

Intellectual Property and Food Security: The Peculiar Connect

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INTRODUCTION

The institution of property- ownership and control of assets is as old as humankind.³ Private property is an essential part of the human experience.⁴ Property rights are generally well understood and considered to be the fundamental basis on which economies are built.⁵ Property is of two kinds: tangible and intangible property. Intellectual property (IP) rights refer to legal property titles to forms of intangible or immaterial phenomena of value, like the structured system of words that make up a novel, or an invention, or a productive process.⁶

Intellectual property is an intangible property that is the result of creativity, such as patents, copyrights,

etc.⁷ IP is an increasingly significant and widespread form of ownership.⁸ Intellectual property rights are a bundle of exclusive rights over creations of the mind.⁹ IP is divided into two categories: Industrial property¹⁰, which includes inventions (patents), trademarks, industrial designs, and geographic indications of source; and Copyright, which includes literary and artistic works¹¹ such as novels, poems and plays, films, musical works, artistic works such as drawings, paintings, photographs and sculptures, and architectural designs.¹² Intellectual Property Rights, particularly patent laws, are traditionally

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³ Terry.L.Anderson & Fred.S.Mc Chesney, *The Economic Approach to Property Rights, In Property Rights: Cooperation, Conflict and Law* (Terry.L.Anderson & Fred.S.Mc Chesney Ed., 2003).

⁴ Timothy Sandefur, *Cornerstone of Liberty: Property Rights in 21st Century America* (2006).

⁵ Peter Lewin, *Creativity or Coercion: Alternative Perspectives on Rights to Intellectual Property*, 71(4) *J. Bus. Ethics* 442, 441-455 (2007) <http://www.jstor.org/stable/25075349> accessed 12/09/2023.

⁶ *Ibid*

⁷ The Oxford English Dictionary, <http://oxforddictionaries.com/definition/english/intellectual+property> accessed on 12/09/2019.

⁸ Edwin C. Hettinger, *Justifying Intellectual Property* (Peter Drahos ed., 1999).

⁹ Dr. B. L Patidar & Dr. D.K. Gupta, *Intellectual Property Rights Boon or Bane*, 2(7) Shodh, Samiksha Aur Mulyankan 299-231 (2009) <http://forum.ignouonline.ac.in/forum/index.php?act=attach&type=post&id=332> accessed on 27/10/2023.

¹⁰ The Paris Convention for the Protection of Industrial Property Art.1(3),1883 reads: "Industrial property shall be understood in the broadest sense and shall apply not only to industry and commerce proper, but likewise to agricultural and extractive industries and to all manufactured or natural products, for example, wines, grain, tobacco leaf, fruit, cattle, minerals, mineral waters, beer, flowers, and flour."

¹¹ Berne Convention for the Protection of Literary and Artistic Works art.2(1), Sep. 9, 1886 reads: "The expression "literary and artistic works" shall include every production in the literary, scientific and artistic domain, whatever may be the mode or form of its expression, such as books, pamphlets and other writings; lectures, addresses, sermons and other works of the same nature; dramatic or dramatico-musical works; choreographic works and entertainments in dumb show; musical compositions with or without words; cinematographic works to which are assimilated works expressed by a process analogous to cinematography; works of drawing, painting, architecture, sculpture, engraving and lithography; photographic works to which are assimilated works expressed by a process analogous to photography; works of applied art; illustrations, maps, plans, sketches and three-dimensional works relative to geography, topography, architecture or science."

