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A Comprehensive Review on the Impacts of Intellectual Property Rights on the Global Agricultural Economy

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ABSTRACT

The agricultural sector is no stranger to the importance of intellectual property, as it serves as a catalyst for innovation, facilitates the transfer of technology, and safeguards the rights of creators and inventors. By examining the effects of IPRs on various dimensions, this paper seeks to shed light on the far-reaching implications for the agricultural industry worldwide. First and foremost, the review explores the intricate relationship between IPRs and agricultural research and development. IPRs are known to provide essential incentives for scientists and researchers to engage in ground-breaking agri-scientific endeavors, leading to advancements in productivity, sustainability, and food security. By offering legal protection and rewards for their innovations, IPRs encourage investment in agricultural R&D, driving progress in crop improvement, genetics, and biotechnology. Furthermore, the review delves into the impact of IPRs on farmers' access to seeds and genetic resources. While strong intellectual property regimes ensure fair compensation for breeders and innovators, concerns arise regarding the potentially limited access to seeds, especially for small-scale farmers in developing countries. Balancing the rights of breeders and the needs of farmers becomes a crucial aspect of agricultural policy formulation, aiming for a sustainable and inclusive agricultural system. Additionally, the review scrutinizes how IPRs affect the overall competitiveness of the agricultural market. IPRs enable agricultural enterprises to gain a competitive advantage through exclusive rights over their unique plant varieties, processes, or technologies. However, the high costs associated with intellectual property protection may pose barriers for smaller farmers and agricultural communities, exacerbating inequalities within the sector. While intellectual property rights undoubtedly play a vital role in fostering agricultural innovation and protection, the review also sheds light on the challenges and controversies associated with IPRs. The potential negative impacts on small-scale farmers, the concerns surrounding access to genetic resources, and the implications for biodiversity conservation all warrant careful consideration in the formulation of IPR policies. Through a comprehensive analysis of scholarly articles, reports, and case studies, this review provides valuable insights for policymakers, stakeholders, and researchers concerned with the multifaceted impacts of intellectual property rights on the global agricultural economy. By understanding these complexities, it becomes possible to strike a balance that maximizes the benefits of IPRs while ensuring equitable and sustainable agricultural development.

Keywords: Intellectual property rights; agricultural sector; agricultural industry; agricultural research and biodiversity conservation.

1. INTRODUCTION

Intellectual property refers to a set of legally recognized rights that are granted to individuals or entities for their creations or inventions [1]. These rights provide exclusive control over the use, distribution, and commercial exploitation of the intellectual property [2]. Intellectual property rights serve as a means to protect and reward creators and innovators for their work, encouraging further creativity and innovation [3]. There are two main classifications of intellectual property rights: industrial copyrights, which encompass patents, trademarks, geographical indications, and designs; and artistic copyrights, which cover literary, artistic, and musical works, performances, and broadcasts [4]. Additionally, there are also sui generis rights that fall outside these categories, such as breeder's rights [5]. The purpose of intellectual property rights is to create an environment that fosters creativity and incentivizes individuals to dedicate their time, effort, and resources to developing new ideas and creations [6]. Intellectual property rights (IPRs) have become increasingly significant in the global agricultural economy [7]. As the agricultural sector faces numerous challenges, including the need for innovation, technology transfer, and the conservation of genetic resources, the role of IPRs has come under scrutiny [8]. This comprehensive review aims to provide a comprehensive analysis of the impacts of IPRs on the global agricultural economy. The agricultural industry relies on intellectual property for multiple reasons. First and foremost, IPRs provide incentives for researchers and scientists to engage in agricultural research and development (R&D) activities [9]. By protecting intellectual property, such as new plant varieties, innovative technologies, or processes, IPRs enable researchers and developers to enjoy exclusive rights and financial rewards, encouraging investment in agricultural R&D [10]. This, in turn, drives agricultural innovation,

