



## Farmer's Varieties in India- Factors affecting their preferential prevalence and the current status of their legal protection

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### ABSTRACT

In India, both High Yielding Varieties (HYVs) and Farmers' Varieties (FVs) are being cultivated in different seasons in various agro-ecosystems in all regions of the country. A review of the contemporary literature reveals that a large number of factors namely, institutional, environmental, socio-economical and technical, determine the choice of a particular kind of variety (HYVs vs FVs). Literature also supports the fact that FVs are adapted better under marginal and low-input environment, due to their inbuilt resilient mechanisms. A large number of FVs of various crops continue to be grown in different states, occupying significant area in different regions and seasons. Also, the contribution of FVs is significant for food and nutritional security, particularly for small and marginal farmers in low-input marginal conditions. With regard to the legal protection of FVs, in case of food grain crops (cereals and pulses), almost all registration of FVs for Plant Variety Protection (PVP) have been for self-pollinated crops by virtue of being homogenous and qualifying the distinctiveness, uniformity and stability (DUS) test for their protection and conservation through legislative mechanism in India. The present study reveals that in case of coarse cereals, vegetables and cash crops, the registration of FVs for PVP are very low/negligible, due to relatively more variability/heterogeneity by virtue of their genetic makeup and pollination behaviour, thus failing to qualify DUS test. The present analysis indicates that provisions under Protection of Plant Varieties and Farmers Rights Act (2001) need further amendment so that important FVs are not excluded from getting intellectual property right protection.

**Key words:** Adaptation, Adoption, DUS, Farmers' varieties, High yielding varieties, PVP certificates, Seed replacement rates (SRRs)

After independence, India adopted a model of public sector plant breeding to address the national food security issues (Ragavan and Mayer 2007). During green revolution (GR) landraces/farmers/traditional/local varieties, characterized by tall, photoperiod-sensitive, low-yielding and drought-tolerant, having a broad maturity duration and good grain quality, were replaced by a few widely adapted varieties including hybrids that are dwarf and photoperiod-insensitive, with early maturity, higher yield, poor grain quality, in relation to traditional/farmers varieties and low pest resistance (Sandhu and Kumar 2017). India ranks first, with 179.8 million ha of net cropland area (9.6% of the global net cropland area) (Ministry of Finance 2018). It has the second highest irrigated area (70.4 million ha) next to China (71.74 million ha) (<http://agricoop.nic.in/recent-initiatives/pocket-book-agricultural-statistics-2017>). Similarly, India ranks first among the rainfed countries in the

world by having 78 million ha and thus constituting 64% of the country's net sown area being rainfed, but in terms of productivity, its position is amongst the lowest (nraa.gov.in). The net sown area of the country is reported to be 43% of the total geographical area along with cropping intensity of 142%. Furthermore, India is blessed with 6 ecosystems, 15 major agro-climatic regions/zones and 46 different soil types out of total 60 types of soil in the world. India is one of the agro biodiversity rich countries of the world with over 160 crop species with hundreds of varieties, 325 crop wild relatives and around 1,500 wild edible plant species (Anil Kumar *et al.* 2015). Unlike irrigated areas, which are homogenous for intensive cropping systems, the rainfed areas are more diverse and heterogeneous. Despite their relative aridity, drylands/rainfed areas in India harbour a great deal of biodiversity, influenced by both climate and latitude and farmers still maintain many of their traditions including nurturing biodiversity in the form of wild and cultivated food crops and medicinal plants, despite the introduction of mono-cropping and/or mono-culturing during the GR (Rao *et al.* 2015).

The invaluable treasures of diversity in various forms give us opportunity to conduct breeding and evaluation research and more importantly, the Indian farmer is

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innovative and quick adopter of new workable and viable technologies (Sharma 2012). Nevertheless, very disappointingly, the country has the largest undernourished children in the world despite achieving high momentum in crop productivity enhancement, promoting cultivation of over 2300 high yielding modern varieties (HYVs), in addition to be the first country in the world to develop hybrid cultivars like grain pearl millet and pigeon pea (Kumara Charyulu *et al.* 2015). In India, more than 20 cropping systems are being practiced, of which rice–wheat and rice–rice are the most important. The rice–wheat cropping system (RWCS) of the Indo-Gangetic plains in the country has revolutionized agriculture during the GR which, on one hand, enhanced food and nutritional security, but on the other hand it has displaced traditional crops and farmers' varieties (FVs) from the prevailing cropping systems. The RWCS is known to be under severe stress and has shown decline in system productivity per se. A great resurgence of malnutrition has been observed among South Asian populations including India by depending entirely on rice and wheat, with micronutrient deficiency being the major cause of malnutrition (Dwivedi *et al.* 2017). In India, 67% of total holdings are by marginal farmers with average holding of just 0.39 ha, and 17.9% small farmers with average farm size of 1.42 ha. Altogether, marginal and small farmers possess 85% of total holdings and cultivate 44.6% area with average farm size of just 0.6 ha. On the basis of input survey (2011-12), conducted by the Agricultural Census Division of Department of Agricultural Cooperation and Farmers Welfare (DAC&FW), Ministry of Agriculture and Farmers Welfare's (Government of India) published report in 2016, out of a total of 138.11 million operational holdings, only 39.41% used certified seeds while 26.96% used seeds of notified varieties (All India Report on Input Survey 2011-12, 2016) implying that only about 73% operational holding used seed of un-notified farmers varieties.

