THE SCIENCE WORLD
A Monthly e Magazine
ISSN:2583-2212
Popular Article
December, 2025 Vol.5(12), 11097-11109

Plant Variety Protection and Registration: Procedures and Challenges

Ananya Singh[1], Dr. Vikram Singh[2], Dr. Kushagra Krishnan[1]*
[1]School of Biotechnology, Gautam Buddha University, Greater NOIDA, Gautam Buddha Nagar, Uttar Pradesh, India-201312.
[2]Department of Biotechnology, Faculty of Applied Science, Amrapali University, Haldwani, Nainital, Uttarakhand, India-263139.
*Corresponding Author- **Kushagra Krishnan**
Corresponding author email: krishnan.kushagra@gmail.com
DOI:10.5281/ScienceWorld.18038565

Abstract

Plant Variety Protection (PVP) is an essential intellectual property mechanism that promotes agricultural innovation by providing breeders with exclusive rights to newly developed plant varieties. This chapter presents an overview of the procedures and challenges related to the registration and protection of plant varieties and analyzes the importance of plant breeding in relation to agricultural progress and food security, while outlining the legal frameworks at both international and national levels that regulate plant variety protection (PVP). It specifically highlights the role of the International Union for the Protection of New Varieties of Plants (UPOV) and India's Protection of Plant Varieties and Farmers' Rights (PPV&FR) Act of 2001. The registration process is fundamentally based on the DUS criteria: Distinctness, Uniformity, and Stability, assessed through comprehensive field trials. This paper delineates the sequential registration process, encompassing application submission, examination, publication, opposition, and the ultimate issuance of a certificate. This text emphasizes the rights granted to breeders, including authority over production and marketing, as well as essential exemptions that reconcile various interests, such as those of researchers and farmers.The PVP system encounters substantial technical, legal, and ethical challenges, despite its significance. The factors encompass the duration and expenses associated with DUS testing, challenges in safeguarding cross-pollinated crops, enforcement issues related to infringement, and ethical concerns regarding access, benefit-sharing, and the consolidation of the seed industry. The paper concludes by examining future implications of emerging biotechnologies such as CRISPR/Cas9, highlighting the necessity for a balanced, transparent, and adaptive PVP system that fosters innovation while protecting the rights of all stakeholders, especially small-scale farmers.

1. Introduction

1.1. The Significance of Plant Breeding and Agricultural Innovation

A plant variety is a specific and identifiable group of plants within a species that has unique traits and can be consistently reproduced [1]. Even in bad weather, high-yielding and stress-tolerant cultivars (drought, salt, pests, illnesses) will make sure that crops keep growing [2]. For example, maize is not very nutritious compared to other cereal crops, so it would be a good idea to mix maize flour with other local items that are high in protein and micronutrients to make up for what maize lacks [3]. Adding orange-fleshed sweet potato, sweet lupine, and moringa leaf powder to maize flour to make instant porridge flour has greatly improved the nutritional value of the maize [3].

1.2. Plant Variety Protection is a special kind of IPR for new plant varieties

Agriculture is what makes human civilization possible [4]. Since human evolution, people have needed to be able to cultivate plants for food, fiber, medicine, and other things in order to stay alive. For hundreds of years, farmers and breeders have chosen, enhanced, and protected different types of plants [5]. These plants are important not just for food security but also for the cultural, ecological, and economic health of society [4]. As technology and globalization have grown, conserving plant variety has become very important for farming and trade.

Plant variety protection (PVP) is a legal system that gives developers of novel plant varieties intellectual property rights (IPR) [6]. It acknowledges their work, encourages more research and new ideas, and makes sure that farmers and consumers benefit from having access to better and higher-yielding varieties [1]. PVP also needs to find a way to balance the requirements of farmers, especially in countries like India where traditional farming methods and biodiversity are very important [7]. Plant varieties are living things that can reproduce, change, and grow, unlike industrial innovations [6]. This is what makes the protection system stand out. Plant breeders spend years doing research, experiments, and tests to create a variety that is unique, consistent, stable, and novel [2]. If there is no protection, other people might just duplicate, replicate, and sell the variety, which would make breeders less likely to come up with innovation [1].