¹² World Intellectual Property Organization <http://www.wipo.int/about-ip/en/> accessed on 12/09/2023.

structured to reward the non-obvious results of human ingenuity.¹³

Intellectual Property Rights: The Rationale

There have been numerous disputes about the interpretation, scope, and justification of intellectual property (IP) ever since its emergence as an important aspect of the political economy more than two centuries ago.¹⁴ Although most inventors consider it essential, it is currently under attack by some academics and policymakers.¹⁵

Historically, IP has been characterized by balance. On the one hand, its exclusionary rights provide incentives to create. On the other, its limits preserve roles in the nation's economy and democracy for competition, cumulative innovation, and free expression.¹⁶ This balancing behind intellectual property by legal system is spelled out by the Constitution of United States of America.¹⁷ The focus of the U.S Constitution is set on 'promoting the progress of science and useful arts' and on setting appropriate incentives. The incentives are thus no more than a means to realize an objective and as a matter of consequence, they are subordinate to this objective.¹⁸ Moreover, the 'promotion of the progress of science and useful arts' must be seen as a public policy objective, and the granting of exclusive rights nothing but an instrument to pursue this objective.¹⁹ Thus the basic justification for

intellectual property rights is that IP system strikes a balance between the interests of the innovators and the public interest, providing an environment in which creativity and invention can flourish, for the benefit of all.²⁰

To prevent under-investment in innovation, governments have developed and enforced a system of IP rights, giving inventors a degree of control over the use of their work. Countries have laws to protect intellectual property for two main reasons:

A. To give statutory expression to the moral and economic rights of creators in their creations and the rights of the public in access to those creations.

B. To promote, as a deliberate act of Government policy, creativity and the dissemination and application of its results and to encourage fair trading which would contribute to economic and social development.²¹

Intellectual properties, unlike tangible properties, require special legal protection because of various reasons. Unlike tangible objects, intellectual objects are public goods. Public good are both non-rivalrous and non-exclusive.²² Non-rivalrous means that their consumption by one does not prevent their consumption by others nor does it exhaust it (compare watching a movie to eating an apple).²³ Non-exclusive means once communicated, multiple individuals can use an idea or thought, as each deems fit, regardless of the intentions or desires

¹³ William Van Caenegem, *Intellectual Property and Innovation*, 18 (2007).

¹⁴ D. B. Resnik, *A Pluralistic Account of Intellectual Property*, 46(4) *J. Bus. Ethics* 319, 319-335 (2003) <http://www.jstor.org/stable/25075110> accessed on 12/09/2023.

¹⁵ Nancy Gallini and Suzanne Scotchmer, *Intellectual Property: When Is It the Best Incentive System?*, 2 *Innovation Policy And The Economy* 51, 51-77(2002) <http://www.jstor.org/stable/25054489> accessed on 12/09/2023.

¹⁶ Michael A. Carrier, *Cabining Intellectual Property through a Property Paradigm*, 54(1) *DUKE L.J.* 4, 1-145 (2004) <http://www.jstor.org/stable/40040481> accessed on 212/09/2019.

¹⁷ U.S. CONST. art. I, § 8 Clause 8 reads: "To promote the Progress of Science and useful Arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries."

¹⁸ Jacob Cornides, *Human Rights and Intellectual Property- Conflict or Convergence?*, 7 *JWIP* 149, 137-167 (2004).

¹⁹ *Ibid*

²⁰ What Is Intellectual Property? 3 (WIPO Publication No. 450(E).

²¹ *WIPO Intellectual Property Hand Book: Policy, Law and Use* (WIPO Publication No.489(E), 2008) http://www.wipo.int/export/sites/www/about-ip/en/iprm/pdf/ip_handbook.pdf accessed on 12/09/2019.

²² Richard A. Spinello & Herman T. Tavani, *Intellectual Property Rights: Theory to Practical Implementation*, in *Intellectual Property Rights in A Networked World* 5(Richard A. Spinello & Herman T. Tavani eds.,2003).

²³ Dotan Oliar, *Making Sense of the Intellectual Property Clause: Promotion of Progress as a Limitation on Congress's Intellectual Property Power*, 94 *Georgetown L.J.* 1797, 1771-1845 (2006) http://papers.ssrn.com/sol3/papers.cfm?abstract_id=924190&download=yes accessed on 12/09/2023.

of the original owner.²⁴ This public good problem with IP is that it can be costly and time consuming to produce, and may require considerable degree of inventiveness or originality. Yet, once this 'mental' investment has been embodied in a material form, it may be relatively cheap and easy to reproduce.²⁵ As a result, absent intellectual property protection, most would prefer to copy rather than create ideas, and inefficiently few new ideas would be created.²⁶ So certain kind of legal protection is necessary for intellectual property.

