and tuber-propagated crops. The Plant Patents Act, 1930 was limited to asexually reproduced varieties and excluded tuber

propagated plants such as potatoes, and in 1970 the US introduced the Plant Variety Protection Act (Act 7 USC §§ 2321-2582) to provide protection to sexually reproduced plants.[7]

Although the discussion commenced more than a decade ago in early 1990s,[8] about the introduction of the plant variety and farmers' rights protection regime in India, this gained momentum after India's ratification of the TRIPS Agreement, and culminated in the enactment of the PPV&FR Act only in 2001. The law enacted in India was a sincere attempt to balance several, often seemingly contradictory, interests. The objectives the Act purports to accomplish are stated in its preamble: (i) To recognize and protect the rights of farmers in respect of their contribution towards conserving, improving and making available plant genetic resources for the development of new plant varieties; (ii) To protect plant breeders rights to accelerate agricultural development in the country; (iii) To stimulate (incentivize) both the public and private sector to invest in R&D for the development of new plant varieties (especially those suited to Indian climatic and other conditions); (iv) Facilitate growth of the seed industry in India to ensure availability of high quality seed and planting material to farmers; (v) To give effect to sub-paragraph (b) of Article 27(3) of the TRIPS Agreement. In the light of history and existing state of Indian agriculture, the stated objectives of the Act are seen under two broad heads: (i) Protecting farmers' rights and conserving landraces and (ii) Protecting plant breeders' rights to promote private sector participation and development. This research reveals areas of contradiction between these two objectives of the Act.

Protecting Farmers' Rights and Conserving Landraces

Traditionally, farmers across the globe have preserved plant genetic diversity while also enriching this diversity by human selection. As a result, there exist numerous landraces, conserved *in situ*, that show high adaptability to local conditions and other desirable characteristics such as drought resistance, pest resistance and medicinal properties.[9] Recognizing the importance of preserving genetic diversity, particularly in the light of the erosion of this diversity resulting from scientific methods of commercial breeding and from the requirement of uniformity, stability and distinctness under the plant breeders rights regime introduced by UPOV, discussions had commenced at the international level under the aegis of the United Nations with the establishment of the International Commission on Plant Genetic Resources in 1983 (ref.10).

In response to international developments[11], India also commenced its efforts to establish a farmers' rights regime to recognize and protect the 'rights arising from the past, present and future contributions of farmers in conserving, improving and making available plant genetic resources' in the early 1990s. However, having reviewed the existing systems of intellectual property protection in relation to plant varieties (namely, patent protection and the plant breeder's rights system under UPOV 1978 and 1991), a different form of protection was felt needed in India in addition to or instead of the existing international models. The reasons being that agriculture provides employment and the key means of livelihood to 65 per cent of India's population.[12] It also constitutes 24.5 per cent of the country's gross domestic product (GDP).[13] Most significantly, more than 67 per cent of the total farming population in India constitutes small and marginal farmers.[12] It was in this background that the farmers' rights regime (in addition to and distinct from the farmers' privileges under the UPOV system) was introduced under the Indian PPV&FR Act.

The newly adopted farmers' rights regime of India also included the element of 'farmers' privilege' based on the UPOV, 1978 model (rather than UPOV, 1991) giving a very broad leeway to farmers to save, exchange and re-sow seeds saved from the harvest of a season, in the next season. Permitting farmers to save and re-sow seeds, rather than mandating the re-purchase of seeds from the market in each season is very important in the Indian context, since a very large percentage of farmers are small, marginal or subsistence farmers who cannot afford to buy proprietary seeds from the market each season. The public and the private seed sector together do not provide the total seeds needed by the Indian farmers, and the seeds saved from the previous harvests are also re-used by them. In the course of saving seeds, farmers have also traditionally engaged in selective re-sowing of seeds derived from that part of the harvest that has desirable traits such as pest resistance, large size, etc. Such traditional practices have also resulted in preservation of unique varieties of commonly consumed cereals, including the award winning medicinal rice, Navara, from Kerala.[14] On the other hand, the practice of saving and re-sowing seeds is a reason why the 'seed-gap' in India continues to be rather high.

Protecting Plant Breeders' Rights to Promote Private Sector Participation and Development

The Evolution of Indian Agriculture and the Need for Further Development

India today, is self sufficient in most of its food requirements but suffered from major famines and severe shortage of food in the past, until the mid 1960s.[15] The Green Revolution, (coupled, to a smaller extent with increase in the cropped and irrigated areas) was responsible for bringing India to the current state of self-sufficiency in agriculture.[16] At the time the PPV&FR Act was passed, Indian agricultural produce was sufficient to feed the entire population of India, and also contributed 15 to 20 per cent of the total value of India's exports.[16] India is an active participant and contributor to international agricultural R&D efforts, including the efforts made towards the international wheat, maize and rice research.[17]