1.3. International and National Frameworks

1.3.1. International Union for the protection of New Varieties of Plants (UPOV)

In the early 20th century, people in Europe started to think about how to protect different types of plants [8]. The International Union for the Protection of New Varieties of Plants (UPOV), which was set up in 1961, was the first international convention in this domain

Official Website
www.thescienceworld.net
thescienceworldmagazine@gmail.com
Published 15/12/2025

[9]. UPOV gives member countries a uniform way to give breeders' rights. Patents mostly addressed microorganisms and their processes until the 1970s. Plants and animals were not included [10]. As crop breeding got better, there was a need for a particular protection system. This resulted in the establishment of a sui generis law under the UPOV Conventions of 1978 and 1991, designed to safeguard new plant varieties while reconciling the rights of breeders, the interests of farmers, and environmental considerations [9].

1.3.2. India's Protection of Plant Varieties and Farmer's Rights (PPV & FR), 2001

The Indian Patents Act of 1970 says that plants and animals, or any portion of them, can't be patented, save for microbes [11]. India passed the PPV&FR Act, 2001 to follow Article 27.3 (b) of TRIPS [7],[12]. This law protects not just new plant varieties but also the rights of farmers. This law is strange since it protects not only breeders but also acknowledges the work of farmers and researchers [7].

1.4. Objectives and challenges of Plant Variety Protection

1.4.1. The primary objectives of PVP

1. Encouraging Innovation: To get plant breeders to work on creating new, better varieties that produce more, are resistant to disease, and can handle climate changes.
2. Rewarding Breeders: Giving breeders rights and money to show that their work is important.
3. Helping Farmers: To make sure that farmers can get good seeds and keep doing what they've always done: preserving and trading seeds.
4. Protecting Biodiversity: To promote the protection of native species and traditional knowledge.
5. Increasing Trade: To encourage exports and trade with other countries by making ownership and rights clear in the law.

1.4.2. Challenges of PVP

1. It takes a lot of time and money to do field trials in different places and at different times of the year. To make sure they are flexible, varieties must be tried in two to three distinct agro-climatic zones [13],[14].
2. To prove that these kinds are the same, at least two crop seasons are needed, which makes the registration procedure take longer [14].
3. To do the tests and look at the data, you need a lot of complex infrastructure and people. This can be a big problem for many countries, especially developing ones that may not have the right tools or people to do it [13].

Official Website
www.thescienceworld.net
thescienceworldmagazine@gmail.com
Published 15/12/2025

4. Farmers don't often retain detailed records of when, when, and how the variety was made. It is exceedingly hard to prove where something came from, how new it is, or how different it is without documented proof [5].

2. Criteria for protection- DUS Test

2.1. A plant variety can be registered if it fulfils the following conditions

1. Novelty: The variety can't have been sold or used for business purposes before a specific date (in India, this is one year before filing) [12].
2. Distinctness: The variety must be noticeably different from other variations in at least one major way, including the height of the plants, the shape of the leaves, the color of the flowers, or the amount of fruit it produces. The people who grade the test have to show that your variety is different from all the other plants in the lineup in a clear, consistent, and important way. It stops someone from taking an existing variety, making a little, unimportant adjustment, and saying that they made it up [15].
3. Uniformity: The variety should have enough of the same traits that individual plants don't differ too much from each other. There can be a little bit of normal variance, but in general, it has to be the same. This gives farmers and customers peace of mind that they are obtaining a product that is reliable and consistent [15]. You might be able to grow the same kind of crop every year from the seed package you buy today.
4. Stability: The variety must keep its basic traits the same after being grown for multiple seasons, usually at least two in a row. Sometimes, statistical tests are employed to make sure that any small changes that are seen are normal and not a symptom of instability. It is done to find out if the differences between generations of the same kind are not statistically significant. For example, the t-test is used to compare the average values of a certain trait from one generation to the next [16].

2.2. The Significance of Correct Denomination

1. **Exclusive identification-** The main job of a denomination is to give a new plant variety a unique name. A variety name is the general term for a certain type of plant. This helps breeders, farmers, and consumers avoid problems. The name must not be the same as any name that already exists for a variety of the same or a closely related species [17].
2. **Marketplace Transparency**- The name of a variety must be on anything that is related to it once it is available for sale. This includes seed packs, seedlings, and blooms. This rule is a key aspect of the PVP system since it makes sure that farmers and customers know exactly what they are buying. It also stops false claims and helps

Official Website
www.thescienceworld.net
thescienceworldmagazine@gmail.com
Published 15/12/2025

people make smarter decisions, such choosing a variety that can handle drought or one that tastes different [17].