improves productivity, and addresses key challenges like food security and sustainability [11]. However, the relationship between IPRs and the agricultural economy is complex and multifaceted [12]. While intellectual property protection offers benefits, concerns have been raised regarding its potential impact on farmers' access to seeds and genetic resources [13]. As IPRs provide exclusive rights to breeders and innovators, it may limit the availability and affordability of seeds, especially for small-scale farmers, in developing countries [14]. The challenge lies in finding a balance that respects the rights of breeders while ensuring access to genetic resources for farmers who play a crucial role in agricultural production [15]. Moreover, the competitive dynamics within the agricultural market are influenced by the presence of IPRs [16]. Intellectual property protection allows agricultural enterprises to gain a competitive edge by maintaining monopoly rights over their creations [17]. However, this can also create barriers to entry for smaller farmers and agricultural communities, widening the gap between large-scale and small-scale players, and potentially intensifying inequalities within the sector. The review also explores the challenges and controversies surrounding IPRs in agriculture. Questions arise regarding the potential negative effects on small-scale farmers, particularly in terms of affordability, sustainability, and involvement in innovation processes. Additionally, concerns are raised regarding the impact of IPRs on access to genetic resources, the implications for biodiversity conservation, and the social and economic consequences at the local and global levels. By examining a variety of sources, such as scholarly articles, reports, and case studies, this comprehensive review aims to provide valuable insights for policymakers, stakeholders, and researchers interested in understanding the far-reaching impacts of intellectual property rights on the global agricultural economy [18]. Ultimately, it seeks to strike a balance that promotes agricultural innovation, ensures equitable access to genetic resources, and supports sustainable development in the agriculture sector.

Intellectual Property Rights (IPRs) have become a defining force in shaping the dynamics of innovation, trade, and economic development in the 21st century [19]. These legal mechanisms, which grant exclusive rights to creators and inventors over their intellectual creations, are omnipresent across various industries [20]. However, in a few domains, the consequences and implications of IPRs as multifaceted and far-reaching as in the realm of agriculture. The global agricultural economy stands as an arena where IPRs wield significant influence, challenging traditional paradigms while fostering innovation and economic growth [21]. Agriculture, as the bedrock of human sustenance and economic activity, has undergone profound transformations in recent decades [22]. These transformations have been driven, in part, by the ever-expanding reach of intellectual property protections into the fields, laboratories, and markets where food and agricultural products are produced, developed, and traded [23]. This comprehensive review seeks to unravel the intricate web of interactions between Intellectual Property Rights and the global agricultural economy. It delves into the historical evolution of IPRs in agriculture, ranging from early patent laws to the international harmonization efforts under the Trade-Related Aspects of Intellectual Property Rights (TRIPS) Agreement [24]. It explores the various types of IPRs applicable to agriculture, including Plant Breeders' Rights, patents, trade secrets, copyrights, and trademarks, dissecting their roles and limitations in shaping agricultural innovation and trade [25]. Furthermore, this review critically assesses the impact of IPRs on agricultural innovation, with a focus on their potential to spur research and development, attract private investment, and drive technological advancements. Simultaneously, it scrutinizes the criticisms and challenges that arise from IPRs, including concerns related to monopoly power, market concentration, and their implications for global food security and smallholder farmers. The nexus between IPRs and global agricultural trade is another pivotal dimension explored here [26]. The review investigates how international trade agreements have intertwined with IPRs, shaping access to genetic resources, fostering trade disputes, and affecting the international flow of agricultural goods. Case studies of trade conflicts linked to IPRs in agriculture are examined to illustrate the real-world implications of these legal frameworks.

2. HISTORICAL EVOLUTION OF IPRS IN AGRICULTURE

2.1 Early Developments and Patent Laws

The historical evolution of intellectual property rights (IPRs) in agriculture dates back to early developments in patent laws [27]. Early patent

laws primarily focused on protecting inventions related to machinery, processes, and industrial applications. However, they did not specifically address agricultural innovations.