However, the growth of Indian agriculture has not been uniform.[18] One of the key reasons for this disparate growth is the sub-optimal average size of almost 80 per cent of India's land holdings, 4000 sq metres (for marginal holdings) and 14,200 sq metres (for small holdings).[19] The size of land holdings is significant because optimal land size is necessary to maximize productivity. The Indian states where the average size of land holdings is larger, witness greater yield per hectare than states with smaller average size of land holdings.[20] However, India's agricultural self sufficiency may be explained partly by the fact that more than 60 per cent of the agricultural land area is included in the rest 20 per cent land holdings, which constitute the large and the medium-sized holdings.[21] India's agricultural production increased by more than 350 per cent, from 50.82 million tonnes in 1950-51 to 230.67 million tonnes in 2007-08 (ref. 22). The corresponding increase in the land area under cultivation was mere 27.87 per cent but increase in yield per hectare of land was 255 per cent; from 522kg/hectare in 1950-51, to 1854 kg/hectare in 2007-08 (ref. 23) Thus, the increase in production is largely attributed to improved production technologies, particularly high yielding seeds introduced under the Green Revolution.

The high yielding seeds and the underlying technology of the Green Revolution was transferred to India without any underlying intellectual property protection although the contribution of Indian scientists in plant breeding activities at CIMMYT, Mexico and IRRI, Philippines was also significant. The Green Revolution in India is attributed to the transfer of large quantities of high yielding varieties (HYV) of wheat from Mexico under the initiative of Norman E Borlaug[24] and of rice from Philippines. With the import of these seeds, appropriate technology and know-how, including the best manner of cultivating, the quantity of pesticides and fertilizers to be used etc., were also innovated and recommended by the Indian National Agricultural Research System (NARS). The HYV seeds of the Green Revolution period were re-sown and re-used by Indian farmers as per the existing practice. As a result, the Green Revolution spread very rapidly in most states.[25] In fact, in the absence of the traditional practice of saving and exchanging seeds, the Green Revolution may not have spread as rapidly as it did in India.[25, 26]

The question is therefore, why despite the encouraging increase in food productivity through improved new high yielding seeds created without underlying IP protection, did India consider it necessary to introduce a plant variety protection regime to promote agricultural development. The objectives underlying of the introduction of the PPV&FR Act can be partly understood from the mandates of the TRIPS agreement, which India was obliged to meet, and partly from India's New Agricultural Policy, 2000 (NAP).[27] The NAP aims, primarily, to increase physical and economic access to food by the masses, increasing food security and nutrition. The NAP seeks to achieve this goal by increasing yield/produce on the one hand and developing new varieties with higher nutritional value on the other. The NAP further aims at providing adequate incentives for farmers to continue to pursue agriculture by 'discouraging migration to urban areas', 'securing a fair standard of living for the farmers and agricultural workers and their families,' increasing and ensuring rural credit, etc.[28]

In addition to these basic objectives, the NAP highlights India's commitment to (i) ensuring agricultural growth that is technologically, environmentally and economically sustainable, (ii) conserving bio-resources including seeds, and (iii) giving greater importance (thrust) to development of (*inter alia*) rainfed and irrigated horticulture (an area that has thus far been largely neglected[29]), floriculture, roots and tubers, plantation crops and aromatic and medicinal plants. In order to achieve

each of these objectives, the policy recognizes the need to encourage both public funded R&D, and also proprietary research in the field of agriculture, giving special emphasis to 'frontier sciences' like biotechnology. This is where India's agricultural policy links up with the Indian PPV&FR Act, which was enacted with the express aim of incentivizing private and public sector investment for the development of new plant varieties.

There are several other key reasons why India needs to ensure further agricultural development and why proprietary rights in the form of PVP laws are considered necessary for this, including: (a) The population of the country continues to grow rapidly, (b) The cultivable land area is shrinking (not only are the land resources of country finite, overuse of chemical fertilizers and pesticides is converting erstwhile agricultural land into infertile drylands), (c) India continues to suffer a significant seed-gap in most of the important/staple food crops, (d) The resources that the public sector can spare for agricultural R&D are limited – funding from the private sector is necessary for continuing robust R&D activity in the agricultural sector and the private sector needs incentives including those in the form of intellectual property rights to invest in agricultural R&D and (e) In the broad area of agricultural research, the 'international cooperation' model is being replaced by 'private proprietary' models, as biotechnology plays an increasingly important role in the development of new plant varieties.

From the above, it is clear that India needs to encourage private participation for the development of Indian agriculture by (i) promoting the development of the private sector seed industry and (ii) encouraging private participation in agricultural R&D.