3. **Regulatory importance and public concern**- When a plant variety gets PVP and its name is registered, that name becomes the official, generic name for the variety. Anyone who sells or advertises that kind after that must use the same name, even after the PVP protection runs out. This rule says that after the breeder's exclusive rights to the name are over, they can't preserve control of it through trademarks. This keeps the name open and available for everyone to use [17].

3. Registration procedure

1. Application Submission: The farmer, breeder, or institution sends an application to the Plant Variety Registry. This is the Protection of Plant Varieties and Farmers' Rights Authority (PPV&FRA) in India [12].
2. The application must include the name of the variety, its traits, how it was developed, and seed samples. This name must be unique and not misleading. It is the plant's permanent name and is used on all marketing and seed materials [14].
3. Examination of Application: The authority checks to see if the variety fits the requirements for eligibility. Examiners examine to see if the application is complete, if all the fees have been paid, and if the name recommended is not already in use or misleading [14].
4. DUS Testing: Field trials are done under certain settings to test for distinctness, uniformity, and stability [15].
5. Publication: The information is made public, and anybody who think they have rights to it can object. If someone files an objection, the register acts as a

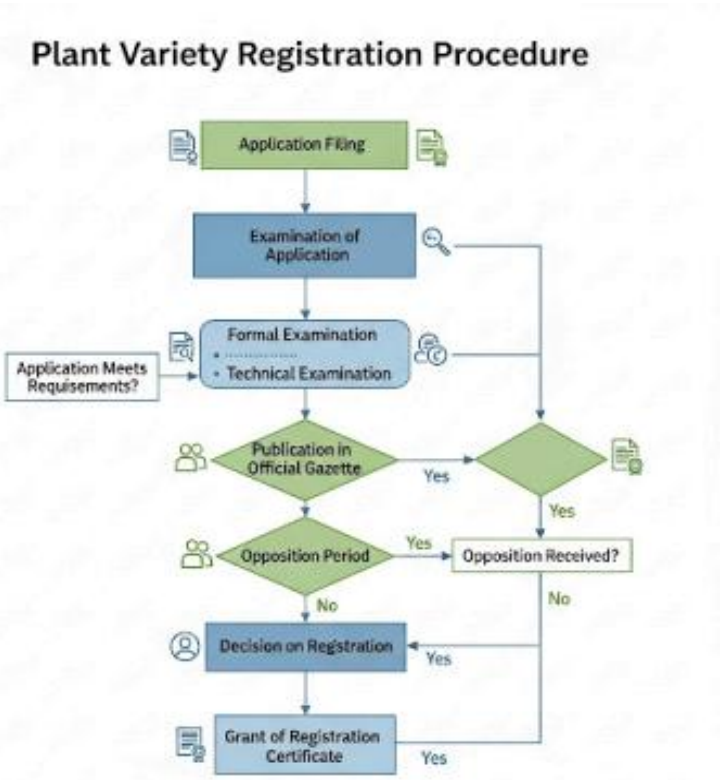

Figure 2: The Process for Registering a Plant Variety

Official Website
www.thescienceworld.net
thescienceworldmagazine@gmail.com
Published 15/12/2025

middleman, listening to all sides and rendering a decision based on the facts. This step is very important for protecting the rights of everyone involved [14].

6. Issuing of a Certificate: If there are no complaints and the variety passes all testing, a registration certificate is given [14].

The above flowchart (Figure 2) gives a clear picture of the key stages involved in registering a new plant variety, from the first application to the final granting of the certificate.

3.1. Required Documentation

1. Application form- It must have the name of the person applying, their address, the official name of the variety, and their country.
2. Variety type- A statement on whether the variety is new, existing, or a farmer's variety.
3. Application type- If it's a new kind or one that comes from another type.
4. Application fee- Proof of payment for the fees that are due.

3.2. Technical questionnaire

It helps professionals learn about the variety's history and what makes it different from other varieties. It is a whole document that includes more than just basic application information; it also includes scientific and technological aspects. It relates the tale of how the variety came to be and what makes it special. The breeder must specify the method used, such as traditional hybridization (the process of crossing two genetically different plants to create offspring that combine useful traits of both parents; the first generation usually shows hybrid vigor, which means better yield, quality, or resistance), controlled mutation (a plant breeding technique where breeders intentionally induce genetic changes in a plant's DNA by exposing seeds, cuttings, or other plant parts to a mutagen, which can be a chemical or a form of radiation), or modern genetic engineering [14].

