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Research Article

Protection and Restriction of Grain-Related Intellectual Property Rights in the Context of Food Security Based on Industrial Internet of Things

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New technologies such as the internet of things and cloud computing are expected to leverage farming development and introduce more robots and artificial intelligence in farming. Food security is an important strategic issue for national economy and security. Intellectual property is a matter of food security. Its power not only plays a role of promoting food scientific and technological innovation, stimulating private and multinational seed industry investment, saving the cost of research and development, and improving agricultural management capacity but also may damage the biodiversity, increase farmers' burden, block food technological innovation and diffusion, increase the farmers' litigation risks, etc. Therefore, from legislation, on the one hand, we should rationally use the current intellectual property system to protect the source of grain-related intellectual property rights, set up the concept of "great protection" of grain-related intellectual property rights, and establish the protection system and operation mechanism with the participation of multiple-related institutions. On the other hand, we should restrict grain-related intellectual property rights according to law to prevent it from controlling the market, restricting competition, hindering innovation, and seeking illegitimate interests. We need to coordinate the relationship between intellectual property rights, food rights and farmers' rights, and rationally control the genetic utilization restriction technology.

1. Introduction

In recent years, Chinese enterprises have used internet of things technology to create a complete set of solutions for grain circulation informatization covering digital grain depot system, grain logistics supervision system, finished grain safety traceability system, and public information platform of grain logistics to guarantee the real quantity and good quality of grain, enhance the digital and intelligent level of grain industry, and strengthen the management of grain logistics system. It plays an increasingly important role in ensuring national food security. Under the background of building a community with a shared future for mankind, many parts of the world are still facing food crisis and barriers to agricultural technical cooperation. Intellectual property system will directly affect the innovation and transfer of agricultural technology, and then affect the quantity and quality of food supply. The impact of the intellectual property system on biodiversity will affect the stability and long-term nature of food supply. In addition, the monopoly of intellectual property rights can affect the accessibility of food. Therefore, food security is closely related to the intellectual property system. In order to ensure China's food security, it is necessary to carry forward the supply-side structural reform of agriculture, among which agricultural science and technology innovation (especially breakthroughs in key agricultural core technologies) is crucial to improving food production and quality. Only with the advantages of agricultural technology can food security be basically guaranteed [1]. For China, if we want to form agricultural technological advantages, we need to establish a sound legal system of agricultural intellectual property rights

to master the main control of food production, so as to ensure the safety of food quantity and quality.

2. Food Security and Its Severity

2.1. The Connotation of Food Security. In 2015, José Graziano da Silva, the director-General of the Food and Agricultural Organization of the UN (FAO), pointed out that food security is an essential foundation for peace, political stability and sustainable development in special session of the UN Peacebuilding Commision. In order to contribute to one of the United Nations Sustainable Development Goals, "Eradicate hunger, achieve food security, improve nutrition and promote sustainable agriculture," state members should strive to achieve: first, the object of food supply should be clear, that is, to whom to supply; second, the quantity of food supply should meet the real needs of life; third, the quality of food supply should be guaranteed and should not be harmful to human health; fourth, the food supply must be stable and should meet the sustainable needs of the population; fifth, food should be accessible, which means it can be both available and affordable.

2.2. Severity of Food Security. In the perspective of international, it is a long-term and arduous task to ensure food security and eradicate poverty and hunger for the international community. Since the 1970s, the Food and Agriculture Organization of the United Nations has endowed "food security" with different connotations in different periods. Its content tends to be rich and improved and is more in line with the concept of building a community with a shared future for mankind. In 2015, the United Nations Sustainable Development Summit adopted the 2030 Agenda for Sustainable Development, which states that food insecurity is not just about hunger. The goal of "zero hunger" is not only to end hunger but also to provide safe, nutritious, and sufficient food for all people all throughout the year and to eliminate all forms of malnutrition. The State of Food Security and Nutrition in the World 2021 report, jointly issued by the FAO, IFAD, UNICEF, WFP, and WHO, stated that the number of undernourished people in the world continues to increase in 2020, with a total of 720 million to 811 million people facing hunger in 2020. If we take its median value (768 million), the number of hungry people in 2020 is about 118 million more than in 2019, and if we take its upper limit (811 million), it increases by 161 million. (See Figure 1 2005–2020. The data of undernourished population in the world.). These people are more vulnerable to the risk of malnutrition and ill health due to their lack of regular access to nutritious and adequate food and are forced to sacrifice in the quality and/or quantity of food, with serious consequences for human health and well-being [2].

In addition, the data from the 2021 State of Food Security and Nutrition in the World Report show that food shortage exists in all countries around the world, not only in low-and middle-income countries but also in high-income countries. The hungry is mainly concentrated in developing countries in Asia, Africa, Oceania, Latin America, and the Caribbean. These countries have insufficient investment in agriculture, so the output is difficult to meet or continuously meet the local food supply. Once the fluctuation of the global economy causes the raise of food prices, the number of hunger people will increase. Thus, it can be seen that food security is a key issue facing mankind and needs to be solved for a long time.