The Private Sector in Indian Agriculture: A Brief History and Current Trends

The Indian Seed Industry and its Growth

Despite the absence of formal intellectual property protection, India witnessed robust growth of its private sector seed industry from the 1980s when it changed its policies, not only permitting, but also luring the entry of the private sector through various incentive mechanisms, particularly by opening up the seed sector for private competition.[30] Therefore, although the Indian seed industry is relatively young (less than 50 years old in total, and only about 20 years old from the perspective of most private corporations), it is economically successful and technologically quite sound. This technological base is not only the result of purely private efforts; a significant amount of technological support has been given to the Indian private sector seed industry by public sector research institutions.[31] Indeed, while technology transfer from the public to the private sector has lagged in most sectors in India, agriculture is perhaps one sector where considerable amount of technology transfer has taken place, once again, without any underlying intellectual property protection.[32]

As of 2003, India had over 150 private seed companies (national and multinational) along with 13 State Seed Corporations.[30] In recent years, the share of MNCs in the Indian seed market has been increasing steadily. There have also been several mergers or acquisitions of local seed companies by MNCs. Recently for example, Dupont, (one of the world's top five seed companies) acquired Nandi Seeds and the cotton germplasm business of Nagarjuna Seeds.[33] The Rs 40-crore acquisition took place through DuPont India's subsidiary, Pioneer Seeds. One would expect the lack of adequate or optimum intellectual property protection to contraindicate the increasing interest of the MNCs in the Indian market. This however, does not appear to be the case.

In fact, despite the absence of any intellectual property protection until 2007, high quality seeds giving very high yield (often the highest recorded yield in the world) have been available in the Indian market for several years. However, discussions with personnel in Monsanto India revealed that most seed MNCs in India do not conduct their own research in in-house research laboratories, but merely adopt the innovation happening in their parent or sister corporations abroad. As a significant amount of agricultural R&D in MNCs involves advanced biotechnology, the results of which are protected by patents in most developed countries, large corporations are increasingly demanding similar protection for the results of their R&D in India as well.

While it is clear therefore, that Indian agriculture was flourishing without intellectual property protection for several decades, the PPV&FR Act and similar legislation throughout the world was and is being introduced on the basis of the international understanding that the private sector will probably not be enthused to meet the growing demands and increasing challenges of modern agriculture, without a suitable incentive mechanism.

Furthermore, legislations aimed at providing incentive mechanisms to the private sector must also encourage diverse R&D efforts, particularly in relation to crops and varieties that are most important for India's food security and nutritional needs. The current research interests of the public and the private sector, and the necessary incentive that the PPV&FR Act is providing to the private sector to broaden their spectrum of R&D activity, may be seen with the help of filing trends under the PPV&FR Act.

R&D in the Seed Industry of India: Public* v *Private Trends

The Indian agricultural research sector, consisting of the Indian Council of Agricultural Research (ICAR), its network of institutes and a network of State Agricultural Universities (SAUs), conducts more than 75 per cent of the agricultural research in India. The ICAR conducts about 43 per cent of the research, the SAUs about 33 per cent, the private sector about 16 per cent, and international centres about 8 per cent.[31] In addition to directly transferring know how generated from its research to farmers, the public research sector in India has also been the key source of inbred lines for the private sector seed industry.[34] In fact, experts opine that the success of private sector research in the agricultural sector is a direct result of the strong research base in the public sector.[35] However, in order to support and encourage agriculture, the government provides both agricultural input subsidies as well as agricultural output price support to its farmers. As a result of this subsidy driven farming (that incurs an expenditure amounting to 2.13 per cent of India's total GDP and 8.8 per cent of its agricultural GDP), the amount of government funds available for agricultural R&D is limited, thereby increasing the need to incentivize private participation in agricultural R&D.[36]

Although, private sector investment in agricultural R&D quadrupled between 1986 and 1998, 30 per cent of all private sector R&D expenses were incurred by subsidiaries and joint ventures of multinational corporations.[30] Furthermore, as stated above, most of the private sector's research efforts are aimed at adapting the research already done in their parent corporations abroad to fit Indian conditions. More importantly from the Indian context and in the light of the objectives of the PPV&FR Act, it is relevant to note that most of the private sector's research efforts are focused on 'crops for which hybrids are important'.[37]

The reasons for the private sector's research focus on hybrids are perhaps obvious. Firstly, hybrids provide inherent trade secret type protection against competitors because their parental lines are not required to be disclosed and are difficult to identify by any process similar to reverse engineering in pharmaceuticals.[38] Furthermore, hybrids also provide inherent protection against widespread seed saving and re-sowing by farmers because of their biological incapacity to reproduce true to type. Under the umbrella of this natural/biological protection, the contribution of the private sector, particularly in relation to sexually propagated cereal crops (and also some cash crops) has been significant and has been growing rapidly. According to estimates for example, 'the share of research hybrids on total turnover of crops like pearl millet, sorghum-sudan grass, sunflower, maize, sorghum and cotton was about 70 per cent in 1997-98 compared to 46 per cent in 1990-91.'[30]

The government, therefore, needs to take specific steps if it wants to encourage the private seed sector to diversify its research and commercialization interests towards crops for which hybridization technology is not currently available. This need is starker when one looks at the large seed gaps and low yield in relation to several important crop groups in India. Under the present PPV&FR Act, however, it has been predicted that in the private sector, the practice of producing low volume and hybrid seeds (that have a necessary 100 per cent seed replacement rate) will probably continue.[39] A look at the trends in plant variety application filings appears to largely confirm this prediction.