3.3. Filing fees and timeline

1. Application fee- The application fee is a payment that can't be refunded and is used to process the application and look over the materials for the first time. It includes the Plant Variety Registry's administrative tasks, like entering data, doing initial legal checks, and talking to the applicant [13].
2. DUS Test- It pays for the land, labour, and materials (like fertilizers and pesticides) needed to plant and care for the new variety over several different seasons (usually two to four), as well as the salaries of the scientists who closely watch, measure, and study the variety's traits. It also pays for the upkeep and acquisition of reference varieties that can be used to compare the new variety and show that it is different [13].

Official Website
www.thescienceworld.net
thescienceworldmagazine@gmail.com
Published 15/12/2025

3. Annual fee- It pays for the costs of keeping the variety's name and information up to date on the official national registry. It makes sure that the public record of protected kinds stays accurate. It's basically a cost to keep the intellectual property right up to date [13].

3.4. Examination of the application

3.4.1. Formal examination

It looks at the basic administration and legal checks that an application needs. This is the first thing the national plant variety protection authority does after a breeder sends in an application. The formal assessment prevents big delays later on by finding and fixing any missing information early on. If the candidate makes a mistake, they usually have a certain amount of time to fix it [14].

3.4.2. Technical examination

It is very important for the Distinctness element of the test. It's the only way to show that the new type is really different from the ones that are already out there. The experiments are well-planned and take place throughout at least two growing seasons in a succession. This longer period is very important for examining for environmental effects and for testing for stability. The growing circumstances, like the kind of soil, the amount of light, and the amount of water, are kept as similar as possible across all plots. This way, any changes seen are due to the variety's genetics and not the environment [15].

3.4.3. Role of DUS test centres

They produce scientific data, such as morphological attributes, blooming period, yield characteristics, and sometimes molecular markers. The Plant Variety Registry gets this information to help them make a judgment about registration. Plant scientists, botanists, and technicians that work at these facilities know a lot about certain crops and teach staff, breeders, and farmers how to evaluate them. The centres have their own plots of land and greenhouses where they can do the growing tests. These surroundings are closely watched to make sure that a variety's traits are shown consistently. Many UPOV member countries accept the findings of the tests since they follow these harmonized protocols. This can save a breeder a lot of time and money if they want to protect their variety in more than one country. This is because they can often utilize the same DUS test report for applications in more than one country [18].

Official Website
www.thescienceworld.net
thescienceworldmagazine@gmail.com
Published 15/12/2025

3.5. Advertisement, Opposition, and Grant

3.5.1 Publication of the application in a journal

The publishing is a public announcement that lets everyone know, including other breeders, farmers, and the general public, that the new variety is looking for protection. It is an open invitation for anyone who has a valid reason to oppose to the registration to do so. This stops the registration of a variety that is already in the public domain or is a well-known variety from a nearby town [14].

3.5.2. The process for filing and hearing oppositions

When someone files an opposition, the Registrar of the Plant Variety Registry sends the applicant (the breeder) a copy of the opposition notice. The applicant must file a counter-statement within a certain amount of time in response to the objection. This is their chance to defend their application and question what the other side says. The Registrar makes a decision after looking at all the evidence and arguments. The application moves on to the final stage if the opposition is turned down. The application for PVP is denied if the opposition is upheld [12].

3.5.3. Issuance of the Certificate of Registration upon successful completion

It is the formal document that gives the breeder legal rights and shows that their new plant variety meets all the requirements. It has a unique marker for the variety, the official name of the protected variety that must be used for all business purposes, the name and address of the breeder or their legal successor who holds the rights, the date on which the protection officially begins, and the length of time for which the rights are granted, which varies by crop type (e.g., 20 years for most crops, 25 years for trees and vines) [12],[15].

3.5.4. Duration and renewal of protection

The length of time that PVP lasts depends on the type of plant. The longest protection period is for trees and vines, which is usually 18 to 30 years. The lengthier period is due to the fact that it takes a lot of time and money to breed, test, and sell new types of trees and vines, which can take years to attain maturity and full production. The protection period for most other crops, like cereals, vegetables, and ornamental plants, is usually 15 to 25 years because they grow and die faster [9],[15].