Issues in connection with food security with exploding population and limited land resources. The global population is expected to touch the 8.9 billion mark in the year 2050 with an anticipated per capita consumption of 3100 Kcal/day. This 40 % increase in population would necessitate a disproportionate 70% increase in agricultural and livestock productivity. This would mean that more land has to be brought under cultivation. However, analysing all possibilities, only 5% of land can be additionally brought in under cultivation during the above-mentioned period. That too has to be carefully done as introducing changes in land use could cause irreparable damage to, or the collapse of, ecological systems. Given this situation, we are left with no option other than to resort to intensified farming practices and higher yields. But this needs to be done in a sustainable way. It still remains a major challenge before us to produce and secure enough food for the world's rapidly expanding population and intellectual property rights would have a very pivotal role to play in this domain. The Green Revolution we achieved during the 1960-90 period by increasing the productivity of cereals, expanding the area of arable land and by massive increases in fertiliser and insecticide use may not be achievable with the present land-use pattern. Achieving food security, no doubt remains a major objective of the

international community which at all times have faced many difficulties including underinvestment in agriculture and rural development, substantial increases in food prices and poverty. Agricultural biotechnology has great potential to alleviate many of the food crises especially in the developing countries.

IPRs and Food Security- The Connection

IPRs were originally (traditionally) conceived to be handy in procuring limited monopolies for innovations in the industrial sector and literary and artistic creations. But more recently, IPRs have been applied to biological processes and products, including living organisms.²⁷ This expansion of IPRs to plant materials and food has however given rise to concerns about the possible implications for food security. The exclusivity and monopoly rights grants by IPRs have created apprehensions in the society about availability of these products /processes on the free domain and about aggressive pricings. These concerns at times find solace in the national and international laws providing for specific exceptions or limitations. But at times they fail in consoling the general public. As many fear, IPRs remove competition and enable the right holder to charge the price that the market will bear. For them the granting of IPRs affects access to protected products and their affordability.

Intellectual property rights impact food security in three principal areas: plant variety rights, protection, patenting and geographical indications. When we analyse the main issues concerning I.P and food security, we can narrow down to the following: Issues related to privatisation of germplasm, adverse effect on agricultural research, adverse effect of Plant breeder's rights on developing economies, Plant Variety rights protection and plight of poor farmers, Plant Variety rights protection and availability of genetic resources for breeding, Farmers rights and

²⁴ Nevin M. Gewertz and Rivka Amado, *Intellectual Property and the Pharmaceutical Industry: A Moral Crossroads between Health and Property*, 55(3) J. BUS. ETHICS 299, 295-308 (2004) <http://www.jstor.org/stable/25123392> .accessed on 12/09/2023.

²⁵ Jennifer Davis, *Intellectual Property Law 4* (3rd ed., 2008).

²⁶ Mark A. Lemley, *Ex Ante versus Ex Post Justifications for Intellectual Property*, 71(1) *U. Chi. L. Rev.* 129, 129-149 (2004)

<http://www.jstor.org/stable/1600514> .accessed on 12/09/2023.

²⁷ Even the Paris Convention for the protection of Industrial Property in 1883 in Article 1(3) declared that Industrial property shall be included within the broadest sense and shall apply not only to industry and commerce proper, but likewise to agricultural and extractive industries and to all manufactured or natural products, for example, wines, grain, tobacco leaf, fruit, cattle, minerals, mineral waters, beer, flowers and flour.

Traditional Knowledge, Conservation of Biological Diversity and food security, technology transfer and food security, Geographical Indications for agricultural products and problems of terminator technologies.