From our country' reality, food security is the great strategic basis to safeguard national security and state independence, and is also an anchor to stabilize the national economy and society. In recent years, China's grain output has achieved steady-state growth, and total grain output has remained the first in the world for years. However, affected by the global economic recession and other factors, China still has a certain scale of food-deficient population. Some scholars point out that there are still about 125 million malnourished people in China in 2017 [3]. Traditional breeding, planting and other grain-related technologies can no longer meet the increasing food and nutrition needs of Chinese in present situation, so the improvement of intellectual property system should be regarded as an important measure to solve the food security problem. We should fully utilize economic, policy and legal measures to promote the transfer of advanced agricultural technology from developed countries to China, and pay attention to the incorporate and re-innovation of technology after the technology import. At the same time, we should encourage and support domestic scientific research institutions to actively research and develop grain-related technologies with independent intellectual property rights and international competitiveness.

3. The Effects of Intellectual Property System on Food Security

Intellectual property system is a two-edge sword. We should not only protect innovations from infringement but also prevent the abuse of the right from hindering the development of innovation. While the achievements of agricultural science and technology innovation are protected, it is inevitable to infringe on farmers' rights to select seeds and grow food. Therefore, it is necessary to fully understand the positive and negative effects of the agricultural intellectual property system on China's agriculture.

3.1. The Positive Effects of Intellectual Property System on Food Security. In 2010, the Outline of Agricultural Intellectual Property Strategy issued by the Ministry of Agriculture defined the scope of China's agricultural intellectual property rights, including the rights of new varieties, the rights of geographical indications of agricultural products, grain-related patent rights, trademark rights and copyrights related to agriculture, etc. It can be seen that the scope of grain-related intellectual property rights is very wide.

Modern agriculture and agricultural industrialization cannot be independent of scientific and technological innovation. On the one hand, it reflects the reliance of modern agriculture and agricultural industrialization development on agricultural science and technology innovation. On the

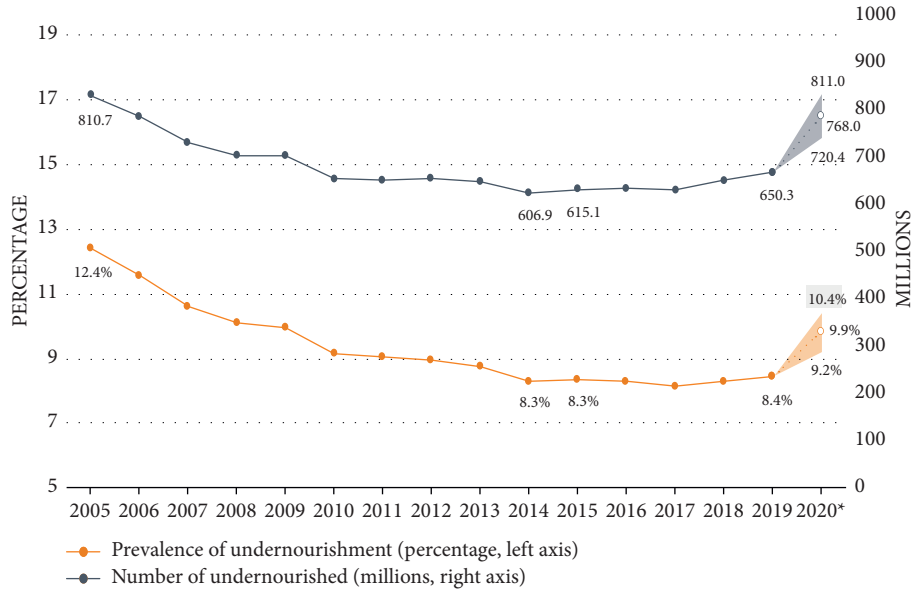

Figure 1: 2005–2020 the data of undernourished population in the world.

other hand, it also reflects that the effectiveness of agricultural science and technology innovation needs to be tested by the actual development of modern agriculture and agricultural industrialization. The author thinks that the use of intellectual property system in agriculture directly reflects the relationship between high-tech agricultural products and the market. Further, the essence is reflected in the relationship between grain-related intellectual property rights and human needs. Since human needs are diverse and ever-changing, food-related intellectual property rights must also be pluralistic, multilevel, and developmental to meet the ever-changing multilevel needs of human beings.