4. Rights and Exemptions under PVP

4.1. Breeder's rights

The breeder has the exclusive right to produce and multiply the propagating material of their variety, sell it (no one else can sell or market the protected variety without the breeder's permission), market it, distribute it (the breeder controls the movement of their variety across

Official Website
www.thescienceworld.net
thescienceworldmagazine@gmail.com
Published 15/12/2025

borders and to different markets, which lets them oversee supply chains and licensing agreements), and trade it. If someone uses a breeder's protected variety (registered plant variety) without permission, and the harvested material (like fruits, grains, tubers, etc.) is obtained illegally, then the breeder's rights extend to that harvested material. The idea of an Essentially Derived Variety (EDV) is an important part of the UPOV 1991 Act that stops a breeder from making small changes to a protected variety and promoting it as a new one without paying the original breeder. If an EDV is made public, the original breeder gets royalties and a share of the profits [19].

4.2. Key Exemptions and Balancing Interests

4.2.1. Researcher's exemption

It allows a protected variety to be used freely for study and breeding, especially to make new variations [9]. This exemption is meant to stop one breeder from controlling all the genetic material of their variety, which would stop more innovation. It makes sure that new and better plant varieties can keep being made by letting researchers and other breeders use a protected variety as a source of genetic variation. If the new variety is an EDV, the original breeder must give permission for it to be made in order to protect the original breeder's work [19].

4.2.2. Farmer's rights

It sees farmers as more than just people who grow crops; it also sees them as people who protect and breed them [7]. Farmers' Rights include their traditional rights to save, use, trade, and sell farm-saved seed and other planting materials. They also have the right to be recognized, rewarded, and supported for their contributions to the world's genetic resources and the creation of new commercial plant varieties. Finally, they have the right to take part in decisions about crop genetic resources and the knowledge that goes along with them. They can use the seed they get from a protected variety for their own crops in the future. This is different from more rigorous intellectual property systems, such patents, which would stop this kind of use. However, they cannot sell a branded seed without the breeder's permission. If they do, the breeder can sue the farmer under the PPV&FR Act, 2001 [12].

4.2.3. Right to allege Compensation for Underperformance

It keeps farmers from losing money because of a bad seed variety. If a breeder offers a protected variety and tells the farmer how it should perform in certain situations, then the variety doesn't live up to those expectations, the farmer might ask for compensation. This makes the breeder responsible for the quality and dependability of their product. It also gives

Official Website
www.thescienceworld.net
thescienceworldmagazine@gmail.com
Published 15/12/2025

farmers a way to get back at breeders if their crops fail because of a bad variety and protects farmers from false advertising or bad seeds [12].

5. Key challenges in the PVP System

5.1. Technical challenges

Testing DUS takes time, money, and knowledge. It can be hard to test some crops, especially small or local ones, using normal methods. It is hard to show that crops that naturally cross-pollinate (like maize) are stable and homogeneous because their genes are different from each other [20]. A cross-pollinated variety is never entirely uniform, unlike self-pollinated crops like wheat. This makes it hard to consistently use the DUS criteria. The DUS method is mostly based on phenotype, which is a variety's visible physical qualities, including the form of its leaves, the color of its flowers, or its height [21]. The uniqueness of a variation is now assessed by its observable distinctions from all other recognized varieties. Molecular markers, on the other hand, look at the plant's genotype, which is its genetic makeup. A major question is whether a genetic variation that doesn't show up in a person's appearance should be enough to protect them. On top of that, application fees, DUS testing costs, and yearly renewal fees might make it hard for small-scale breeders, universities, and public research institutes to do their jobs [13].

5.2. Legal challenges

Getting into a protected variety without permission is a big threat to the PVP system. This is a common concern, especially with "brown-bag" sales, where farmers sell seed that they saved from their own farms to their neighbours, which is like being an unregistered seed dealer [22]. This practice cuts out the breeder and hurts their income. It can be challenging to find infringement, especially in big, distant farming areas. It can be hard and expensive to prove the infringement and take legal action. Different countries have different sets of laws. For example, some countries follow the UPOV 1991 Act, which protects breeders more and limits farmers' rights more. Others, like India, have passed their own "sui generis" laws, like the PPV&FR Act, which give farmers' rights more weight. This lack of harmony makes it hard for breeders to protect their varieties in more than one country. It makes international trade and technology transfer more complicated [23].