One of the primary ways IPRs influence food security is through the privatization of germplasm, which refers to the genetic material essential for breeding crops. IPR protection restricts access to germplasm, hindering public research and the development of resilient crop varieties needed to address agricultural challenges. This privatization undermines genetic diversity, making crops less adaptable to climate change, pests, and diseases. Furthermore, the imposition of IPRs often has adverse effects on agricultural research, particularly in developing countries. Licensing costs and restrictive terms prevent public institutions and independent researchers from innovating and producing affordable agricultural solutions, thereby exacerbating food insecurity in regions that are already resource-constrained.

The extension of plant breeders' rights (PBRs) in developing economies presents another challenge. While PBRs incentivize innovation by rewarding breeders for developing new varieties, they often result in higher seed prices and dependency on commercial seed producers. This situation disproportionately affects small and marginal farmers, who form the backbone of agriculture in many developing countries. These farmers, already burdened by limited resources, find it difficult to bear the additional costs of purchasing proprietary seeds every season, ultimately reducing their ability to produce food sustainably.

The protection of plant varieties under IPRs often restricts traditional practices of saving, exchanging, and reusing seeds, which have been critical for the survival of smallholder farmers. These restrictions force farmers to depend on expensive proprietary seeds, trapping them in cycles of debt and dependency. Moreover, the monopolization of genetic resources limits their availability for further breeding, which is essential for developing crops that can withstand emerging agricultural challenges. The increasing reliance on genetically modified seeds and high-tech agricultural solutions often exacerbates this dependency, further marginalizing traditional agricultural systems.

IPRs also have significant implications for farmers' rights and traditional knowledge. In many cases, traditional agricultural knowledge held by

indigenous and local communities is appropriated without adequate recognition or benefit-sharing. This not only undermines the rights of these communities but also erodes the cultural heritage associated with traditional farming practices. Ensuring the protection of farmers' rights and equitable benefit-sharing mechanisms is crucial for preserving agricultural biodiversity and supporting food security in the long term.

Biodiversity plays a critical role in ensuring food security, as it provides the genetic resources needed for breeding resilient and productive crop varieties. However, the overemphasis on commercial interests under IPR regimes often leads to monoculture practices, which diminish biodiversity and increase agriculture's vulnerability to pests, diseases, and environmental changes. This loss of biodiversity threatens the sustainability of food systems and compromises global efforts to achieve food security. Technology transfer is another area where IPRs have a profound impact on food security. While IPRs are designed to promote innovation, they often create barriers for developing countries to access advanced agricultural technologies. High licensing fees and restrictive agreements prevent these countries from acquiring technologies that could enhance their agricultural productivity and address food security challenges effectively. This inequity further widens the gap between developed and developing nations in terms of agricultural development.

Geographical indications (GIs), which protect the unique qualities of agricultural products linked to specific regions, have both positive and negative implications for food security. While GIs can help promote local products and protect the livelihoods of small farmers, the over-commercialization of these rights can limit their broader benefits. It is important to ensure that the benefits derived from GIs are distributed equitably among all stakeholders to balance economic development and food security.

The advent of terminator technologies, which render seeds sterile after a single planting season, has added another layer of concern. These technologies prevent farmers from saving seeds, forcing them to rely on commercial seed producers for each planting cycle. Such practices not only increase production costs for farmers but also threaten the sustainability of food production systems, particularly in developing countries where seed-saving traditions are integral to agricultural resilience.

The mechanisms of intellectual property rights (IPRs) in plant varieties, as mandated under Article

27.3(b)²⁸ of the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS), may lead to increased expenses for farmers, as they could be required to purchase new seeds annually. Prior to TRIPS, many developing nations maintained relatively lenient patent laws in critical areas such as food and medicine due to their essential societal importance. Interestingly, until the 1960s, even industrialized nations refrained from granting substance patents on food, pharmaceuticals, plants, or animals.