2.2 The Green Revolution and Plant Breeding Rights

The Green Revolution marked a significant turning point in agricultural IPRs. With advancements in agricultural science and technology, particularly in plant breeding, the need for protecting plant varieties emerged [28]. This led to the introduction of plant breeding rights and the establishment of seed laws to safeguard the efforts and investments of plant breeders.

2.3 TRIPS Agreement and International Harmonization

The Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS Agreement) played a critical role in international harmonization of IPRs, including those related to agriculture [29]. TRIPS required member countries to provide protection for plant varieties either through patents or through an effective sui generis system [30].

2.4 Contemporary Trends in Agricultural IPRs

Contemporary trends in agricultural IPRs include the development and utilization of various mechanisms such as plant patents, plant variety protection, patents on biotechnological inventions, and the use of geographical indications and trademarks to protect agricultural products [31]. These trends reflect the ongoing efforts to balance the interest of innovators and the need for access to genetic resources and traditional knowledge in agriculture.

3. IPR IN AGRICULTURE

The protection of intellectual property rights in the agricultural sector is crucial for safeguarding the goods and services created within the industry [32]. Several forms of intellectual property rights are applicable in agriculture, including patents, geographic indications, plant breeder's rights, trademarks, and trade secrets [33]. Patents, in particular, play a significant role in providing assurance and protection for patentable plants, animals, and biotechnological processes. In India, the Protection of Plant Varieties and Farmers' Rights Act of 2001 ensures the protection of plant varieties and crops [34]. This legislation aims to encourage the development of new plant varieties and grants rights to the owner to control or prevent the use of their licensed innovation by external parties [35]. However, it is important to note that the exercise of these rights can only occur after public disclosure of the patent document. The publication of these documents facilitates further research and development by other individuals or organizations, leading to advancements in the agricultural sector [36].

3.1 The Application of IPRs in Agriculture

The application of Intellectual Property Rights (IPRs) in agriculture has seen a significant expansion in recent years [37]. It now includes various innovations and resources that are crucial to farming and food production. This expansion covers areas such as plant varieties, biotechnology, and genetic resources. These aspects of agriculture are now subject to intellectual property protection, allowing individuals or entities to have exclusive rights over their use and commercialization. This expansion of IPRs in agriculture has raised important discussions and debates regarding access to genetic resources, farmer rights, and the overall sustainability of agricultural practices [38].

A. The application of IPRs in agriculture has expanded to include various innovations and resources related to farming and food production [39]. This includes plant varieties, biotechnology, and genetic resources.

B. Examples of IPRs in agriculture include plant breeders' rights, which grant exclusive control over new plant varieties; patents that protect biotechnological advancements such as genetically modified crops or agricultural processes; and trade secrets that safeguard proprietary information related to agricultural innovations [40].

3.2 What is Intellectual Property Rights (IPR)?

Intellectual property rights (IPR) are defined as the ideas, inventions, and creative expressions that are granted the status of property by society [41]. These rights provide exclusive benefits and protections to creators and inventors, allowing

them to profit from their innovative work [42]. IPR play a crucial role in technology development, transfer, and dissemination [43]. The main objective of intellectual property rights is to incentivize innovation by promoting the protection and utilization of inventions and creative works [44]. This helps foster the growth of industries, promote technological advancements, and facilitate the transfer and dissemination of technology. Protecting IPR is crucial for any industry as it provides a foundation for progress and innovation. Intellectual property protection is necessary to encourage investment in research and development, and it is especially important for bringing new innovations to farmers and other sectors [45]. The Trade-Related Intellectual Property Systems (TRIPS) Agreement, established by the World Trade Organization (WTO), plays a significant role in shaping and defining the importance of intellectual property rights [46]. The TRIPS Agreement, which came into effect on January 1, 1995, is considered the most comprehensive multilateral agreement on intellectual property to date [47]. It encompasses various forms of intellectual property and sets standards for protection, enforcement, acquisition, and maintenance at both national and international levels [48]. It also addresses the applicability of general principles from the General Agreement on Tariffs and Trade (GATT) and provisions in other international agreements on intellectual property.