5.3. Ethical challenges

Rather than competing, large multinational corporations often procure smaller seed companies that have a promising new variety. A big company can buy a smaller one to get its valuable genetic material, get rid of a rival, and improve its own market position. entitlements. A single patented gene can effectively limit the usage of an entire plant, as farmers must

Official Website
www.thescienceworld.net
thescienceworldmagazine@gmail.com
Published 15/12/2025

purchase the seed from the patent holder. This provides big companies that own these copyrighted traits a lot of power, since other breeders might not be able to exploit those traits to make new types without a license [24]. The Convention on Biological Diversity (CBD) and the Nagoya Protocol set up a framework for Access and Benefit-Sharing (ABS) [25]. This goes against the ideas of intellectual property rights, such as those given by the PVP system. For example, if a breeder wants to get a plant from another nation, like a wild variety that can handle drought, they must first get Prior Informed Consent (PIC) from the country of origin. Once permission is acquired, the breeder must next work out Mutually Agreed Terms (MAT), which spell out how the provider countries will get its part of any new product's benefits, such as a new variety that sells well. The Nagoya Protocol says that countries must make it clear how to get genetic resources and share the advantages. It also makes consumers of genetic resources more responsible by making them follow the ABS norms of the providing country [25].

6. Conclusion

Plant Variety Protection (PVP) is particularly important for making sure that plant breeders get the recognition and praise they deserve for their new ideas. It protects intellectual property and also helps agriculture grow by promoting research and the creation of better kinds. However, getting PVP might take a long time and be hard on the wallet, especially for small-scale farmers and breeders. Also, problems including farmers' rights, access to germplasm, and the balance between innovation and fairness still make it hard for PVP systems to work well over the world.

New technologies like CRISPR/Cas9 and other genome-editing techniques are thought to be game-changers in plant breeding because they make it possible to create better varieties more quickly and cheaply. Within the PVP framework, these technologies bring up major legal and moral issues. One important question is whether plants that have had their genes modified should be called "discoveries" (naturally occurring genetic possibilities discovered by science) or "inventions" (human-made creations that deserve exclusive protection). The way that lawmakers and the legal system handle this difference will have a big impact on how easy it is to get new plant kinds and how they are controlled. It will need a lot of thought to make sure that laws are current, adaptive, and fair in a time of rapid technological change when NBTs are added to the PVP framework.

A well-balanced and open PVP system is important for the future of farming. A forward-looking approach must defend the rights and livelihoods of farmers, who are the backbone of agricultural sustainability, as well as the interests of breeders and research

Official Website
www.thescienceworld.net
thescienceworldmagazine@gmail.com
Published 15/12/2025

institutes. Policymakers should work to build a system that promotes innovation while keeping things fair and affordable, so that the best variety get to the people who need them most. A secure and sustainable future for agriculture can be formed by bringing together scientists, lawyers, policymakers, and farming communities. This future will be one that combines progress with fairness, innovation with inclusion, and progress with fairness.

6.4. Future Prospects

Plant variety protection is more than just giving people rights. It is about making an agricultural system that lasts, rewards new ideas, values old knowledge, and makes sure there is enough food.

Future directions include:

1. Greater use of biotechnology and molecular markers in testing varieties.
2. Digital systems for registration and monitoring.
3. International cooperation to harmonize standards.
4. Strengthening farmer awareness and participation.
5. Integrating climate change resilience into breeding programs.

References

[1] World Intellectual Property Organization (WIPO), "Plant Variety Protection," *WIPO Magazine*, no. 4, 2019. [Online].
Available: https://www.wipo.int/wipo_magazine/en/2019/04/article_0001.html
[2] S. S. Yadav, R. J. Redden, J. L. Hatfield, H. Lotze-Campen, and A. E. Hall, *Crop Adaptation to Climate Change*. John Wiley & Sons, 2011.
[3] M. A. Dube, T. M. M. Malunga, and G. T. F. Kgasago, "Nutritional and functional properties of instant porridge flour from maize fortified with orange-fleshed sweet potato, sweet lupine and moringa leaf powder," *International Journal of Food Science & Technology*, vol. 57, no. 8, pp. 5247-5256, Aug. 2022, doi: 10.1111/ijfs.15878.
[4] Food and Agriculture Organization of the United Nations (FAO), *The Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture*. Rome, 2010. [Online].
Available: https://www.fao.org/docrep/013/i1500e/i1500e00.htm
[5] P. R. Mooney, "The Law of the Seed: Another Development and Plant Genetic Resources," *Development Dialogue*, vol. 1, no. 2, pp. 1-172, 1983.
[6] N. P. Louwaars, *Plant Breeders' Rights in Developing Countries: A study on the implications of the UPOV Convention for the development of the plant breeding sector*. Centre for Genetic Resources, The Netherlands, 2002.
[7] S. Sahai, "India's Protection of Plant Varieties and Farmers' Rights Act," *Current Science*, vol. 84, no. 3, pp. 340-341, Feb. 2003.
[8] G. Van Doorn, "A History of Plant Breeders' Rights," *Plant Variety Rights: An Introduction*, GEVES, France, 2005.
[9] International Union for the Protection of New Varieties of Plants (UPOV), "The UPOV Convention," *UPOV Publication No. 437(E)*, 2016. [Online].
Available: https://www.upov.int/edocs/pubdocs/en/upov_pub_437.pdf
[10] D. G. Keely, "Patenting Life Forms: An International Comparison," *Journal of the Patent and Trademark Office Society*, vol. 60, p. 263, 1978.