Article 27.3(b) of TRIPS obligates World Trade Organization (WTO) member states to provide protection for new plant varieties. This can be achieved through a *sui generis* system, such as plant breeders' rights (PBRs), patents, or a combination of the two. However, this provision has faced significant criticism. One concern is that patenting genetic resources—particularly those used in genetically modified organisms (GMOs)—may lead to the replacement of local and traditional crop varieties with high-tech seeds, thereby promoting monoculture in agriculture. Furthermore, TRIPS does not adequately address areas such as traditional knowledge or farmers' rights, which hold considerable significance for developing and least-developed countries (LDCs). As a result, LDCs face a dual challenge of fulfilling existing international obligations while also creating legal frameworks that address their unique priorities.

The Way Ahead- The IPR Way

²⁸ plants and animals other than micro-organisms, and essentially biological processes for the production of plants or animals other than non-biological and microbiological processes. However, Members shall provide for the protection of plant varieties either by patents or by an effective *sui generis* system or by any combination thereof. The provisions of this subparagraph shall be reviewed four years after the date of entry into force of the WTO Agreement.' See Art 27 (3)(b), TRIPS: Agreement on Trade-Related Aspects of Intellectual Property Rights, pmb1, Apr. 15, 1994, Marrakesh Agreement Establishing the World Trade Organization, Annex 1C

²⁹ Robert H. Trudell, *Food Security Emergencies and the Power of Eminent Domain: A Domestic Legal Tool to Treat A Global Problem*, 33 *Syracuse J. Int'l L. & Com.* 277, 277-78 (2005).

Looming threat of scarcity of food resources in the upcoming future and the present problems of unequal distribution of sufficient food resources are to be addressed soon. Food security “exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life.”²⁹ Agricultural biotechnology, which was heralded as a great tool in ensuring food security has become a contentious issue. Though the technology succeeds in creating GM crops that reduce the use of pesticides, improve stress tolerance, and provide better product quality and increased nutritional value critiques claim that GM crops are “inherently dangerous,” and that the scientific understanding of the impact that GM crops have on the environment and human health is inadequate.³⁰ And in developing countries like ours, though approvals have been granted limitedly for many of these GM crops, regulatory legislations are far from being put in place. Critics also add on to their criticisms saying that multinational corporations exploit the hungry in developing countries for “commercial opportunity,” some going as far as labelling this activity as criminal.³¹ However proponents of agricultural biotechnology argue that its benefits far outweigh its potential risks, and that the risks that do exist are not inherent properties of the technology³².

The justifications given for intellectual property rights have always somehow managed to outweigh the arguments against the grant of such rights.

³⁰ See, e.g., Sean D. Murphy, *Biotechnology and International Law*, 42 *Harv. Int'l L.J.* 47, 57 (2001) & Greenpeace International, *Say No to Genetic Engineering*, <http://www.greenpeace.org/international/campaigns/genetic-engineering/> accessed on 12.09.2019.

³¹ Reece Walters, *Crime, Bio-Agriculture and the Exploitation of Hunger*, 46 *Brit. J. Criminology* 26, 26 (2006).

³² According to the Declaration of Support for Agricultural Biotechnology, signed by over 3400 international scientists, including twenty-five Nobel Prize Laureates, 13 the technologies utilized to create GM crops can safely and substantially enhance efforts to ensure food security. See *Petition In Support of Agricultural Biotechnology*, Agbioworld, <http://www.agbioworld.org/declaration/petition/petition.php> accessed on 12.09.2023.

Perhaps it is the industrial nature of the economies that keeps it intact or may be the deceitful and selfish practices adopted by certain world powers. But one thing is for sure; the Intellectual Property Rights are here to stay. It cannot be completely removed from the horizon. The best method with regard to IP protection for the 'not-so-beneficent' countries and economies would be to adopt measures and strategies to get the maximum benefits from the realm and prevent the misuse of IP rights by the more developed countries.