The Modern Varieties (MV's) developed through formal breeding programme (Morris *et al.* 2003) and products of crop improvement give higher yield and known as High Yielding Varieties (HYVs). However, Herdt and Capule (1983), had shown reservation to use it because new varieties may not be high yielding unless a high level of input is used, so it is better to use MVs. In case of rice, the term MVs refers to the short-statured, stiff-straw, fertilizer-responsive, photoperiod-insensitive *indica* rice varieties (Chandler 1982). The MVs have high yield potential and good resistance to biotic stresses, but are highly vulnerable to abiotic stresses such as drought and in the course of post GR breeding, unknowingly, the drought tolerance contributing alleles of traditional cultivars have not been properly retained/maintained in the modern cultivars (Sandhu and Kumar 2017). Moreover, MVs have simply replaced landraces as one of the extremely important source of diversity, but have not finished informal way of crop improvement practiced by farmers since millennium. The reason for this development is that farmers often recognize the attractive features of MVs, including high yields and

novel resistances but also identify various characters that are not appreciated, especially regarding taste, processing qualities, resilience under unfavorable and low input marginal growing environments (Salazar *et al.* 2007). Furthermore, MVs that have been successfully adopted by low-input producers generally have been developed using local germplasm, increasing genotype  $\times$  environment ( $G \times E$ ) interaction, adaptability, including crop performance (Yapi *et al.* 2000) and breeding for low-yielding and variable stress conditions is more complex than breeding for uniform, high input productive systems (Fess *et al.* 2011). Generally, effect of crop improvement research/technology generation could be realized in terms of yield gain, production cost reduction, technology spill-over and increased yield stability (Charyulu *et al.* 2013). Maurya *et al.* (1988) showed that if the formal seed system provides advanced lines which are equal to well-adapted and accepted FVs, there may be a substantial acceptance, adoption and diffusion among farmers, as well as diversification of the genetic base, and, as shown by Simmonds and Talbot (1992), significant yield increases under farmers' own conditions. According to the Food and Agriculture Organization (FAO) of the United Nations, both improved and traditional varieties will have an important role to play here, but there are important gaps to address in both (Food and Agriculture Organization 2010). In the present study, an attempt has been made to review the literature to analyze various factors responsible for the prevalence of FVs in India. The current status of the protection and conservation of FVs through a legal instrument, namely, Protection of Plant Varieties and Farmers' Rights (PPV&FR) Act, 2001, in terms of registration and granting of Plant Variety Protection (PVP) certificate to FVs has been analyzed in cereals, pulses, oilseeds, vegetable, plantation, ornamental and cash crops.

*Factors affecting the prevalence of local varieties:* Contemporary literature on seed supply systems refers to seed as either 'modern varieties' (MV's) which are improved by organized breeding programs or local varieties (LVs) popularly known as land races without passing through a formal crop improvement program. A working definition of plant landraces put forward by Villa *et al.* (2005) is a dynamic population(s) of a cultivated plant that has historical origin, distinct identity and lacks formal crop improvement, as well as often being genetically diverse, is locally adapted and associated with traditional farming systems. The FVs, usually applied to local cultivars, seen as intermediate between a land race and a cultivar (Ramanandan 1997) may also include landraces when referring to plant varieties not subjected to formal breeding programs. A landrace identified with a unique feature, and selected for uniformity over a period of time for maintenance of the characteristic features of the population, can evolve into a FV, or even a modern cultivar, such as 'Maruti' in the case of pigeon pea (Friis-Hansen and Sthapit 2000) and HMT variety in rice (Gupta 2008).

HYVs are bred to respond to the added application of large quantities of agrochemicals and water and thus

the proper cultivation of HYVs requires a 'package' of inputs which includes not only fertilizers and irrigation, but also pesticides to control disease, insects and weeds, and increased mechanization (Freebairn 1995). It has been reported by Pandey and Gauchan (2012) that the extent and patterns of adoption of modern rice varieties vary among farmers and locations. Moreover, differential pattern of adoption of MVs can be observed during different seasons in the same region. A classic example is rice in Odisha; during summer the area is covered with MVs while in autumn and winter, LVs play important role. Similarly, in Bihar during autumn (locally known as '*Bhadai*' season) only local varieties are grown. In maize both MVs and LVs are grown during '*Bhadai*' and summer (locally known as '*Garma*') while during *rabi* season only LVs are predominantly cultivated. This clearly indicates the importance of season to decide use of MVs or LVs over one another. In India, sorghum is grown in two seasons, in the rainy season as a rainfed crop and in the post rainy season under residual soil moisture/limited-irrigated conditions. Traditionally, sorghum is a staple food crop for millions of poor in the semi-arid regions of India, unlike rainy sorghum which is dominated with hybrids, post-rainy sorghum growing areas are cultivated with LVs, especially landrace selections. The adoption of MVs in cereal and coarse cereals fluctuates in less favorable environments and the main driver for adoption of MVs is irrigation, socio-economic conditions, land reforms etc. Overall the adoption of MVs in different regions and seasons of Indian states is highly asymmetrical (Singh *et al.* 2016 and 2017). The MVs co-exist in different cropping systems with traditional/FVs. Many farmers grow both MVs under high input management while FVs are being grown for their own consumption under traditional systems. The agrarian integration of MVs into traditional systems may lead to the genetic integration of MVs and FVs and the process by which the modification of MVs take place is known as 'criolloization' (Lamola and Bertram 1994) or 'rustication' (Prain, 1993) and during this process, MVs exchange genes with landraces. Valuable features of MVs are integrated under farmer management, with desirable features of traditional varieties (Wood and Lenné 1997). Contemporary literature was screened to decipher the issues which trigger preferential prevalence of FVs. Numerous factors belonging to institutional, environmental, socio-economical and technical categories were found, and these are enlisted in Table 1.