3.3 Type of Intellectual Property Right and Its Application

(i) Copyright: Copyright laws generally protect a wide range of creative works, including literary works, musical works, art, maps, technical drawings, photographs, motion pictures, computer programs, and multimedia products [49]. These laws grant exclusive rights to the author or creator of an original work, such as the right to copy, distribute, and adapt the work [50]. It's important to note that copyright protection extends to the expression of ideas, rather than the ideas themselves. The duration of copyright protection can vary, but for literary works, it typically lasts for the author's life plus sixty years [51]. However, it's important to consult specific national laws for precise details and variations in copyright protection.

(ii) Patent: Patents play a significant role in protecting and encouraging technological innovation [52]. In India, the first patent laws were introduced in 1856, and since then, they have been modified and updated to align with international standards, such as the TRIPS agreement [53]. The Indian Patent Act of 1970 underwent several amendments, with the most recent in 2005 [54]. Patents grant exclusive rights and legal protection to inventors for their new inventions, whether it be a new process or product [55]. This system promotes the development of industries and technological innovation by incentivizing the protection and utilization of inventions. Patents provide inventors with property rights and the ability to prevent others from commercializing their invention without permission [56]. It's important to note that patent rights are territorial in nature, meaning a patent obtained in one country is not enforceable in another. Applicants or inventors must file separate patent applications in different countries to obtain protection in those jurisdictions. The process of obtaining a patent involves filing an application with the regional or national Patent Office, accompanied by a description of the invention and a comparison with existing ones [57]. The duration of a patent is generally 20 years from the filing date of the patent application [58]. During this time, the patent holder has the exclusive right to prevent others from making, using, selling, offering for sale, or importing the patented invention without permission. Timely examination requests are necessary, and claims can relate to a single invention or group of inventions forming a single inventive concept.

3.3.1 There are several types of patent applications that can be filed

a) Ordinary Application: This is the standard application for a patent where the applicant seeks protection for their invention [59].

b) Application for Patent of Addition: This type of application is filed for an improvement or modification of an already patented invention [60]. It allows the applicant to add new features or enhancements to the existing patent and receive protection for the unexpired term of the main patent.

c) Divisional Application: If the main patent application discloses multiple inventions, a divisional application can be filed to separate out and pursue protection for each individual invention [61]. This allows for more focused examination and separate claims.

d) Convention Application: This application is filed when seeking to claim priority based on a previously filed application in a Convention Country [62]. It allows the applicant to secure a priority date for their invention from the date of the earlier filing.

e) National Phase Application under PCT: The Patent Cooperation Treaty (PCT) allows for the filing of an international patent application [63]. After the international phase, the applicant has the option to enter the national phase in various countries/regions. This involves filing a national phase application in each desired country/region to pursue patent protection.

(iii) Trademarks: Trademarks are indeed important for businesses to differentiate their goods or services from others in the market [64]. They can consist of various elements like words, letters, numerals, drawings, colors, pictures, shapes, logotypes, or labels [65]. There are several advantages to having a trademark. Firstly, it allows customers to easily identify and distinguish a product or service from one manufacturer or provider compared to others. Additionally, a trademark can be a powerful marketing tool, helping to attract customers and build a positive image and reputation for a company. Proper use of a trademark can also help in gaining customer goodwill. Trademarks also provide an incentive for companies to uphold the quality of their products or services. By investing in maintaining or improving quality, companies can protect and enhance the reputation associated with their trademark. Trademark protection is important as it prevents fraudulent use of a mark by others, ensuring that businesses maintain their distinctive identity [66]. Trademarks are generally valid for 10 years, after which renewal is required to continue their protection [67]. As examples, the label 'PUSA' by IARI in New Delhi, 'KNOCK WP' (formulation) by DOR in Hyderabad, and 'CIFAX,' an antibiotic formulation for use in fisheries and aquaculture, are all used as trademarks to distinguish and promote specific products or services in their respective fields.