Closely connected to the issue of private participation in agricultural R&D and seed production, are the issues of 'seed gap,' and the related issue of seed replacement. The government's objective of reducing the seed gap and promoting seed replacement appears to directly contradict several policy decisions of the government under the PPV&FR Act.

Agricultural Productivity, Seed Gap, Seed Replacement and Private Sector Participation

According to India's National Seed Plan (NSP), there is a significant gap between seed production and seed requirement (the 'seed gap') for most of India's important cereal crops, pulses, oilseeds and fibre. Perhaps, the most surprising is the seed gap for wheat. Although, wheat has the lowest seed gap (of 1.76 lakh quintals) among the important cereal

crops, namely, rice, wheat and maize; the gap is surprising and perhaps alarming given the self-pollinating nature of the crop with low seed replacement rate.[40] In order to fill this seed gap, active participation of the private sector is necessary.

The seed gap problem is closely connected to the government's 'seed replacement' policy. Given the nature of hybrid seeds, in order to ensure continued high yield (or continued presence of other desirable traits such as pest resistance), it is necessary to buy new seeds every season. In other words, the hybrid seeds must be replaced (instead of re-using the seeds derived from the previous season's harvest). The requisite seed replacement rate for hybrid seeds is 100 per cent (i.e. new seeds must be bought each season in order to ensure consistent produce in terms of quality and quantity). However, seed replacement is also necessary for open and self-pollinated crops such as wheat and rice at the rate of 33 per cent and 25 per cent respectively.[41] Yet, as per the statistics of the Department of Agriculture and Cooperation, the national average seed replacement rate had only reached 15 per cent in 2005. This low seed replacement rate is a major disincentive for private participation in R&D related to open and self-pollinated crops. However, it has been predicted that even with a small increase in seed replacement rate, the private sector would be enthused to invest in R&D in open and perhaps, self-pollinated crops.[39, 42]

Furthermore, according to the NSP, the sub-optimal seed replacement rates in India also contribute significantly to low crop yield. From the available statistics, differences in seed replacement practices might, at least partially, explain the significant differences in the yield per hectare in different regions in India. For example, the available statistics in relation to maize (corn) show that the seed gap for maize is 4.10 lakh quintals.[43] There are also stark differences in regional productivity of maize. For instance, the state of Rajasthan records the lowest average yield of maize in India (0.885 tonne/hectare) while the state of Andhra Pradesh not only records the highest average yield/hectare for maize in India (2.825 tonne/hectare), but certain farmlands within Andhra Pradesh record the world's highest yield per hectare for maize (10 tonne/hectare).[43] This difference may be explained by the seed replacement rate for maize in Andhra Pradesh (AP). Among all Indian states, AP had the highest seed replacement rate of 84 per cent and 87 per cent, respectively in the years 2005 and 2006. The corresponding seed replacement rate in Rajasthan was a mere 17.8 per cent and 19.8 per cent in 2005 and 2006, respectively. It is relevant to note here that maize seeds are mostly hybrid seeds, a significant per cent of which is sold by the private sector in the Indian market.[44]

The impact of low seed replacement is however, understandably, not so stark in relation to wheat, which is a self pollinated crop requiring only a 25 per cent seed replacement. According to statistics provided in the NSP, the lowest yield in wheat is witnessed by the state of Karnataka at 0.648 tonne/hectare and the highest yield is in the state of Punjab at 4.2 tonne/hectare (averages of all agricultural lands in these states).[43] In Karnataka, the seed replacement rate for wheat in the years 2004, 2005 and 2006 were 20, 29 and 26 per cent, respectively. In Punjab, on the other hand, the higher yield is despite the significantly lower seed replacement rate of 10, 11 and 13 per cent in the years 2004, 2005 and 2006 respectively.

While low seed replacement rates may not be the problem with respect to self-pollinated crops, the fact that India needs to boost its R&D efforts in relation to self and open pollinated crops is clear from the fact that while Karnataka has a lot of work to do to meet Punjab's yields, Punjab itself has a lot to learn from the Netherlands which notes the highest yield in wheat in the whole world, at 10 tonne/hectare.[43] This clearly indicates the higher quality of wheat seeds in the Netherlands as compared to the seeds available in India, suggesting the need to improve R&D efforts in wheat.