3.1.1. Promote Innovation in Grain Science and Technology. Scientific and technological achievements have played an important role in increasing grain quantity and improving grain quality. Each round of advances in agricultural science and technology has been reflected in the improvement of grain quantity and quality. On a world scale, scientific and technological progress has promoted the development of modern agriculture, such as the proposal of the cell theory in the 19th century, which changed the traditional empirical farming habits; the establishment of plant mineral nutrition theory has promoted the application of chemical fertilizer in agriculture; the theory of evolution provides a theoretical basis for biogenetics and breeding. At the beginning of the 20th century, with the proposal and application of the hybridization, new varieties of grain crops were bred continuously, which provided a foundation for stable and increased yields. In the 1970s, the application of bioengineering technology improved grain productivity.

Practice demonstrates that the role of science and technology is indispensable among the various elements of promoting grain production, and the intellectual property system to ensure the development of science and technology has played a key role as a legal means. The intellectual property system has greatly aroused the initiative and enthusiasm of R & D's innovation investment by giving developers a monopoly right to commercial utilization for a certain period of time, encouraging innovation and protecting innovations. In 1997, China promulgated the Protection Regulations of Plant Variety Right, which not only promoted the investment enthusiasm and innovation enthusiasm of breeders but also promoted the emergence of more and more new food varieties. It is of great significance to ensure food security according to law.

3.1.2. Encourage the Investment Enthusiasm of Breeders. The new plant variety protection system has effectively promoted the development of China's breeding industry and give farmers more opportunities to choose seeds. At present, research institutions still hold a dominant position in the research and development of new varieties in China, and breeding is affected by national policies to varying degrees. In recent years, China's enterprise has also made great progress in breeding, and breeders have begun to pay attention to the protection of their own rights and interests. With the in-depth implementation of the variety right system, variety right has increasingly become the dominant competitiveness of enterprises. Some scholars think that new variety right can provide lasting incentive power of innovation for obligee by granting breeders with private property rights and promote the transformation of breeding innovations into realistic advanced productivity. In recent years, the national financial investment is inclined to the field of basic scientific research, while social funds are inclined to the research and development of new varieties, which shows that the research and development of variety rights has great economic value.

Variety right protection start late in China, but it has some influences. In 2018, the number of applications for new variety rights of agricultural plants ranked first in the world.

However, the defects of the new variety protection system cannot be ignored [4]. First of all, China's variety system obviously lags behind the international development. Biotechnology and agricultural technology are far from the perfection. Second, local governments lack sufficient comprehend of new varieties, and their propaganda and promotion are insufficient to fully implement the new variety system. Finally, the infringement of new agricultural varieties is serious, and there are some prominent problems, such as long period of right protection, the difficult problem of proof, high cost, low compensation, poor effect, and so on [5]. Breeders cannot really stand up for themselves. Protecting the rights and interests of breeders through intellectual property rights system can fully mobilize the enthusiasm of breeders and stimulate innovation, which will increase the opportunity for farmers to choose new varieties, promote farmers to reasonably predict the yield and protect their production interests.

3.1.3. Promote the Timely Application of Grain-Related Technologies. Before the establishment of the intellectual property system, based on competitive considerations, people tended to protect their intellectual creation achievements through secrecy, which caused a certain degree of delay in the dissemination of scientific and technological information and affected the promotion and application of inventions and creations. After the establishment of the intellectual property system, it not only promoted the formation of grain-related technology but also accelerated the application of grain-related technology and avoided the waste and loss of grain-related technological resources. The requirement of openness of technical information in the patent application system not only helps to avoid unnecessary investment and duplication in R&D but also helps developers to discover new problems and initiate new lines of discussion based on the disclosure of technical information.

3.1.4. Improve the Market Competitiveness of Grain Varieties. In recent years, with the implementation of land circulation policy, a number of agricultural leading companies have carried out agricultural industrialization and large-scale operation, which not only promoted agricultural mechanization and modernization but also increased farmers' income and promoted the development of related industries by increasing agricultural income. Among them, the trademark rights and geographical indication rights have been effectively used in food business, forming a greater competitive advantage.

In the Agreement of Trade-related Intellectual Property Rights (TRIPs), geographical indication right is an international protection right parallel to trademark right, and its reasonable use not only shows local characteristics to the society but also can obtain more obvious economic benefits through location advantage and comparative advantage. For example, the sales price of Wuchang rice in Heilongjiang province, which has a large sales volume in China, is more than twice that of similar rice; Qinzhou millet, Shanxi's special agricultural product, sold at 10 yuan per catty more than ordinary millet. The increase in income of these grain varieties is the direct result of geographical indication right. Based on geographical indications, through the protection of certification trademarks, not only the quality standards are guaranteed but also the regional advantageous varieties have realized large-scale and industrialized production and management.