*Protection and conservation of farmer's varieties through legislative mechanism:* The Protection of Plant Varieties and Farmers' Rights (PPV&FR) Authority of India established during 2005 started accepting applications for the protection of varieties to grant PVP certificates in 2007 under the PPV&FR Act, 2001. The PPV&FR Act is a *sui generis* legislation ('of its own kind'), and a unique one worldwide because it combines plant breeders' rights with elements of the Article 8(j) of the United Nations 'Convention on Biological Diversity' (CBD) and Article 9 of the FAO's 'International Treaty on Plant Genetic

Resources for Food and Agriculture' (ITPGRFA), also known as Seed Treaty), wherein farmers' claims as stewards of plant genetic resources (PGR) are enshrined. The first FVs to obtain registration under the PPV&FR Act, in 2009, were three varieties of rice – *Tilak Chandan*, *Indrasan* and *Hansraj*. Three more varieties were registered in 2012, which consisted of one variety of rice (*Dadaji HMT*) and two of bread wheat (*Kudrat 9* and *Wheat Ravi No.1*). Until 2012, only six FVs were registered, primarily due to lack of awareness amongst the farmers (Hanchinal *et al.* 2014). The pace of farmers' variety registration picked up in 2013. The crop-wise decadal progress of proposals submitted for granting of PVP certificates under PPV&FR Act 2001 by farmers and other stakeholders is given in Table 2.

Farmers are considered the creators, maintainers and conservators of genetic diversity of important crops especially those for food and nutritional security (cereals, millets, pulses and oilseed). Correspondingly, farmers submitted highest number of applications for seeking PVP certificates in cereals (75%) (maximum in rice i.e. 5596), pulses (80%), Oilseeds (62%), plantation crops (78%), fruits (95%), ornamentals (43%), Condiments and spices (93%) and Aromatic and medicinal plants (96%). In cash crops, potato submitted by farmers for 39 varietal protection proposals occupied top rank for the protection of their varieties.

The crop-wise status with respect to the granting of PVP certificates by PPV&FR Authority from the year 2007 to 30 June, 2018 is given in Table 3. Under the provisions of the PPV&FR Act, extant variety protection exists and farmers are supposed to protect as much as they can in the form of FVs after satisfying the varietal protection requirements. The highest number of FVs were provided protection in Rice. In other crop groups, FVs lagged behind with respect to their varietal protection in comparison to private sector and public sector. It is worth mentioning that in case of food grains (cereals and pulses), almost all FV certificates have been for self-pollinated crops (1351 in rice, 11 for wheat, 3 for pigeon pea, 2 for chickpea and 1 for black gram) and has a low seed replacement rate (SRR). In contrast, new varieties registered have been for hybrid varieties of maize, sorghum, pearl millet and most for tetraploid cotton, which have a negligible SRR and which therefore compels a farmer to source these seeds from the market.

The National Commission of Agriculture in its report in 1976 had indicated that India is in a vulnerable position with regard to devastating and debilitating epidemics because of the few varieties with a narrow genetic base which are presently under cultivation. Genetic erosion of cultivated diversity occurs in several stages namely, the initial replacement of landraces by MVs and further reduction in diversity due to modern breeding practices, while it may also occur at three levels of integration namely crop, variety, and allele. In India, the drastic reduction in the area coverage under sorghum, finger millet and barley and other minor millets provide evidence of genetic erosion of FVs. Van de Wouw *et al.* (2010 and 2010a) further argued that there is a

Table 1 Institutional, environmental, socio-economical and technical issues responsible for the preferential prevalence of FVs in India (based upon review of literature)