Therefore, even if one were to consider seed replacement as largely insignificant for self and open-pollinated crops, it is clearly of very high significance (i) in relation to hybrid seeds, and (ii) in order to encourage the private sector to invest in R&D for crops other than hybrids. It is therefore not surprising that the government actively promotes optimal seed replacement. What is surprising, however, is that alongside encouraging seed replacement, the government's policy under the PPV&FR Act is to permit farm saving and re-sowing of all types of seeds. The contradiction in the government's policy to promote seed replacement on the one hand, and allow seed saving and re-sowing on the other, is particularly stark in relation to hybrid seeds that require 100 per cent seed replacement.

Whether, despite the broad permission granted to farmers to save and re-sow seeds in the form of the 'farmers' privilege', the PPV&FR Act is providing

incentives to the private sector to increase and diversify its R&D efforts has been further studied with the help of plant variety protection data.

Application Trends under the PPV&FR Act

The analysis of plant variety application trends during the period 2007-2010 aims at determining the 'effectiveness' of the PPV&FR Act from a national perspective in the light of the preceding discussion. The data analysed herein has been compiled from the Plant Variety (PV) Journal of India, which is the official gazette for the activities of the Protection of Plant Varieties and Farmers' Rights Authority (PVA or the Authority). It is first necessary to understand the key terms used in the PV Journal to appreciate the data analysis that follows.[45]

Understanding Key Terms for Data Analysis

The PVA was established in 2005 as per the requirements of Section 3 of the PPV&FR Act.[46] It launched the plant variety registration process in May 2007 (ref. 47). So far, while DUS centres have been identified for almost 50 crop species, only about 17 species are ready for registration.[48] The Authority periodically publishes the accepted applications for the registration of new varieties, extant varieties and farmers' varieties of these species in the PV Journal. However, until December 2010, the passport data for only about 1/3rd of the total applications made in the period 2007 to November 2010 had been published in the PV Journals.

In all applications for the protection of plant varieties, it is necessary, *inter alia*, to provide (i) the name of the species within which the variety falls; and (ii) a classification of the variety (for example as being 'hybrid', 'typical', 'parental line' or 'transgenic hybrid').

Analysis of Plant Variety Application Trends

Annual Application Trends and Public v *Private Sector Trends*

As on 22 November 2010, the PVA had received 673 applications for new varieties, 1180 applications for extant varieties and 55 applications for farmers' varieties. Table 1 shows the annual filing trends divided for three major categories under which applications are accepted, namely, 'new', 'extant' and 'farmers' varieties.

While the number of extant variety applications has, as expected, been decreasing since 2008,[49] the annual number of applications for new varieties has been increasing steadily. This is a promising trend and shows both a growing awareness about the existence of the Act and a confidence or at least a positive expectation that the law will likely be useful in proving and enforcing one's exclusive rights.

As of November 2010, the passport data of 473 extant variety applications, 172 new variety applications and 3 farmers variety application had been published in the PV Journal of India to invite objections, if any, from interested parties.[50] The analysis hereunder is based on this published passport data (information regarding who has filed the application and what is the classification of the variety, is available only through the published passport data). For the purposes of the analysis in this section, all public sector R&D and educational institutions have been categorized as 'public sector' and all corporations, whether domestic or multinational, have been categorized as 'private sector.'[51] Table 2 provides a broad overview of application trends by the public versus private sector in India.

The private sector is clearly most active in filing applications for new varieties and appears to be only sparsely interested in filing extant variety applications. A possible explanation for the apparent disinterest of the private sector in filing extant variety applications was found during interviews with private sector seed corporations in India during April/May 2009. According to interviewed corporations, most varieties enjoy only brief periods of exclusivity in the market before they are either copied by competitors or are replaced by other varieties. It may therefore not be profitable for the private sector to obtain protection for varieties that have already been in the market for several years.

The public sector, on the other hand, is focusing almost entirely on protecting its existing knowledge under the extant variety category and is significantly

Table 1—Annual trends

Variety/Year	2007	2008	2009	2010	Total
Extant variety	355	389	382	54	1180
Farmers' variety	2	5	44	4	55
New variety	69	152	179	273	673
Grand total	426	546	605	331	1908

Table 2—Application trends: Public v private sector

Classification	Private	Public	Total
Extant variety	73	400	473
Farmers' variety	N/A	N/A	3
New variety	144	28	172
Grand total	217	428	648

slower in filing applications for new varieties. The continuing interest of the public sector in filing applications for extant varieties suggests that it expects the private sector to be interested either in mass producing and marketing these varieties or in using these varieties as initial material for the creation of essentially derived varieties (EDVs), thereby generating licence revenue for the public sector.[2] The ICAR conducts about 43 per cent of the total research done in India in the field of agriculture and transfers a great deal of its know-how to the private sector and to farmers. It is however, not clear whether the freshly obtained protection for extant varieties would entitle the public sector to royalties or compensation from entities that have adopted or 'copied' the seeds for their own breeding programs before the commencement of the Act.