To ensure food security across the globe including that of mitigating unequal distribution of food products across continents, agricultural innovations need to be affordable to the cultivators and should have incentives to adopt them. Exceptions provided for in all IP statutes should be beneficially interpreted and adopted. This would ensure that a balanced reconciliatory approach develops between the IP owners and the agriculturists. The provisions of the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGR) introduce an important perspective to this question. They seek to establish a concrete balance between access to biodiversity for incremental innovation and benefit-sharing to reward farmers for on-farm conservation and management of such biodiversity. The principal aim of the ITPGR is to "facilitate the exchange of seeds and other germplasm for research, breeding, and crop development."³³ Compulsory licensing provisions should be adequately and effectively adopted to secure the ends of the societal requirements by fixing appropriate royalty rates. Shortening terms of IP protection, weakened protection measures bringing in flexibilities, developing alternative methodologies for ensuring a balanced and reconciliatory approach including utility models are all progressive need-of-the-hour methods to be employed.

CONCLUSION

The intersection of Intellectual Property Rights (IPRs) and food security presents one of the most complex yet critical challenges of the 21st century. As the global population is projected to reach nearly 10 billion by 2050, ensuring equitable access to safe, nutritious, and affordable food while fostering

innovation in agriculture becomes an existential imperative. The role of IPRs in this context is both a double-edged sword and a potential catalyst. On one hand, IPRs incentivize groundbreaking innovations in agricultural biotechnology, crop improvement, pest resistance, and climate-resilient farming practices—advancements that are indispensable for addressing the multifaceted dimensions of food insecurity. On the other hand, the monopolistic tendencies inherent in stringent IP regimes risk exacerbating inequalities, marginalizing smallholder farmers, and creating barriers to access essential agricultural inputs such as seeds, fertilizers, and technologies. Therefore, reconciling the imperatives of IPRs with the ethical and practical demands of food security necessitates a nuanced, multi-stakeholder approach that balances private incentives with public welfare.

A comprehensive analysis of the impact of IPRs on food security reveals both positive and negative implications across multiple dimensions. Positively, IPRs have spurred significant advancements in agricultural research and development, particularly in areas like genetically modified crops, drought-tolerant varieties, and biofortified staples. These innovations hold immense potential to enhance productivity, reduce post-harvest losses, and mitigate the adverse effects of climate change on agriculture. For instance, the development of high-yielding rice and wheat varieties during the Green Revolution was instrumental in averting widespread famine in many parts of the world. Similarly, modern biotechnological tools such as CRISPR gene editing offer unprecedented opportunities to address nutritional deficiencies and improve crop resilience.

However, the negative implications of IPRs cannot be overlooked. Excessive patenting of plant genetic resources, proprietary seed technologies, and restrictive licensing agreements often result in the concentration of control over agricultural inputs in the hands of a few multinational corporations. This not only undermines the livelihoods of small-scale and subsistence farmers but also limits their ability to save, exchange, or reuse seeds—a practice deeply embedded in traditional farming systems. Furthermore, the enforcement of stringent IP

protections can lead to higher costs for farmers, reduced biodiversity, and increased dependency on external inputs, thereby threatening long-term sustainability. In developing countries, where agriculture remains the primary source of livelihood for millions, these challenges are particularly acute and demand immediate attention.

To navigate the intricate relationship between IPRs and food security, it is imperative to embark upon detailed research and analysis at the earliest possible juncture. Such studies should encompass all levels of impact—economic, social, environmental, and ethical—and adopt a holistic perspective that accounts for both short-term exigencies and long-term aspirations. Stakeholder institutions, including governments, international organizations, academia, civil society groups, and the private sector, must collaborate to undertake interdisciplinary research that evaluates the trade-offs and synergies between IPRs and food security. Key areas of focus should include the impact of patents on seed sovereignty, the role of IPRs in promoting sustainable agricultural practices, and the potential for alternative models such as open-source biotechnology to democratize access to innovations.