| Institutional                                                                                                                                                                                                          | Environmental                                                                                                                                                                                                                                                       | Socio-economical                                                                                                       | Technical                                                                                                                                                                                                                                                                                                |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Delay between notification and cultivation (Vyas 1995; Witcombe <i>et al.</i> 1998)                                                                                                                                    | -Degradation of natural resource base (Pingali 2012; Webb 2009; Pingali <i>et al.</i> 1994).                                                                                                                                                                        | -Cash/input requirements (Herath and Jayasuriya 1996).                                                                 | -Huge gap exists between varieties released and varieties in seed chain (Gautam 2013; Singh <i>et al.</i> 2017).                                                                                                                                                                                         |
| -Land reforms policies (Fujita 2013; Singla <i>et al.</i> 2016).                                                                                                                                                       | -Declining water (Kumar <i>et al.</i> 2017).                                                                                                                                                                                                                        | -Risk aversion, transaction costs, input availability, credit, knowledge etc. (Feder and Umali 1993; Meng 1997).       | -Low mineral/nutritional content in MVs in comparison to FVs (Fan <i>et al.</i> 2008; Garvin <i>et al.</i> 2006; Deb <i>et al.</i> 2015; Anandan <i>et al.</i> 2011; Zhao <i>et al.</i> 2009; Dwivedi <i>et al.</i> 2017).                                                                               |
| -Low public investment to develop high-yielding, short-duration pulses (Kumar <i>et al.</i> 2017).                                                                                                                     | -One-third of the rice area in India is affected by droughts (Bithal <i>et al.</i> 2015).                                                                                                                                                                           | -Holding size (Matuschke <i>et al.</i> 2007)                                                                           | -Seed unavailability of newly released varieties (Patnaik, 2013; Singh and Morris 1997).                                                                                                                                                                                                                 |
| -Narrow genetic base particularly in pulses and oilseed crops.                                                                                                                                                         | -Poor performance of MVs in less favourable environment (Kulkarni 2013; Shetty <i>et al.</i> 2013; Nagarajan <i>et al.</i> 2008; Mandal <i>et al.</i> 2010).                                                                                                        | -Hydrology and tenurial status (Samal <i>et al.</i> 2011).                                                             | -Reduced genetic advantage will result in slower replacement rates (Witcombe <i>et al.</i> 1998; Nagarajan 2005; Walker <i>et al.</i> 2015).                                                                                                                                                             |
| -Varietal 'permanency' in sorghum and groundnut (Kumara Charyulu <i>et al.</i> 2015).                                                                                                                                  | -Reduction in wheat yields by 100 kg/ha/100 km eastwards (Nagarajan 2004; Erenstein and Thorpe 2011).                                                                                                                                                               | -Only 30% farmers wait >3 years to replace the seed varieties (NSSO 2005; Singh and Chand 2010).                       | -Preference of less-vulnerable, climate resilient and locally adapted FVs, in spite of full adoption of MVs (Raghu <i>et al.</i> 2015; Raghu <i>et al.</i> 2015).                                                                                                                                        |
| -Major emphasis placed on the production of large quantities of seed and the marketing of just a few varieties with wide adaptation (Salazar <i>et al.</i> 2007; Louwaars and De Boef 2012; Singh <i>et al.</i> 2017). | -Decline in household income by 24-58% and 12-33% rise in farm-household poverty in a drought year in few eastern states (Bhandari <i>et al.</i> 2007).                                                                                                             | -Subsistence farming in marginal areas (Williams <i>et al.</i> 2008; Lacoste <i>et al.</i> 2012).                      | -No/less domestic use of MVs for household consumption (Raghu <i>et al.</i> 2015).                                                                                                                                                                                                                       |
| -Poor participation of private seed sector in high-volume-low-value self-pollinated crops due to poor profit margins (Singh 2017).                                                                                     | -The lack of apparent adaptive capacity (Hijioaka <i>et al.</i> 2014); (Kumar <i>et al.</i> 2006) (Duncan <i>et al.</i> 2017).                                                                                                                                      | -Better adaptation of local varieties under marginal environments (Bellon and Etten 2014; Dwivedi <i>et al.</i> 2016). | -Recycling of seed (Pixley and Bänziger 2004); (Morris <i>et al.</i> 1999).                                                                                                                                                                                                                              |
| -Lack of accountability mechanisms for scientists and extension staff and information (Pope 2013; Kumar <i>et al.</i> 2017).                                                                                           | -Poor adoption of MVs of upland rice due to their unstable nature (Pandey <i>et al.</i> 2015), sorghum (poor grain quality, and susceptibility to diseases) and groundnut (Singh 2015); (Singh <i>et al.</i> 2017; Kambiranda, D M Vasanthaiah <i>et al.</i> 2011). | -Asymmetrical adoption of high yielding varieties in different regions and seasons (Singh <i>et al.</i> 2017).         | -High seed cost (Singh <i>et al.</i> 2017).                                                                                                                                                                                                                                                              |
| -Structural problem which maintains the research status quo (Pope 2013).                                                                                                                                               | -Unprofitable nature of upland rice compared with irrigated transplanted rice (Witcombe <i>et al.</i> 2009).                                                                                                                                                        | -Higher rate of illiteracy (~30%) among M&S farmers (Ministry of Finance 2018).                                        | -High seed rate and high transportation cost (Gadwal 2003; Patil <i>et al.</i> 2004)                                                                                                                                                                                                                     |
| -Variety release is based on poorly designed and unrepresentative trials (Ceccarelli 2015).                                                                                                                            | -Varietal mismatch in eastern India, most prevalent varieties are the outcome of spill over benefit (Singh 2015; Singh <i>et al.</i> 2017)                                                                                                                          |                                                                                                                        | -Lack of maintenance breeding (Peng <i>et al.</i> 2010).                                                                                                                                                                                                                                                 |
| -Prevalence of breeding philosophy of wide adaptation (Baranski 2015).                                                                                                                                                 | -Modification of modern varieties (MV) by traditional farmers known as 'criolloization' (Lamola and Bertram 1994) or 'rustication' (Prain 1993), appears to be widespread.                                                                                          |                                                                                                                        | -Problem in variety testing (Ceccarelli 2015).                                                                                                                                                                                                                                                           |
| -Non-implementation of land reforms policies uniformly (Fujita 2013).                                                                                                                                                  |                                                                                                                                                                                                                                                                     |                                                                                                                        | -Use of obsolete experimental designs and statistical analysis, with no attempts to capture spatial variability and correlation between the plot errors (Singh <i>et al.</i> 2003; Ceccarelli 2012) or increasing the number of locations by the use of partial replication (Cullis <i>et al.</i> 2006). |
| -No regulatory approval to commercialize any transgenic grain crop (USDA-FAS 2017).                                                                                                                                    |                                                                                                                                                                                                                                                                     |                                                                                                                        |                                                                                                                                                                                                                                                                                                          |

Table 2 Crop wise decadal progress with respect to applications submitted for granting of PVP certificate under PPV&amp;FR Act-2001 by farmers and others (from 2007 to 30 June, 2018)