Further, it appears that while the private sector is most interested in filing applications for varieties of cotton, maize, rice and pearl millet, the public sector has been active in filing applications for almost the entire range of species for which published data is available. However, the public sector is significantly more active in filing applications for varieties of wheat and maize than it is in any other crop species. Table 3 provides an overview of the species-wise application trends between the public and private sector in India.

Application Trends by Species and Classification of Varieties

Even before the enactment of the PPV&FR Act, India witnessed robust private sector participation in the seed sector since the late 1980s onwards. However, the private sector has been most active in relation to crops for which hybrids are important (e.g., maize, cotton etc.) whereas, the public sector was almost single handedly involved in R&D related to open and cross pollinated varieties such as wheat and rice. In this sub section, the filing trends are examined to determine whether, following the enactment of the PPV&FR Act, there has been any shift in the focus of the public or private sector.

Table 3 shows that applications (particularly by the private sector) are most popularly being filed for varieties of cotton, maize, pearl miller and rice. In relation to wheat however, while the public sector is active in filing extant variety applications (Tables 3 and 4), very few new variety applications have so far been filed, and of those, only five have been filed by the private sector. Table 4 lists the total number of applications received under each of the three categories divided by crop species.

Further, a closer look at the classification of varieties for which applications have been filed (Table 5) reveals that the private sector is most active in filing applications for hybrids, transgenic hybrids and corresponding parent lines. Less than 10 per cent of the total applications made by the private sector are for 'typical' varieties (i.e. varieties that need 25 or 3 per cent seed replacement).

Looking at Tables 4, 5 and 6 together, it is clear that the private sector is continuing to focus its R&D efforts in crops for which hybrids have been and continue to be important, namely, cotton, maize and pearl millet. While the private sector's interest in rice

Table 3—Public v Private trends by species

Species name (common name)	Private	Public	Total
Cajanus cajan (Pigeon pea)	0	17	17
Cicer arietinum (Chickpea)	0	30	30
Corchorus capsularis (Jute)	0	5	5
Corchorus olitorius (Jute)	0	6	6
Diploid cotton- *Gossypium arboreum* (Cotton)	3	10	13
Lens culinaris (Lentil)	0	11	11
Oryza sativa (Rice)	30	36	66
Pennisetum glaucum (Pearl millet)	27	35	62
Phaseolus vulgaris (Kidney bean)	0	7	7
Pisum sativum (Field pea)	0	25	25
Sorghum bicolor (Sorghum)	14	39	53
Tetraploid Cotton- *Gossypium hirsutum* + *Gossypium barbadense* (Cotton)	80	28	108
Triticum aestivum (Bread wheat)	5	70	75
Vigna mungo (Black gram)	1	12	13
Vigna radiata (Green gram)	2	22	24
Zea mays (Maize)	55	75	130
Grand total	217	428	645

Table 4—Number of plant variety applications filed by species

Species	Common name	New varieties	Extant varieties	Farmers' varieties
Cajanus cajan	Pigeon pea	21	24	2
Ricinus communis	Castor	5	1	0
Cicer arietinum	Chickpea	8	46	2
Corchorus capsularis	Jute	3	10	0
Corchorus olitorius	Jute	2	9	0
Gossypium hirsutum	Cotton	2	0	0
Diploid cotton *(Gossypium arboreum)*	Cotton	5	38	0
Indian mustard	Mustard	1	1	0
Lens culinaris (Medik)	Lentil	1	13	0
Oryza sativa	Rice	92	198	39
Pennisetum glaucum	Pearl millet	75	110	0
Phaseolus vulgaris	Kidney bean	1	9	5
Pisum sativum	Field pea	3	25	0
Rapeseed (*Toria*)	Rapeseed	0	2	0
Saccharum	Sugarcane	2	0	0
Sesame	Sesame	0	2	0
Sorghum bicolor	Sorghum	75	91	1
Sunflower	Sunflower	38	15	0
Tetraploid cotton *(Gossypium barbadense)*	Cotton	2	0	0
Tetraploid cotton *(Gossypium hirsutum)*	Cotton	208	307	0
Triticum aestivum	Bread wheat	9	89	6
Vigna mungo	Black gram	2	21	0
Vigna radiata	Green gram	6	39	0
Zea mays	Maize	110	130	0
Grand total		673	1180	55

Table 5—Classification of species: Public v private trends

Classification	Private	Public	Total
Hybrid	86	90	176
Inbred parent/line	54	0	54
Parental single cross	3	0	3
Transgenic hybrid	54	0	54
Typical	20	338	358
Grand total	217	428	645

(an open pollinated variety that requires 33 per cent seed replacement) is surprising, a closer look at the data in relation to rice however, reveals that only 1/3rd of the applications filed by the private sector for rice varieties are for 'typical' rice varieties; all others are for hybrid varieties or corresponding inbred/parental lines. It may be relevant to note here that inbred/parental lines are not commercialized, and prior to the enactment of the PPV&FR Act, were mostly held secret.