3.2. Negative Effects of Intellectual Property System on Food Security

3.2.1. Damage Biodiversity. In theory, the intellectual property system has a protective effect on biodiversity and genetic resources [6]. But in practice, the intellectual property system has some negative effects, which is reflected in: first, it has caused the loss of a large number of traditional crop varieties. The intellectual property system encourages the research and development of new varieties and replaces traditional varieties with new varieties, which directly causes the diversity of crop genetic resources to face the challenge of constantly changing new varieties all over the world. Some scholars evaluate that it leads to irreparable loss of biodiversity [7]. For example, genetically modified organism (GMO) technology plays an obvious role in solving food shortage, reducing pesticide use and avoiding environmental pollution. However, the genetic pollution has the characteristics of concealment, proliferation, nonelimination, and uncertainty of consequences [8]. And the phenomenon of gene flow produces superweeds, resists antibiotics, and induces new viruses. These results in GM crops affect and alter the natural environment of non-GM crops in a certain range outside their growing area. Second, the exclusivity of intellectual property right may make new food varieties controlled by a few economic entities, and it is extremely vulnerable to abuse, which will inevitably affect environmental protection and the sustainable development of food production. For example, the protection of new plant varieties may lead to monoculture, which may result in the substitution of a large number of traditional crop varieties, thus seriously damaging the biodiversity [9].

3.2.2. Increase Farmers' Grain Planting Burden. Intellectual property system not only promotes the development of science and technology and economic growth but also leads to the increase of social costs and aggravates the burden of farmers. Although many countries including China have been implementing the policy of farmers' interests' protection, the problem of increasing farmers' burden caused by the implementation of intellectual property system in the agricultural field still exists. According to the case of Monsanto Canada Inc. v. Percy Schmeiser, the implementation of TRIPs is a devastating disaster to farmers, especially in developing countries, because TRIPs increases the cost of seeds, medicines, and basic necessities of life. And the farmers' habit of recovering and sowing seeds of agricultural plants, which has lasted for

thousands of years, is now being prosecuted on suspicion of theft.

Domestically, if the protection of new variety rights is not handled well, it will also have a chain reaction. Transgenic rice is a foreign patented product. Foreign companies have also applied for the protection of new variety rights in China. If commercialized in China, it will inevitably be restricted by foreign obligees. The cost of restricting rights will naturally be transferred to the farmers who grow grain. If farmers use this variety of seeds, grain prices will naturally rise; if farmers cannot afford seeds, it may lead to a decline in planting and a reduction in farmers' income. Over time, it is bound to destroy our government's policy of reducing the burden on farmers because it is involved in the trap of international patents.

3.2.3. Block the Transformation of Grain-Related Technologies. In terms of the number of transferable patents, the exclusive right of the patentee obviously has a certain restrictive effect on it, which directly affects the transformation rate of scientific and technological achievements and prolongs the time lag of technological innovation [10]. As early as in the Human Development Report released by the United Nations Development Programme in 1999, it has pointed out that the strict protection of intellectual property rights has made developing countries lose the advantage of later development in industry and opportunities for the follow-up development of biotechnology industry. The Convention on Biological Diversity (CBD) also makes relevant requirements in this regard, "Parties shall adopt legislation as appropriate to transfer technology to developing countries in accordance with the principles of equity and mutual benefit." Developed countries should actively fulfill their international obligations on relevant agricultural technology transfer and encourage or compel private corporations (especially multinational corporations) to actively participate in technology transfer by regulations, while developing countries should undertake to give intellectual property protection to the transferred technology [11]. It can be seen that if only one-sided emphasis is placed on intellectual property right protection in the process of agricultural technology transfer without addressing the issue of high license fee, the transfer of advanced agricultural technologies is bound to be affected.

3.2.4. Create the Risk of Litigation against Farmers. Grain-related intellectual property owners not only enjoy the right to implement, license, and transfer their achievements but also enjoy the right to prohibit others from using their achievements without permission. If anyone is found to have implemented his patented technology or variety rights without permission, means including litigation will be initiated to safeguard his rights. For example, in order to safeguard the rights of GM crops, Monsanto not only hired professional lawyers but also hired private detectives in North America to collect evidence of infringement. Some scholars point out that, according to the contract, Monsanto files a large number of lawsuits as the plaintiff. In 1999 alone, there were 475 lawsuits against farmers for breach of contract.

4. Grain-Related Intellectual Property Rights and their Characteristics

4.1. The Scope of Grain-Related Intellectual Property Rights. Grain-related intellectual property rights include patents formed in the field of grain production, new plant variety rights, copyrights in the promotion of grain science and technology, trademark rights, and geographical indication rights in the grain commercialization, trade secrets related to grain, etc.

4.1.1. Grain-Related Patents. Since grain varieties are not protected by the patent law in China, grain-related patents mainly include two parts: the first part mainly refers to the cultivation methods of grain varieties and the substances specially used in cultivation. This part of patent technology can be divided into four categories: the first are the production methods and invention of new grain varieties, such as traditional biotechnology methods, modern hybridization methods, and gene recombination methods; the second are the inventions of microbiological methods and microorganisms. Microorganisms mainly refer to all kinds of bacteria, actinomycetes, fungi, viruses, protozoa, and algae; the third are automatic breeding methods of new grain varieties, such as the method for culturing artificial seeds by cell totipotency, the technics of embryo bisection, technics of animal hormone transfer; and the fourth is the invention of genetic engineering. The second part are the patents related to grain production: first, the patents of various tools needed in grain production are collectively called agricultural production materials; Second, "agriculture, rural areas, and farmers" products generally refer to agricultural chemical fertilizers, pesticides, agricultural films, and packings.