| Group/Crop                          | Farmer        | Pvt. sector   | Public sector | Total | Group/Crop            | Farmer       | Pvt. sector   | Public sector | Total |
|-------------------------------------|---------------|---------------|---------------|-------|-----------------------|--------------|---------------|---------------|-------|
| <i>Cereals &amp; Coarse cereals</i> |               |               |               |       | <i>Vegetables</i>     |              |               |               |       |
| Wheat (durum)                       | 11            | 2             | 17            | 30    | Bell pepper           | 5            | 0             | 0             | 5     |
| Wheat                               | 213           | 27            | 171           | 411   | Chilli                | 84           | 195           | 18            | 297   |
| Wheat ( <i>dicoccum</i> )           | 0             | 0             | 5             | 5     | Paprika               | 0            | 0             | 1             | 1     |
| Finger millet                       | 78            | 0             | 16            | 94    | Pumpkin               | 97           | 0             | 3             | 100   |
| Foxtail millet                      | 41            | 0             | 1             | 42    | Ridge guard           | 52           | 7             | 1             | 60    |
| Maize                               | 496           | 481           | 140           | 1117  | Spinach beet          | 1            | 0             | 1             | 2     |
| Pearl millet                        | 48            | 271           | 65            | 384   | Tomato                | 65           | 260           | 32            | 357   |
| Rice                                | 5596          | 429           | 368           | 6393  | Muskmelon             | 2            | 3             | 4             | 9     |
| Barley                              | 78            | 9             | 17            | 104   | Okra                  | 51           | 155           | 16            | 222   |
| Sorghum                             | 112           | 106           | 120           | 338   | Onion                 | 25           | 9             | 15            | 49    |
| Sub total                           | 6673<br>(75%) | 1325<br>(15%) | 920 (10%)     | 8918  | Vegetable<br>Amaranth | 13           | 0             | 1             | 14    |
| <i>Pulses</i>                       |               |               |               |       | Watermelon            | 2            | 16            | 0             | 18    |
| Black gram                          | 247           | 3             | 32            | 282   | Bitter gourd          | 60           | 36            | 4             | 100   |
| Chickpea                            | 157           | 0             | 69            | 226   | Bottle gourd          | 140          | 16            | 5             | 161   |
| Field pea                           | 160           | 3             | 42            | 205   | Brinjal               | 192          | 251           | 24            | 467   |
| Green gram                          | 107           | 4             | 49            | 160   | Cabbage               | 6            | 17            | 2             | 25    |
| Kidney bean                         | 84            | 3             | 11            | 98    | Cauliflower           | 16           | 61            | 5             | 82    |
| Lentil                              | 112           | 0             | 15            | 127   | Cucumber              | 46           | 32            | 4             | 82    |
| Pigeon pea                          | 318           | 25            | 36            | 379   | Sub total             | 857<br>(42%) | 1058<br>(51%) | 136 (7%)      | 2051  |
| Sub total                           | 1185 (80%)    | 38 (3%)       | 254 (17%)     | 1477  | <i>Fruits</i>         |              |               |               |       |
| <i>Oilseeds</i>                     |               |               |               |       | Acid lime             | 22           | 0             | 4             | 26    |
| Castor                              | 26            | 10            | 6             | 42    | Almond                | 1            | 0             | 0             | 1     |
| Groundnut                           | 59            | 1             | 45            | 105   | Apple                 | 7            | 2             | 0             | 9     |
| Indian mustard (Karan Rai)          | 14            | 0             | 3             | 17    | Apricot               | 43           | 0             | 0             | 43    |
| Indian mustard (Sarso)              | 126           | 33            | 54            | 213   | Bael                  | 13           | 0             | 0             | 13    |
| Rapeseed (Gobhi sarso)              | 12            | 1             | 5             | 18    | Cherry                | 1            | 0             | 0             | 1     |
| Rapeseed (Toria)                    | 94            | 0             | 9             | 103   | Custard apple         | 8            | 0             | 0             | 8     |
| Linseed                             | 108           | 0             | 8             | 116   | Grapes                | 12           | 7             | 1             | 20    |
| Safflower                           | 8             | 0             | 10            | 18    | Indian jujube (Ber)   | 172          | 0             | 2             | 174   |
| Sesame                              | 133           | 0             | 13            | 146   | Jamun                 | 5            | 0             | 0             | 5     |
| Soybean                             | 37            | 15            | 38            | 90    | Mandarin              | 0            | 0             | 2             | 2     |
| Sunflower                           | 4             | 121           | 11            | 136   | Mango                 | 265          | 0             | 2             | 267   |
| Sub total                           | 621 (62%)     | 181 (18%)     | 202 (20%)     | 1004  | Peach                 | 6            | 0             | 0             | 6     |
| <i>Cash crops</i>                   |               |               |               |       | Pear                  | 1            | 0             | 0             | 1     |
| Jute                                | 10            | 4             | 32            | 46    | Pomegranate           | 4            | 0             | 7             | 11    |
| Sugarcane                           | 36            | 2             | 67            | 105   | Sweet orange          | 2            | 0             | 1             | 3     |
| Potato                              | 45            | 25            | 19            | 89    | Walnut                | 7            | 0             | 5             | 12    |

Contd.

Table 2 (Concluded)

| Group/Crop                     | Farmer    | Pvt. sector | Public sector | Total | Group/Crop                             | Farmer    | Pvt. sector | Public sector | Total |
|--------------------------------|-----------|-------------|---------------|-------|----------------------------------------|-----------|-------------|---------------|-------|
| Cotton (Tetraploid)*+2         | 3         | 979         | 85            | 1067  | Sub total                              | 569 (95%) | 9 (1%)      | 24 (4%)       | 602   |
| Cotton (Diploid) + 15          | 5         | 27          | 44            | 76    | <i>Ornamentals</i>                     |           |             |               |       |
| Sub total                      | 99 (7%)   | 1037 (75%)  | 247 (18%)     | 1383  | Bougainvillea                          | 2         | 0           | 1             | 3     |
| <i>Plantation crop</i>         |           |             |               |       | Carnation                              | 0         | 0           | 1             | 1     |
| Banana                         | 32        | 0           | 0             | 32    | Casuarina                              | 0         | 0           | 6             | 6     |
| Coconut                        | 10        | 0           | 15            | 25    | Chrysanthemum                          | 3         | 0           | 11            | 14    |
| Eucalyptus                     | 0         | 0           | 1             | 1     | Gladiolus                              | 1         | 0           | 6             | 7     |
| Papaya                         | 27        | 0           | 0             | 27    | Marigold                               | 7         | 0           | 0             | 7     |
| Tea                            | 0         | 0           | 4             | 4     | Orchids                                | 10        | 0           | 1             | 11    |
| Sub total                      | 69 (78%)  | 0 (0%)      | 20 (22%)      | 89    | Rose                                   | 6         | 10          | 2             | 18    |
| <i>Condiments &amp; spices</i> |           |             |               |       | Sub total                              | 29 (43%)  | 10 (15%)    | 28 (42%)      | 67    |
| Black pepper                   | 8         | 0           | 4             | 12    | <i>Aromatic &amp; medicinal plants</i> |           |             |               |       |
| Coriander                      | 97        | 0           | 2             | 99    | Isabgol                                | 2         | 0           | 0             | 2     |
| Fenugreek                      | 36        | 0           | 0             | 36    | Jasmine                                | 1         | 0           | 0             | 1     |
| Garlic                         | 70        | 0           | 12            | 82    | Menthol Mint                           | 7         | 0           | 1             | 8     |
| Ginger                         | 73        | 0           | 3             | 76    | Neem                                   | 1         | 0           | 0             | 1     |
| Small cardamom                 | 13        | 0           | 3             | 16    | Nutmeg                                 | 30        | 0           | 0             | 30    |
| Turmeric                       | 152       | 0           | 10            | 162   | Brahmi                                 | 3         | 0           | 0             | 3     |
| Sub total                      | 449 (93%) | 0 (0%)      | 34 (7%)       | 483   | Canna                                  | 0         | 0           | 1             | 1     |
|                                |           |             |               |       | Sub total                              | 44 (96%)  | 0 (0%)      | 2 (4%)        | 46    |