For further analysis, the filing trends in relation to the top five species (namely maize, tetraploid cotton, wheat, rice and pearl millet) were studied in greater detail. Similarity in filing trends (Table 6) is noticeable for almost all species for which hybridization technology has been known and successfully practised for many years (particularly, tetraploid cotton, maize and pearl millet). In maize, less than 25 per cent of the applications are for typical varieties of maize; all applications for typical varieties of maize have been filed by the public sector. In tetraploid cotton, less than 20 per cent of the applications are for typical varieties of tetraploid cotton and all but one application for typical varieties of tetraploid cotton have been filed by the public sector. In case of pearl millet, while 30 per cent of the applications are for typical varieties of pearl millet, all these applications have been filed by the public sector.

Almost the opposite trends are seen in the applications for wheat and rice. In wheat, less than 0.5 per cent of the applications for wheat are for 'non typical' varieties – namely hybrid or parental lines. However, applications for all non typical varieties of wheat have been filed by the private sector and only 2 applications for typical wheat varieties have been filed by the private sector. In rice, while almost 30 per cent of the applications are for hybrid varieties (or the corresponding parental lines), all these applications have been filed by the private sector. The remaining 70 per cent of the applications are for typical rice varieties, less than 17 per cent of which have been filed by the private sector.

Table 6—Classification of varieties by species

Species	Hybrid	Typical	Transgenic hybrid	Inbred line/parent	Parental single cross	Total
Cajanus cajan	2	15				17
Cicer arietinum		30				30
Corchorus capsularis		5				5
Corchorus olitorius		6				6
Diploid cotton	5	7		1		13
Lens culinaris		11				11
Oryza sativa	13	49		7		69
Pennisetum glaucum	37	19		6		62
Phaseolus vulgaris		7				7
Pisum sativum		25				25
Sorghum bicolor	18	29		6		53
Tetraploid Cotton *(Gossypium hirsutum)*	19	19	54	16		108
Triticum aestivum	1	72		2		75
Vigna mungo	1	12				13
Vigna radiata		24				24
Zea mays	80	31		16	3	130
Grand total	176	361	54	54	3	648

These trends clearly point to the fact that the research interests of the private sector have not drifted away from hybrid varieties following the enforcement of the PPV&FR Act. While it may still be too early to judge, given that the Act has been in force only since 2007, it appears unlikely that the trends will change significantly.

However, it is interesting to note that the public sector is also active in filing applications for hybrid varieties of various species, particularly cotton, maize and pearl millet. It is likely that once plant variety protection certificates are obtained for these varieties, the public sector will seek remuneration from any private sector corporation using these varieties for commercial purpose. From these trends, it seems likely that in the near future, the public sector's filing interests will shift closer to those of the private sector. This possibility is clear from the fact that more than 50 per cent of the total applications for hybrid varieties have been filed by the public sector (Table 5). A significant percentage of the public sector research appears to continue to be for 'typical' varieties that can be saved and re-sown by farmers. However, the shift of public sector research interests away from the staple self-pollinated crops may raise concerns from the food security perspective. The data pertaining to plant variety protection is not adequate to conclusively determine whether the public sector research interests and investment may be moving away from open pollinated and typical varieties to the more income promising hybrid varieties. Other sources of data need to be tapped for such a study. However, the public sector may have to focus its attention more on developing typical varieties of self and open pollinated crops.

A Closer Look at Farmers' Variety Applications

One of the key objectives of the PPV&FR Act is to encourage farmland innovation by providing for a farmers' rights regime in addition to the breeders' rights regime prevalent in most (developed) countries. It was therefore encouraging to see the sudden rise in applications for farmers' varieties in 2009 (Table 1). However, the trend in 2010 was far from optimal with only four applications being filed. In total, only 55 applications have been filed for farmers' over the past four years, a number significantly lower than the corresponding numbers for new varieties and extant varieties. Reasons for the low number of filings under this category need to be studied closely. Of particular interest would be studies designed to determine whether the farmers' privilege of saving seeds is in any way counter-productive or supportive of the aim of promoting farmland innovation.

A closer look at the applications for farmers' varieties shows that the most number of applications have been filed for varieties of rice and wheat. However, in the absence of passport data for most of these varieties, it is not possible to conduct an in depth analysis of filing trends.

The government and non-governmental organizations therefore, need to take steps to promote awareness about the farmers' rights regime. Alongside, studies must be undertaken on an ongoing basis to determine whether the regime as currently designed is truly appropriate for protecting informal farmland innovations involving landraces that may not fulfill the strict criteria of uniformity and stability.