4.1.2. New Plant Variety Rights. First, a new plant variety must be artificially cultivated, and if it is a wild plant, it must also be artificially cultivated; second, a new plant variety must also meet the constitutive elements, that is, novelty, specificity, consistency, and stability; [12] third, the plant variety shall have an explicit name. The rights resulting from the plant variety referred to in the above concept are the exclusive rights granted to the developer by the national authority in accordance with law, and their implementation rights include the rights to produce, the rights to sell, the rights to use, and the identifier rights, etc. And the disposal rights include license rights, transfer rights, pledge rights, trust rights, securitisation rights, etc.

4.1.3. Trademark Rights of Agricultural Products. Trademark is a symbol to distinguish the source of products and an edge tool for agricultural products to participate in market competition. The agricultural product trademark has developed from the simple identification function to the recognition function of the product and has become a

symbol to identify the quality of the agricultural product and even the corporate culture. For agricultural enterprises, except for agricultural products, agricultural by-products and agricultural processed products can apply for trademark registration.

4.1.4. Agricultural Trade Secret. Agricultural trade secret mainly refers to agricultural technology information and agricultural business information. Agricultural technology information mainly includes the patent technology program to be applied for or applied for but not disclosed; the new plant varieties, new germplasms, and new (propagation) materials to be applied for or applied for but not disclosed; the microbial strains to be applied for or applied for but not disclosed; the cultivation methods, test data, and propagation materials in the process of experimentation; the know-how, process formula, and technological information in the research and development stage, etc. Agricultural business information mainly includes business methods, management models, production and marketing strategies, supply resources, clients information, financial statements, supply and sales channels related to production, and sales and other business activities.

4.1.5. Geographical Indication of Agricultural Products. According to the provisions of Article 22 of the Agreement of Trade-related Intellectual Property Rights (TRIPs), geographical indication indicates that a product originates in a member territory, or in a region or a place within that territory, and the specific quality, reputation, or other characteristics of the product are mainly related to the geographical origin. The objects protected by geographical indication are usually agricultural products, agricultural by-products, and agricultural processed products.

4.2. Characteristics of Grain-Related Intellectual Property Rights. Compared with other intellectual property rights, grain-related intellectual property rights have four notable characteristics.

4.2.1. Biology of the Carrier. The carriers of grain-related intellectual property rights are organisms, which have biological activity and can replicate themselves, while industrial intellectual property rights are all attached to industrial products. Aside from technical factors, industrial products can be controlled by human beings, and they do not have life movement. However, the objects of grain-related intellectual property rights are mostly attached to the material with life characteristics. In addition to the influence exerted by human beings, they still have some degree of autonomy, such as self-reproduction and variation, which makes grain-related intellectual property rights have great instability. Take the new plant variety right as an example, one of the conditions for obtaining it is stability. Therefore, once the variety cannot maintain the characteristics at the time of application, the obligee will lose the variety right. In addition, unlike industrial intellectual property, it is difficult for new plant varieties to describe and examine their characteristics and traits in writing. Therefore, novelty cannot be determined by reviewing technical programs, but propagation materials and harvest materials must be reviewed.

4.2.2. Difficult Control of Rights. In practice, in order to facilitate the dissemination of new varieties, new agricultural scientific research achievements and new technologies are generally demonstrated and popularized in the field. Because of its poor controllability and weak technical confidentiality, it is difficult for the owners of intellectual property rights to use effective mechanisms and means to ensure that their rights and interests are not infringed. It can be seen that grain-related intellectual property rights are relatively easy to lose and spread. Some scholars said, "there is still a big gap between the protection of agricultural science and technology intellectual property rights and the protection of industrial technology intellectual property rights in China."

4.2.3. Complexity of Infringement Judgments. Food production is related to science and technology, as well as to the impact of crop production cycle and the distribution of agricultural resources. Therefore, the infringement judgment of grain-related intellectual property rights is complex. Influenced by seasonal factors, cases involving new agricultural plants are often faced with the evidence collection difficulty. The technical means used by the courts in China to hear disputes on plant variety rights are not scientific enough, and the number of infringement cases heard is also very small [13]. There are defects in the current relevant laws and regulations on the game between variety rights and seed reservation right [14], which has caused obstacles to the judgment. Some foreign practices in this regard are worth learning from. The United States provides breeders with a variety of IPR products (plant patents, utility patents, plant variety certificates, etc.) to choose from. Some scholars pointed out, "breeders do not have to choose only one type of protection. For more valuable varieties, the scope of protection can be expanded by stacking rights."