Table 3 Number of PVP certificates granted to varieties in different crops developed by farmers, public and private sector under PPV&amp;FR Act-2001 (2007 to 30 June, 2018)

| Crop                      | Category of variety |           |            | Category of applicants |          |           |            |       |
|---------------------------|---------------------|-----------|------------|------------------------|----------|-----------|------------|-------|
|                           |                     |           |            | Public                 |          | Private   | Farmer     | Total |
|                           | Extant              | New       | Farmers    | ICAR                   | SAU      |           |            |       |
| Cereals & Coarse cereal   |                     |           |            |                        |          |           |            |       |
| Wheat (Bread wheat)       | 119                 | 24        | 11         | 117                    | 17       | 9         | 11         | 154   |
| Wheat (durum)             | 16                  | 0         | 1          | 9                      | 7        | 0         | 1          | 17    |
| Wheat ( <i>dicoccum</i> ) | 5                   | 0         | 0          | 3                      | 0        | 2         | 0          | 5     |
| Finger millet             | 5                   | 0         | 0          | 5                      | 0        | 0         | 0          | 5     |
| Maize                     | 122                 | 94        | 6          | 103                    | 2        | 111       | 6          | 222   |
| Pearl millet              | 79                  | 43        | 0          | 33                     | 1        | 88        | 0          | 122   |
| Rice                      | 223                 | 89        | 1351       | 117                    | 64       | 131       | 1351       | 1663  |
| Sorghum                   | 73                  | 57        | 4          | 54                     | 29       | 47        | 4          | 134   |
| Sub total                 | 642 (28%)           | 307 (13%) | 1373 (59%) | 441 (19%)              | 120 (5%) | 388 (17%) | 1373 (59%) | 2322  |
| Pulses                    |                     |           |            |                        |          |           |            |       |
| Black gram                | 19                  | 0         | 1          | 10                     | 8        | 1         | 1          | 20    |
| Chickpea                  | 46                  | 2         | 2          | 37                     | 11       | 0         | 2          | 50    |
| Field pea                 | 27                  | 0         | 0          | 27                     | 0        | 0         | 0          | 27    |
| Green gram                | 31                  | 0         | 0          | 26                     | 4        | 1         | 0          | 31    |
| Kidney bean               | 10                  | 0         | 0          | 10                     | 0        | 0         | 0          | 10    |
| Lentil                    | 12                  | 0         | 0          | 11                     | 1        | 0         | 0          | 12    |

Contd.

Table 3 (Concluded)