(iv) Design: Industrial design refers specifically to the aesthetic aspects or outward appearance of a product [68]. It encompasses a wide range of industries and products, including technical and medical instruments, luxury items like watches and jewelry, household products, furniture, electrical appliances, cars, architectural structures, textile designs, sports equipment, and even product packaging and containers [69]. Protecting industrial designs is crucial for businesses as these designs are valuable assets that can increase the commercial value of a company [70]. An effective industrial design can contribute to the successful marketing of products and help to define the brand image of a company [71]. Furthermore, protecting an industrial design provides additional opportunities for revenue generation. Companies can license out the right to use their registered designs to others for a fee [72]. They can also sell the registered design rights to interested parties. The protection period for industrial designs is typically 10 years, with the possibility of renewal after every 5 years to maintain the exclusive rights over the design [73].

(v) Geographical Indications (GI): Geographical indications (GIs) are a form of intellectual property rights that cover agricultural, natural, and manufactured goods [74]. They are not related to ownership or usership interests of ICAR but can have broader significance. GIs are associated with specific geographical locations and represent a link between goods and their place of production [75]. Well-known examples include Champagne, Tequila, Darjeeling, Roquefort, Pilsen, Porto, Sheffield, and Havana. Similar to trademarks, GIs are used in product marketing and can be represented in various forms such as words, figures, graphics, and diagrams. However, GIs govern collective rights rather than individual rights. The registration of geographical indications provides protection against unauthorized use and promotes the economic prosperity of the producers [76]. It also enables seeking legal protection in other member countries of the World Trade Organization (WTO). Unlike some other intellectual property rights, the protection period for geographical indications is unlimited, with renewal required every ten years. This ensures the ongoing safeguarding of GIs and their associated cultural and economic value.

(vi) Trade secrets: Trade secrets are confidential business information that provides a competitive advantage to a company [77]. It could include formulas, processes, customer lists, or any other valuable information. Unlike patents, trade secrets are protected without registration and rely on keeping the information confidential.

(vii) Protection of plant varieties and farmers' rights: This type of intellectual property

protection recognizes the contributions of farmers and traditional communities to agro-biodiversity [78]. It aims to reward and support the development of new plant varieties while safeguarding the rights and interests of farmers.

(viii) Protection of Biological Diversity: The Biological Diversity Act covers issues related to traditional knowledge and associated knowledge in the context of conserving biological resources [79]. It recognizes the contributions and rights of traditional knowledge holders and aims to ensure fair and equitable sharing of benefits derived from biological resources.

3.4 Governing Regulations

In India, intellectual property rights are governed by various Acts. These include (Table 1).

4. INTELLECTUAL PROPERTY MANAGEMENT

Intellectual Property Management plays a crucial role in various aspects of innovation and knowledge creation [86]. It provides scientists and innovators with an inherent incentive to engage in the generation of new ideas and products. Moreover, it ensures that they receive greater professional recognition for their contributions. One significant benefit of IP management is the sharing of monetary incentives among staff [87]. By rewarding individuals for their intellectual property, organizations can motivate their employees to contribute to the development of innovative technologies and advancements [88]. This, in turn, leads to faster technological progress and a more dynamic industry. IP management also safeguards the protection of public sector research. It ensures that the valuable knowledge generated in public institutions remains secure and can be used to benefit society. Furthermore, it guarantees the availability of genuine and original products, allowing consumers to access high-quality goods. Another advantage of IP management is the improvement in the rate of adoption of technology. By providing material rewards for intellectual property, it encourages individuals and organizations to invest in research and development, leading to the creation and dissemination of new technologies [89]. Moreover, IP management provides protection for plant varieties. The TRIPs Article 27.3(b) allows for the provision of Plant