4.2.4. The Risk of Variety Breeding. For the acquisition and commercialization of new grain varieties, there are great risks: the first is the risk brought by nature. Although the cultivation of new grain varieties can be carried out in the laboratory, these varieties must experience the test of nature. In addition to the influence of scientific research level and technical conditions in the early cultivation, they will also be affected by natural factors such as seasonal change, climate change, regional differences, and soil moisture. In the event of natural disasters, such as insects, floods, and hurricanes, the new varieties in experimental fields may be completely lost. Second, from the perspective of commercialization process, new varieties of agricultural seeds are quite different from commodity grains in processing, storage, and transportation. Once their biological characteristics are

destroyed, their value will decrease sharply and even cause irreparable losses.

5. Protection System of Grain-Related Intellectual Property Rights

In the existing legal system, the legislation and protection of intellectual property rights of some crops are relatively sound, but there are still legislative omissions in the other part. The author believes that grain-related genetic resources and traditional grain-related intellectual property rights need to be protected, which are closely related to food security. In the process of legislation, we should not only consider the protection standards and intensity but also start from the market law and reflect the diffusion and dissemination of intellectual property rights from the protection scope, protection period, and protection mode.

5.1. Protection System of Grain-Related Genetic Resources. Agricultural genetic resources are the source of agricultural intellectual property rights. For a long time, agricultural genetic resources have been regarded as the common heritage of mankind. Developed countries have taken advantage of technology to use them without compensation, not only to produce a large number of new plant varieties but also to be protected by international intellectual property rules; [15] at the same time, genetic resources are excluded from intellectual property protection, so that developing countries not only fail to share the benefits derived from the use of genetic resources in developed countries but also are subject to their intellectual property rights. This has a serious impact on the food security of developing countries [16]. Therefore, it is necessary for China to strengthen the protection of genetic resources and guarantee food security by innovating the intellectual property system. To create a new right, it is necessary to clarify the elements of that right, including the subject, object, and content.

5.1.1. The Subject of Genetic Resources Right. As a new type of intellectual property right, the subject of genetic resources right itself is uncertain, and the realization of the right has been troubled for a long time. Because there may be legal subject and factual subject of grain-related genetic resources, according to the principle of state sovereignty, the state should be the legal subject, but farmers' long-term preservation and use of these resources also constitute the factual subject [17]. How to determine the subject of rights? Only when we first establish the state as the subject can we avoid the dispute of rights, but we must respect farmers' right of access and use.

5.1.2. The Object of the Genetic Resources Right. The object of genetic resources right includes both genetic resource itself and genetic information resource. The former has the attribute of tangible property. Although it should be protected by property law, but due to the deficiency of property law protection, it should also be included in the protection of genetic resources right. The object of the latter is intangible, and the later is the main object of the genetic resources right.

5.1.3. The Content of the Genetic Resources Right. Regarding the content of genetic resources right, Riley believes that genetic resources rights should include the right to save seed, the right to use the latest technology, the right to be informed when third parties collect genetic material, the right to reproduce samples, and the right to gain social prestige for providing genetic resources. Girsberger believes that genetic resources rights include the right of exclusive use and sale; the right of informed consent is that no one shall use it without the consent of the owner of the genetic resources; and the right to be paid includes economic and noneconomic compensation. At the same time, the owner of the genetic resources must fulfill due obligations, such as preserving, naming, indicating, or helping to collect the plant genetic resources and their wild and weed parent [18]. It can be seen that genetic resources rights are similar to patent rights in that they include both enforcement and disposition rights.

On improving the legal protection of agricultural genetic resources, efforts should be made from two aspects: first, in terms of domestic law, China's current patent law reflects the protection of genetic resources. The patent law includes genes, DNA sequences, and other genetic substances into the protection scope in the form of genetic resources protection and requires patent applicants to disclose the source of genetic resources they use in the process of invention in their application documents. While protecting genetic resources, it safeguards the interests of obligees. At the same time, it also reduces the phenomenon of our genetic resources being copied and abused by foreign countries. It is suggested that China join the International Treaty on Plant Genetic Resources for Food and Agriculture as soon as possible, strengthen international cooperation and protection of agricultural genetic resources, promote sustainable use of plant genetic resources for food and agriculture, and further enhance China's voice in the formulation of international rules in the field of plant genetic resources for food and agriculture. Second, in terms of international law, all stakeholders in the states parties, including governments, public institutions, the private sectors, and local communities, shall jointly actively implement the measures required by the Convention on Biological Diversity(CBD), the International Treaty on Plant Genetic Resources for Food and Agriculture, the Nagoya Protocol on access and benefit sharing (ABS), and other international laws. The relevant reward and punishment mechanism and other supporting systems should be further improved.