| Crop                           | Category of applicants |           |            |           |          |           |            |       |
|--------------------------------|------------------------|-----------|------------|-----------|----------|-----------|------------|-------|
|                                | Category of variety    |           |            | Public    |          | Private   | Farmer     | Total |
|                                | Extant                 | New       | Farmers    | ICAR      | SAU      |           |            |       |
| Pigeon pea                     | 22                     | 8         | 3          | 21        | 0        | 9         | 3          | 33    |
| Sub total                      | 167(91%)               | 10 (6%)   | 6 (3%)     | 142 (78%) | 24 (13%) | 11 (6%)   | 6 (3%)     | 183   |
| <i>Oilseed</i>                 |                        |           |            |           |          |           |            |       |
| Castor                         | 6                      | 2         | 0          | 4         | 0        | 4         | 0          | 8     |
| Groundnut                      | 34                     | 0         | 0          | 19        | 15       | 0         | 0          | 34    |
| Indian mustard (Sarso)         | 60                     | 3         | 2          | 39        | 9        | 15        | 2          | 65    |
| Indian mustard (Karan Rai)     | 2                      | 0         | 0          | 2         | 0        | 0         | 0          | 2     |
| Rapeseed (Gobhi sarso)         | 6                      | 0         | 0          | 0         | 5        | 1         | 0          | 6     |
| Rapeseed (Toria)               | 7                      | 0         | 5          | 4         | 3        | 0         | 5          | 12    |
| Linseed                        | 5                      | 0         | 0          | 5         | 0        | 0         | 0          | 5     |
| Safflower                      | 6                      | 0         | 0          | 3         | 3        | 0         | 0          | 6     |
| Sesame                         | 8                      | 0         | 0          | 0         | 8        | 0         | 0          | 8     |
| Soybean                        | 29                     | 2         | 0          | 26        | 2        | 3         | 0          | 31    |
| Sunflower                      | 27                     | 28        | 0          | 4         | 6        | 45        | 0          | 55    |
| Sub total                      | 190 (82%)              | 35 (15%)  | 7 (3%)     | 106 (46%) | 51 (22%) | 68 (29%)  | 7 (3%)     | 232   |
| <i>Cash crop</i>               |                        |           |            |           |          |           |            |       |
| Jute                           | 11                     | 6         | 0          | 16        | 1        | 0         | 0          | 17    |
| Sugarcane                      | 43                     | 5         | 0          | 42        | 5        | 1         | 0          | 48    |
| Potato                         | 15                     | 10        | 0          | 15        | 0        | 10        | 0          | 25    |
| Cotton (Diploid)               | 32                     | 9         | 0          | 2         | 25       | 14        | 0          | 41    |
| Cotton (Tetraploid)            | 164                    | 65        | 1          | 9         | 37       | 183       | 1          | 230   |
| Sub total                      | 265 (74%)              | 95 (26%)  | 1 (0%)     | 84 (23%)  | 68 (19%) | 208 (58%) | 1 (0%)     | 361   |
| <i>Vegetables</i>              |                        |           |            |           |          |           |            |       |
| Garden pea                     | 27                     | 0         | 0          | 27        | 0        | 0         | 0          | 27    |
| Tomato                         | 26                     | 11        | 0          | 8         | 1        | 28        | 0          | 37    |
| Okra                           | 24                     | 8         | 0          | 11        | 3        | 18        | 0          | 32    |
| Onion                          | 8                      | 0         | 0          | 7         | 1        | 0         | 0          | 8     |
| Bottle gourd                   | 3                      | 0         | 0          | 1         | 1        | 1         | 0          | 3     |
| Brinjal                        | 26                     | 4         | 0          | 10        | 2        | 18        | 0          | 30    |
| Cabbage                        | 1                      | 0         | 0          | 1         | 0        | 0         | 0          | 1     |
| Cauliflower                    | 3                      | 1         | 0          | 2         | 1        | 1         | 0          | 4     |
| Sub total                      | 118 (83%)              | 24 (17%)  | 0 (0%)     | 67 (47%)  | 9 (6%)   | 66 (47%)  | 0 (0%)     | 142   |
| <i>Plantation crop</i>         |                        |           |            |           |          |           |            |       |
| Coconut                        | 6                      | 0         | 0          | 6         | 0        | 0         | 0          | 6     |
| Sub total                      | 6 (100%)               | 0 (0%)    | 0 (0%)     | 6 (100%)  | 0 (0%)   | 0 (0%)    | 0 (0%)     | 6     |
| <i>Condiments &amp; spices</i> |                        |           |            |           |          |           |            |       |
| Black pepper                   | 0                      | 0         | 3          | 0         | 0        | 0         | 3          | 3     |
| Garlic                         | 7                      | 0         | 0          | 6         | 1        | 0         | 0          | 7     |
| Small cardamom                 | 1                      | 0         | 6          | 1         | 0        | 0         | 6          | 7     |
| Turmeric                       | 4                      | 0         | 0          | 2         | 2        | 0         | 0          | 4     |
| Sub total                      | 12                     | 0         | 9          | 9         | 3        | 0         | 9          | 21    |
| <i>Ornamental</i>              |                        |           |            |           |          |           |            |       |
| Rose                           | 1                      | 0         | 0          | 0         | 0        | 1         | 0          | 1     |
| Sub total                      | 1 (100%)               | 0 (0%)    | 0 (0%)     | 0 (0%)    | 0 (0%)   | 1 (100%)  | 0 (0%)     | 1     |
| Total                          | 1401 (43%)             | 471 (15%) | 1396 (42%) | 855 (26%) | 275 (8%) | 742 (23%) | 1396 (43%) | 3268  |

Adapted and modified from [http://plantaauthority.gov.in/List\\_of\\_Certificates.htm](http://plantaauthority.gov.in/List_of_Certificates.htm) visited on 30.06.2018

reduction in diversity due to the replacement of landraces by MVs. Nevertheless, FVs are still occupying a significant position in Indian agriculture and their contributions are enormous in terms of food and nutritional security and on-farm agro-biodiversity conservation. The prevalence and preference of FVs depend upon various factors which include bio-geophysical, geographical, topographical, irrigation facilities, timely availability of quality seed, inputs and credits, land holdings and farm size, acceptable nutritional qualities, economics of production, desirable varietal traits for food, feed and fodder values, tolerance to various abiotic and biotic stresses, and socio-economical condition of the farmers etc. Nevertheless, due to known nutritional, medicinal and therapeutic properties, farmers prefer FVs, at least for their own consumption. Also, FVs adapt better under marginal environments and their performance in these marginal and low input conditions is comparable to those of HYVs. As in Bihar state, the HYVs adoption is high in case of wheat while it is low in rice crop, because in wheat, a smaller number of irrigations are required as compared to rice. Poor varietal replacement rates (VRRs) also compel farmers to opt FVs because of the decreasing performance of aging MVs overtime due to change in environmental conditions including abiotic and biotic pressures.