Possible Explanations of Available Trends

It is not clear at this stage whether the introduction of the PPV&FR Act has increased overall private sector R&D expenditure. But it is clear that the trends in R&D by the private sector have not changed after the introduction of the PPV&FR Act. The private sector continues to focus on R&D in crops for which hybrids are important. A more comprehensive and clear conclusion as to trends can perhaps only be gleaned once India notifies DUS tests for more species of crops, particularly fruits, vegetables and flowers and accepts applications for these species.

While the disinterest in filing applications for typical varieties by the private sector may be expected, the popularity of 'hybrid variety' filings is surprising in the light of the inherent protection mechanism within hybrids that prevents farmers from re-sowing seeds saved from a harvest in the following season. It is also surprising from the perspective of competitors because the parental lines of hybrids are usually maintained as a trade secret. One might therefore imagine that the private sector would not invest resources in obtaining time bound protection under the PPV&FR Act when it already enjoys potentially unlimited (from a time perspective) protection from using hybridization technology and keeping the parental lines secret.

Discussions with private sector seed companies in India reveal possible reasons for the above trends. The broad farmers' and breeders' privileges under the Indian law are reasons why the private sector has not changed its business model significantly, away from their historic focus on producing hybrids. While the law continues to protect farmers by permitting saving and (re)sowing of seeds, the private sector is not devoting significant R&D attention to self or open pollinated staple crops such as wheat and lentils, but is continuing to focus on development of new hybrid varieties. However, there is significantly robust filing activity despite the inherent protection offered by hybrid technology because of (i) frequent defection of scientists to competitors' firms, and (ii) the difficulty in maintaining secrecy of parent lines. The system provided by the PPV&FR Act is therefore seen more as a means of preventing competitors from 'stealing' proprietary information, rather than as a means of preventing farmers from saving and (re)sowing seeds; as was inferred from interviews with personnel and scientists at Monsanto, Indo-American Hybrid seeds, and the Indian Council for Agricultural Research in New Delhi in May/June 2009.

Although scarce, the interest of the private sector in typical and non-hybrid seeds for self-pollinated crops is not entirely absent. Pockets of interest are visible, particularly among domestic seed companies such as JK Agrigenetics, Ankur Seeds, etc. The reasons for this may be that even in non-hybrid varieties, there is still a 33 per cent or 25 per cent suggested seed replacement rate. Further, by marketing seeds for staple crops, private corporations may have a means of winning over farmer-clients for their hybrid seeds.

Conclusion

The robust trends in filing activity in relation to extant varieties and new varieties suggest that the public and private sector enterprises view the system established by the PPV&FR Act as one worth utilizing. However, the slow activity under the category of farmers' varieties suggests that efforts will have to be made to create greater awareness about the Act among farmers and also to clarify the mechanism that will be used to evaluate the farmers' varieties for protection. The private sector does not appear to be shifting its focus away from hybrids towards R&D in typical varieties of self and open-pollinating staple crops such as rice, wheat and lentils. To this extent, the PPV&FR Act does not appear to grant any additional incentive (beyond the inherent protection granted by hybridization technology) to the private sector. India, therefore, needs to re-assess whether, through the current regime, it will indeed be able to meet its policy objective of encouraging the growth of the private sector seed industry and the R&D efforts therein. Such an assessment may also be necessary to justify India's stand in the ongoing review of Article 27.3(b) of TRIPS. While it is relevant that the private sector is actively utilizing the system to apply for plant variety protection for hybrids, a reason for this may be to prevent copying of hybrid varieties including parental lines by competitors.

Not all varieties for which protection is being sought by the public sector fall within species that interest the private sector. Therefore, to the extent that the public sector views the PPV&FR Act as a means to earning revenue for the know how transferred to the private sector, the number of species for which the public sector will seek protection (under both new and extant variety categories) may reduce with time or match the filing interests of the private sector. This may be a strategic move and may not, on its own, be adequate to conclude that the public sector research interests are moving away from self and open pollinated crops to crops for which hybrids are important. However, given the continuing private sector emphasis on hybrids, the government may need to adopt policy or regulatory measures to ensure that the necessary research and development of non-hybrid varieties of self-pollinating crops continues, particularly in the public sector research institutions and corporations.

Given the importance of agriculture in India's economy, the importance of monitoring the functioning of legislations such as the PPV&FR Act cannot be overstated. Further, India's farmers' rights regime is an inspiring model for several developing countries. As a pioneer and role model in the protection of farmers' rights, India is duty bound to closely monitor the effectiveness of this regime, not only for the benefit of its own large farming community, but also for the benefit of the farming communities in other developing countries. For this purpose, statistics such as those that are made available in the PV Journals are extremely important. Academic and scientific analysis of such data ought to be undertaken by all concerned parties on a regular basis. In addition to this, in the light of the discouraging filing trends *vis-à-vis* farmers' varieties, efforts must be strengthened to educate farmers about their rights under the Act. Alongside, scientific studies must be undertaken to determine whether the current law is truly appropriate to encourage informal farmland innovation by individual farmers who do not have access to modern scientific R&D technology.

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