5.2. Protection System of Traditional Grain-Related Intellectual Property Rights

5.2.1. The Scope of Traditional Grain-Related Intellectual Property Rights. The scope of its objects is relatively broad, referring to the general knowledge related to the traditional grain production process, seed selection and sowing, daily management techniques, tips for solving problems in the

production process, and all production experience in daily operations, etc. It also includes traditional grain-related geographical indications.

5.2.2. The Protection Methods of Traditional Grain-Related Intellectual Property Rights. The first is the patent protection. Whether traditional knowledge can be protected by patent system depends on its novelty, creativity, and practicability. The judgment of novelty is the difficulty of patentability of traditional knowledge. Traditional knowledge can be divided into two categories according to the state of existence: disclosed and unpublished. The first category is the traditional knowledge that has been disclosed. According to the degree and scope of its disclosure, it can be divided into traditional knowledge that is open to the outside society and traditional knowledge that is not open to the outside society but is freely circulated and publicly used internally. The former belongs to the traditional knowledge that has been disclosed to the external society. In terms of appearance, its novelty has been lost. But in terms of essence, its commercial value has not been realized. So it should be judged that it doesn't lose its novelty. The latter is limited to free circulation and public use within the collective and also doesn't lose its novelty. The second type is the unpublished traditional knowledge. The reason why it is judged to be unpublished is that the knowledge is controlled by a small number of people in the collective and retains a secret state, which is suitable for trade secret protection. Creativity is reflected in the fact that traditional agricultural knowledge is bred under the specific and long-term historical and cultural background, and modern agricultural technology cannot replace it. Its practicality is outstanding. The traditional grain-related production knowledge is not only born in a specific cultural environment but also has been used for a long time and effective. So new inventions based on traditional knowledge can certainly be patented.

The second is the trademark protection. Trademark right protection may be applied for marks and names related to grain production. Generally, collective trademarks and certification trademarks are used for protection, which not only protect the traditional marks that have enjoyed certain goodwill but also protect the origin marks of the grain varieties.

The third is the trade secret protection. As mentioned earlier, a portion of traditional knowledge is undisclosed knowledge held by a few members of the collective. Such knowledge is suitable to be protected by the trade secret system. The key is that not all traditional knowledge can directly drive business value, especially those with a unique religious connotation, cultural implication of traditional knowledge. It is difficult to meet the business value elements. In addition, in order to obtain legal protection of trade secrets, the holders of trade secrets must take security measures, which is often difficult to achieve because the cost of taking security measures is too high in indigenous and local communities where the level of economic development is generally low. Therefore, traditional knowledge that is confidential, has business value, and is suitable to be controlled by security measures can be protected by the trade secret system.

The fourth is the protection of geographical indication right. If it is determined that a certain crop variety only comes from a certain region, the name of the region can be used to apply for the protection of geographical indication right, and the traditional production technology and production knowledge can also be included in the protection scope or protection requirements, such as Yunnan PUER tea (PUER), Darjeeling tea, Colombia coffee, and Idaho potato in the United States.

The fifth is the special law protection. Based on the limitations of the current intellectual property right system on the protection of traditional grain-related knowledge, many countries in the world have enacted laws to protect them, such as Thailand, Brazil, Panama, South Africa, Peru, and so on.

These forms of intellectual property (IP) protection can be applied comprehensively, and different forms of IP protection can be adopted according to different situations of traditional knowledge. In addition to direct intellectual property protection for traditional knowledge, defensive protection can also be implemented for traditional knowledge. This protection is useful to prevent the granting of illegal intellectual property rights. We can achieve defensive protection through the documentation of traditional knowledge, the establishment of traditional knowledge database, the source disclosure system of traditional knowledge, and the antiunfair competition system.

6. Restriction System of Grain-Related Intellectual Property Rights

The farmers' convention of saving seed is not only a common cultivation pattern for generations but also the main reason why many agricultural genetic resources can maintain such a rich and diverse style. Therefore, while protecting advanced agricultural technologies, farmers' long-standing saving seed convention should be taken into consideration. However, since there is no farmer's exemption provision in the U.S. patent law, and the courts have interpreted the relationship between the U.S. Plant Variety Protection Act (PVPA) and the patent law as independent of each other. Although the PVPA has a farmer's exemption provision, it does not affect the scope of protection granted to the patentee by the patent law [19]. From the case of Monsanto Co. v. McFarling, we can see that the U.S. courts have adopted the traditional explanation of the first sale principle and tying arrangement [20]. So that in the face of this biotechnology case, it may be deficient and inappropriate, and it is impossible to use PVPA to protect farmers' rights.

In the light of our legislation, China has not included new plant varieties into the scope of patent law protection, therefore, farmers' reservation of seed does not constitute patent infringement. Even if grain varieties are included in patent law, farmers must be given the right to save seed, or saving seed must be taken as reasonable terms of use provisions. Otherwise, it is not conducive to the protection of

farmers' legitimate interests, and it is also difficult to ensure food security. In practice, the excessive protection of grain-related intellectual property rights will restrict farmers' grain growing rights. Therefore, while protecting grain-related intellectual property rights, we must also restrict the exercise of grain-related intellectual property rights from the perspective of protecting grain growing rights.