The PPV&FR Act, 2001, under farmers' rights, recognizes a farmer as a breeder, conservator, and user who is entitled to save, use, sow, re-sow, exchange and share or sell his farm produce, including seed of a variety protected under this Act, just as he was entitled before the enforcement of this Act, provided that the farmer shall not be entitled to sell branded seeds of a variety protected under this Act. Also, the Indian *sui-generis* system of PVP is unique, because under this Act a variety can be registered under either of 3 categories: new variety, essentially derived varieties and extant variety. Initially farmer's response was slow due to ignorance but as time progressed, farmers started to take interest to protect their varieties and consequently there was a steady increase in the number of proposals for registration in the Authority. This was facilitated by two major initiatives of the Authority. First was organization of major awareness workshops across all regions in the country (about 250 awareness programs each year at the level of Krishi Vigyan Kendra). Second was ease in the criteria for registration of FVs. Commercial cultivars presuppose a high level of genetic uniformity and stability (not found, nor considered desirable), in FVs which are bred for diversity and resilience. Thus, criteria have been modified for FVs whereby farmers submit half the quantity of seed material required for a commercial variety, and the number of 'off types' (any seed or plant that deviates in one or more characteristics from the variety as described) cannot exceed double the number of off-types specified for a new variety (Government of India 2009). However, these accommodations need to be further refined to address the inadequacy of DUS criteria for FVs (Peschard 2017). From the present study also, it is clear that in case of coarse cereals (maize, pearl millet, sorghum etc.), the PVP

certificates granted to FVs are very low in spite of the fact that large number of FVs of these crops are still being grown in different states and at the same time virtually they cover significant crop area in different regions and seasons. Same situation exists for FVs in vegetable and cash crops and therefore, warrant further amendments in the PPV&FR rules and regulations. The genetically heterogeneous nature of open pollinated varieties is an asset for farmers because they can adapt these varieties to specific local conditions and production objectives. Therefore, farmer's open pollinated varieties (OPVs) should receive more support through social and regulatory recognition (Serpoly-besson *et al.* 2014).

Plucknett and Horne (1992) argued that conservation biology is the biology of scarcity while in contrast, agro-biodiversity conservation is the biology of farm productivity, which warrants further mankind support and interest in the agro-ecosystems or else their productive capacity and genetic diversity will not survive on-farm (Wood and Lenné 1997). Recognizing this, the FAO has been working to identify globally important agricultural heritage systems (GIAHSs) since 2002 using five different criteria's namely (i) food and livelihood security, (ii) agro-biodiversity, (iii) local and traditional knowledge systems (iv) culture, value systems and social organizations, and (v) landscape and seascape features. Till date, 50 GIAHSs have been identified and recognized. The GIAHS combine agricultural biodiversity, resilient ecosystems, traditional farming practices and cultural identity. It also introduced the concept of 'dynamic conservation' and finally outlines how the GIAHS program itself fits in with global issues such as the UN Sustainable Development goals, agroecology and agrobiodiversity. Furthermore, GIAHS works at national level by capacity building in policy, regulatory and incentive mechanisms to safeguard these outstanding systems and use them as sustainability bench mark systems, and at local level by empowerment of local communities and technical assistance for sustainable resource management, promoting traditional knowledge and enhancing viability of these systems through economic incentives. In India also 3 GIAHSs namely Saffron Heritage of Kashmir (2011), Koraput Traditional Agriculture (2012) and Kuttanad Below Sea Level Farming System (2013) have been identified (Food and Agriculture Organization 2018).

The public sector institutes/organization can play significant role by facilitating farmers for the registration of FVs in order to get them protected legally. In this endeavour, the Krishi Vigyan Kendras (KVKs) of Jharkhand have been closely associated with local farmers and have played a pivotal role in conservation of area-specific FVs. During the last two years, KVKs organized more than 35 awareness-cum-training programs on PVP and identified and registered more than 1,800 FVs for PVP entitlement at PPV&FR Authority, New Delhi. In 2015, five KVKs located in Jharkhand, (in Chatra, Palamau, Simdega, Gumla and Ranchi), jointly received first prize for special contribution in protection of local crop varieties at Koraput, Odisha during a national seminar (Singh *et al.* 2016). In



pursuance of amendment in Rule 22 for sub-rule (2) of the PPV&FR Rules, 2015, the PPV&FR Authority in its 23<sup>rd</sup> Authority meeting ("Proceedings of the 23<sup>rd</sup> meeting held on August 14, 2015,") has fixed the time limit for registration of FVs of all crop species notified before 15 June 2015 by another 10 years from the date of expiry of original time limit which was only 5 years from the date of notification of a crop species. This shall give a further scope to the farmers to get their varieties registered before the expiry of the extended period.

### CONCLUSION

In spite of the adoption and diffusion of "miracle HYVs in order to increase the production and productivity to ensure food and nutritional security, FVs still occupy an important position by virtue of not only covering remarkable area in the different regions and seasons, but also contributing significantly under low input marginal environmental conditions which are inhabited by resource poor small and marginal farmers. The FVs proved beneficial to the farming communities in terms of providing food and nutritional security, and being climate resilient. Moreover, the harsh climatic conditions and farmers own wisdom in these areas are mainly responsible for the dynamic evolution of new varieties through the process of criolloization or rustication. The protection and conservation of the FVs through legislative mechanism is of critical importance and India has recognized this by adopting and implementing the *suigeneris* system of plant variety protection through PPV&FR Act (2001), which recognizes farmers as breeders. According to Ceccarelli (2016), five of the global issues most frequently debated today are the decline of biodiversity in general and of agrobiodiversity in particular, climate change, hunger and malnutrition, poverty and water. The protection, conservation and effective utilization of the vast treasures in the form of FVs is the need of the day and probably through proper approach, FVs can be of great help to resolve all the five issues mentioned herein as the farmers varieties are efficient in terms of resource (moisture and low nutrient) utilization. The present analysis shows that in self-pollinated crops FVs are being protected by passing the DUS test, while in cross pollinated crops these varieties are far behind as compared to the varieties developed through formal crop breeding programs. It is clear that there is further need of revisiting PPV&FR rules and regulations, in order to protect and conserve FVs in crops which are more genetically heterogeneous. Finally, on the line of the FAO's GIAHS, many more important agricultural heritage systems need to be identified in order to protect the FVs in their dynamic forms to maintain the legacy for the future as well as for resilience to the unforeseen challenges.

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