Table 1. Governing regulations of intellectual property rights

Act	Key Provisions	References
Copyright Act, 1957	Grants creators exclusive rights over their original works, such as literary, artistic, musical, and dramatic works.	[80]
Patents Act, 1970	Grants inventors exclusive rights over their inventions for a limited period, during which they can prevent others from using, making, or selling their patented invention without authorization.	[81]
Trademarks Act, 1999	Allows individuals and businesses to register distinctive signs, logos, or symbols to differentiate their goods or services from others in the market.	[82]
Designs Act, 2000	Provides protection for the aesthetic features of an industrial design. It enables creators to register and protect the visual appearance of their products, such as shapes, patterns, and ornamentation, giving them exclusive rights to their unique designs.	[83]
Geographical Indications of Goods (Registration and Protection) Act, 1999	Grants protection to goods that have specific geographical origins and possess qualities or reputation attributable to that place of origin.	[84]
Protection of Plant Varieties and Farmer's Rights Act, 2001	Provides intellectual property protection to plant varieties. It enables breeders to register and protect new plant varieties, and it also recognizes and protects the rights of farmers in relation to their contributions to the development and conservation of plant genetic resources.	[85]

Variety Protection, which safeguards the interests of plant breeders and encourages innovation in agriculture [90]. Additionally, the commercialization of intellectual property enables technologies through public-private partnerships. It allows organizations to leverage resources and expertise from both sectors, leading to the development and deployment of innovative solutions.

5. IPRS AND GLOBAL AGRICULTURAL TRADE

5.1 International Trade Agreements and IPRs

International trade agreements, such as the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS Agreement), have had a significant impact on intellectual property rights (IPRs) in the context of global agricultural trade [91]. These agreements promote the protection and enforcement of IPRs, including those related to agriculture, with the aim of fostering innovation, fair competition, and economic growth.

5.2 Effects on Access to Genetic Resources

The implementation of IPRs in agriculture can have implications for access to genetic resources [92]. IPRs may restrict access to proprietary plant varieties or technologies, potentially affecting the ability of certain countries or farmers to utilize genetic resources for crop production and breeding [93]. This has led to debates regarding the equitable sharing of benefits arising from the use of genetic resources.

5.3 Trade Disputes and Their Resolution

IPR-related trade disputes can arise when countries have differing interpretations or implementation of IPR obligations [94]. These disputes may involve allegations of patent infringements, unfair competition, or market access barriers [95]. They can be resolved through negotiation, mediation, or through the dispute settlement mechanisms provided by international trade agreements, such as the World Trade Organization (WTO).

5.4 Case Studies of IPR-Related Trade Conflicts

There have been various case studies of IPR-related trade conflicts in agriculture [96]. These include disputes over seed patents, genetically modified organisms (GMOs), plant varieties, and food products [97]. Examples include the U.S.-European Union dispute on genetically modified crops, the India-U.S. conflict on pharmaceutical patents, and the EU's stance on geographical indications for food products.

6. IMPACTS OF INTELLECTUAL PROPERTY RIGHTS ON THE GLOBAL AGRICULTURAL ECONOMY

Intellectual Property Rights (IPRs) play a significant role in shaping the global agricultural economy. While they seek to protect and incentivize innovation, their impacts can be complex and multifaceted. Here are some key details on the impacts of IPRs on the global agricultural economy:

6.1 Encourages Innovation

IPRs, such as patents and plant variety protection, provide a legal framework that grants exclusive rights to inventors and developers of new agricultural technologies, products, and plant varieties [98]. These protections encourage investment in research and development, driving innovation in the agricultural sector [99]. By protecting intellectual property, IPRs offer incentives for scientists, companies, and farmers to develop and adopt new technologies and improved crop varieties.

6.2 Promotes Modernization

IPRs facilitate technology transfer, enabling the diffusion of advanced agricultural tools and techniques across countries [100]. This promotes the modernization of agricultural practices and the adoption of more efficient and sustainable farming methods. The ability to protect intellectual property fosters collaboration between different stakeholders, leading to increased agricultural productivity and competitiveness on a global scale [101].

6.3 Enhances Agricultural Productivity

IPRs provide incentives for the development of improved crop varieties with enhanced traits such as disease resistance, drought tolerance, or higher yields [102]. Farmers gain access to these improved seeds, which can significantly enhance agricultural productivity. By protecting the investments made in research and development, IPRs ensure a steady supply of high-quality

seeds and promote the adoption of improved agricultural practices, leading to increased yields and enhanced food security [103].