Official Website
www.thescienceworld.net
thescienceworldmagazine@gmail.com
Published 15/12/2025

[11] The Patents Act, 1970, Act No. 39 of 1970, India Code, Vol. 16.
[12] The Protection of Plant Varieties and Farmers' Rights Act, 2001, Act No. 53 of 2001, India Code. [Online].
Available: https://plantauthority.gov.in/sites/default/files/ppvfr_act_2001.pdf
[13] A. M. Abdel-Mawgoud, S. A. G. Al-Abdallat, A. M. Al-Ghzawi, and M. I. Al-Rawashdeh, "Plant Variety Protection: Current Status and Challenges," *Journal of Agricultural Science and Technology*, vol. 12, no. 1, pp. 1-14, 2010.
[14] Protection of Plant Varieties and Farmers' Rights Authority (PPV&FRA), Ministry of Agriculture & Farmers Welfare, Government of India, "General Guidelines for the Conduct of Test for Distinctiveness, Uniformity and Stability," 2007. [Online].
Available: https://plantauthority.gov.in/sites/default/files/general_guideline.pdf
[15] International Union for the Protection of New Varieties of Plants (UPOV), "General Introduction to the Examination of Distinctness, Uniformity and Stability and the Development of Harmonized Descriptions of New Varieties of Plants," Document TG/1/3, Apr. 19, 2002. [Online].
Available: https://www.upov.int/edocs/tgdocs/en/tg001.pdf
[16] T. A. Jones and D. A. Johnson, "Statistical tools for the analysis of stability and uniformity in variety trials," *Crop Science*, vol. 35, no. 3, pp. 723-728, 1995.
[17] International Union for the Protection of New Varieties of Plants (UPOV), "Explanatory Notes on Variety Denominations under the UPOV Convention," Document UPOV/INF/12/5, Nov. 6, 2015.
[18] C. Y. Cho, "Role of DUS Test Centers in the PVP System," *Journal of Plant Breeding and Crop Science*, vol. 5, no. 8, pp. 161-167, 2013.
[19] D. J. F. Eaton, "Essentially Derived Varieties under the UPOV Convention," *European Intellectual Property Review*, vol. 32, no. 5, pp. 245-251, 2010.
[20] H. G. Gauch Jr., "Statistical analysis of yield trials by AMMI and GGE," *Crop Science*, vol. 46, no. 4, pp. 1488-1500, 2006.
[21] N. P. Louwaars et al., "Breeding is Trust: A review of the role of molecular markers in the protection of plant varieties," Wageningen University and Research, 2009.
[22] D. L. Byerlee and K. D. Fischer, "Accessing modern science: policy and institutional options for agricultural biotechnology in developing countries," *IP Strategy Today*, no. 4, pp. 1-36, 2002.
[23] M. Blakeney, "International proposals for the protection of plant varieties: from UPOV to TRIPs and beyond," *European Intellectual Property Review*, vol. 24, no. 1, pp. 9-18, 2002.
[24] P. H. Howard, "Visualizing consolidation in the global seed industry: 1996-2008," *Sustainability*, vol. 1, no. 4, pp. 1266-1287, 2009.
[25] Secretariat of the Convention on Biological Diversity, *Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity: Text and Annex*, 2011. [Online].
Available: https://www.cbd.int/abs/doc/protocol/nagoya-protocol-en.pdf