Moreover, the findings from these studies must inform the development of robust policy frameworks that can be implemented with a vision extending to the years 2050-2100. Given the urgency and complexity of the issue, international forums such as the World Trade Organization (WTO), the United Nations Food and Agriculture Organization (FAO), and the Convention on Biological Diversity (CBD) should serve as platforms for dialogue and consensus-building. These discussions must aim to create flexible, adaptive, and equitable IP regimes that accommodate the diverse needs of different regions and communities. For example, developing countries may require greater flexibilities under international treaties such as the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) to safeguard their food security interests, while developed nations may need to invest in mechanisms that promote technology transfer and capacity-building.

One of the most promising avenues for reconciling IPRs and food security lies in the adoption of sui generis legislations tailored to the specific socio-economic and ecological contexts of individual countries. Unlike one-size-fits-all IP frameworks, sui

generis systems allow for the customization of rules governing plant variety protection, traditional knowledge, and farmer's rights. For instance, India's Protection of Plant Varieties and Farmers' Rights Act (PPVFR) serves as a model for balancing the interests of breeders, farmers, and society by recognizing the rights of farmers to save, use, and exchange seeds while providing incentives for innovation. Similar approaches could be adopted globally, with adaptations to suit local conditions.

In addition to sui generis legislations, broader guidelines and policies must be formulated to ensure that IPRs contribute positively to food security. These guidelines should emphasize principles such as affordability, accessibility, and inclusivity, while discouraging practices that prioritize profit over people. Specific measures could include:

1. **Establishing Global Seed Banks and Knowledge Repositories:** To preserve genetic diversity and prevent the monopolization of plant genetic resources, international efforts should be intensified to expand and maintain seed banks. Simultaneously, digital repositories of traditional knowledge should be created to protect indigenous innovations and ensure fair benefit-sharing.
2. **Promoting Open-Source Innovation Models:** Encouraging open-source platforms for agricultural research and development can democratize access to cutting-edge technologies and foster collaboration among stakeholders. Initiatives like the Open Source Seed Initiative (OSSI) provide a blueprint for ensuring that innovations remain freely available for future generations.
3. **Strengthening Farmer's Rights:** Governments must enact and enforce laws that explicitly recognize and protect the rights of farmers, particularly in relation to seed saving, exchange, and reuse. Subsidies and support programs should be designed to empower smallholder farmers and enable them to adopt sustainable practices without being burdened by IP-related costs.
4. **Enhancing International Cooperation:** Addressing the global dimensions of food security requires enhanced cooperation among nations. Bilateral and multilateral agreements should be negotiated to facilitate the sharing of agricultural technologies, expertise, and best practices. Special emphasis should be placed on supporting least-developed countries (LDCs) in building resilient food systems.

5. Integrating Sustainability into IP Policies : Future IP frameworks must incorporate sustainability as a core principle. Innovations that contribute to environmental conservation, resource efficiency, and climate adaptation should be prioritized and incentivized through preferential treatment in patent applications and licensing agreements.

Looking ahead to the decades spanning 2050-2100, the coexistence of IPRs and food security must be envisioned not as a zero-sum game but as a symbiotic relationship that fosters innovation while safeguarding societal well-being. Achieving this balance will require active intervention from governmental, non-governmental, and private entities operating at local, national, and global levels. By embedding equity, transparency, and accountability into the fabric of IP governance, we can ensure that the benefits of innovation are shared equitably and that no segment of society is left behind in the pursuit of progress.

Ultimately, the reconciliation of IPRs and food security represents a moral and practical imperative for humanity. It is a challenge that calls upon us to reimagine the very purpose of intellectual property—not merely as a tool for economic gain but as a means to uplift lives, nourish communities, and secure a brighter future for generations to come. Through collective action, visionary leadership, and unwavering commitment, we can transform this challenge into an opportunity to build a world where innovation and food security coexist harmoniously, paving the way for a more just, prosperous, and sustainable planet.