6.4 Facilitates Market Access

Intellectual property protection helps create a favorable environment for agricultural trade [104]. It encourages investment in quality control systems, promotes branding, and facilitates market access by ensuring that products meet specific standards and regulations. This promotes trust among trading partners and enhances the exchange of agricultural goods globally, ultimately contributing to economic growth.

6.5 Challenges for Small-Scale Farmers

IPRs can pose challenges for small-scale farmers in developing countries [105]. By granting exclusive rights to patented technologies or protected plant varieties, access to these innovations may become limited or subject to high licensing fees, particularly when controlled by multinational corporations [106]. This can result in inequalities, as small farmers may struggle to afford or access modern agricultural technologies, hindering their productivity and competitiveness in a globalized market.

6.6 Balancing Public Interest

Striking a balance between protecting intellectual property and ensuring access to affordable technologies and seeds for farmers, especially in developing countries, remains a critical challenge [107]. Governments and international organizations work to develop policies and frameworks that safeguard intellectual property rights while also considering the public interest and the need for equitable access to innovations necessary for sustainable agricultural development [108].

7. POSITIVE IMPACTS OF IPRS ON THE GLOBAL AGRICULTURAL ECONOMY

- IPRs serve as incentives for innovation and technological advancements in agriculture [109]. By granting exclusive rights to inventors and creators, IPRs encourage them to develop new and improved agricultural technologies, methods, and products.
- IPRs promote investment in research and development within the agricultural sector [110]. The protection offered by IPRs ensures that innovators and companies can recoup their investment and secure returns, which incentivizes increased funding for agricultural research and development.
- IPRs facilitate the commercialization of agricultural innovations by offering legal protection and market exclusivity [111]. This allows innovators and companies to monetize their inventions and technologies, leading to increased dissemination of these advancements in the agricultural sector.
- IPRs can contribute to enhancing agricultural productivity and efficiency. By encouraging and protecting innovation, IPRs enable the adoption of new technologies and practices that can improve agricultural processes, increase yields, and optimize resource utilization [112]. These advancements can ultimately benefit the global agricultural economy by generating higher productivity and more sustainable practices.

8. NEGATIVE IMPACTS OF IPRS ON THE GLOBAL AGRICULTURAL ECONOMY

- One concern is that IPRs can restrict access to genetic resources and traditional knowledge [113]. This can limit the ability of farmers and communities to freely access and use genetic materials for breeding and traditional farming practices.
- IPRs can also limit farmers' rights and impede traditional farming practices [114]. The enforcement of IPRs may restrict farmers from saving seeds, practicing seed exchange, or engaging in other customary agricultural activities, leading to a loss of agricultural diversity and cultural practices [115].
- Another negative impact of IPRs is the potential increase in costs and reduced affordability of agricultural technologies [116]. Exclusive rights granted by IPRs can result in higher prices for patented seeds, biotechnological advancements, and other agricultural innovations, making them less accessible for small-scale farmers with limited resources.
- IPRs can contribute to the concentration of power and market control in the hands of a few large corporations [117]. This can create barriers to entry for smaller players, limit competition, and result in monopolistic

practices that disadvantage smaller farmers and hinder agricultural development.

9. CONCLUSION

Intellectual property has emerged as a crucial aspect in the agricultural sector, as it provides incentives for innovation, promotes technology transfer, and safeguards the rights of creators and inventors. This article analyzes the effects of IPRs on agricultural research and development, farmers' access to seeds and genetic resources, and the overall competitiveness of the agricultural market. Additionally, it discusses the challenges and controversies associated with IPRs, such as potential negative effects on small-scale farmers and concerns regarding biodiversity conservation. Through a systematic analysis of scholarly articles, reports, and case studies, this review aims to shed light on the intricate relationship between intellectual property rights and the global agricultural economy, ultimately providing insights for policymakers, stakeholders, and researchers alike.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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