6.1. Establish the Protection System of Farmers' Right to Grow Grain. The protection of farmers' right to grow grain needs to coordinate the conflict with new variety right of grain. Internationally, the Food and Agriculture Organization of the United Nations and other similar international organizations are usually responsible for coordinating and managing farmers' right to grow grain among member states. Each country should establish relevant domestic institutions in accordance with international treaties to enjoy the rights and fulfill the duties on behalf of farmers in each country. Farmers' right to grow grain is a kind of prior right of use, which can be applied to international organizations for confirmation in advance, and can be used as a statutory defense in the face of infringement charges. For the benefits obtained from the prior right of use, farmers naturally enjoy distributive rights and interests. Legislative processes on farmers' rights have been initiated in some countries. In 2001, India enacted the Plant Variety Protection and Farmers' Rights Act, the first law on farmers' right to grow grain in the world, which set an example for other countries to protect farmers' right to grow grain [21].

6.2. Reasonably Restrict the Grain-Related Intellectual Property Rights. Intellectual property rights are private and social in nature, and the purpose of protecting private rights is to encourage innovation and protect the innovative achievements of researchers. However, its social attribute also requires the IPR system to protect the public interest, and when the private right protection conflicts with the public interest, the public interest enjoys priority protection. Food security is the greatest public interest. When the protection of grain-related intellectual property rights endangers food security, governments of all countries can take measures to restrict grain-related intellectual property rights. Specific restrictions are mainly reflected in the following two aspects.

6.2.1. Establish Farmers' Right of Saving Seed. The law protects breeders' interest through new variety rights. This protection should be limited to the protection of the number of varieties produced by breeders. Farmers should have the right of saving seed, and the use of these seeds should not be regarded as an infringement of the new variety right. This regulation is not only a restriction on the new variety right but also a respect for farmers' growing habits and a guarantee for food security.

6.2.2. Restrict the Genetic Utilization Restriction Technology. Genetic utilization restriction technology (GURT) is a new trend in grain-related intellectual property right. The application of GURT will have a negative impact on food security and farmers' right to grow grain. We must design relevant systems to restrict the innovation and application of biotechnology. Technology that is not bound by any legal system is dangerous [22].

First, we should maintain farmers' privilege and ensure the availability of the gene pool. Saving seed is a traditional cultivation practice that is natural in our country, but GURT provides sterile seeds. Harvested with these seeds can no longer be reused as seeds [23]. Although GURT is allowed to exist in China as a case, the author suggests that: first, GURT cannot be used in main food crops; second, for the GURT implemented by foreign multinational agricultural enterprises, we must maintain the availability of gene pool; third, legislation should be passed to require that if GURT crop varieties are promoted in China, they must apply for patent or be protected through variety right, and other developers cannot be excluded from enjoying the paid use right of the special gene.

Second, we should ensure that farmers have the right to know their seed choices. Farmers choose to purchase seeds with termination technology even when they realize that it will increase production costs. This is often the result of information asymmetry between GURT providers and farmers. When GURT seeds first hit the market, seed companies try their best to bring farmers to the platform of sterile seeds, touting this platform as the safest seed technology. Giant genetic companies fix the price of seeds low to encourage farmers to buy their sterile seeds. After destroying their competitors in other industries, the genetic giants raise the price of seeds and the chemicals that change the reproductive ability of seeds, forcing farmers to buy them. One scholar said that Monsanto would never provide any technology to anyone who breaks the rules. Therefore, China needs to protect farmers' right to know about grain seed selection and help farmers fully understand modern agricultural biotechnology.

Third, in the revision of the antimonopoly law, special emphasis should be placed on the antimonopoly measures of the grain seed market to avoid the control of China's seed market by a few multinational companies. In addition, our government must also strengthen the public research and development of grain seeds, expand the scope of farmers' choice of grain seeds, and effectively reduce the occurrence of monopoly in the seed market.

6.2.3. Compulsory License of Grain-Related Technologies. The High People's Court of Jiangsu province focused on actively promoting the transformation and application of agricultural innovations and promoting the production and sales of grain seeds through the trial of intellectual property disputes in the field of the seed industry. In a case where the male parent and female parent of the seeds were owned by different subjects and their stakeholders, respectively, in the absence of relevant legal provisions, the court, with reference to the provisions of compulsory licensing in the patent law, creatively decided for the first time in China to compel both parties to cross-license, which not only effectively promoted

the promotion and production of superior hybrid rice but also fully guaranteed the sharing of agricultural science and technology achievements, and was instrumental in promoting the realization of legislation purpose of "encouraging the cultivation and use of new plant varieties and promoting the development of agriculture and forestry" in the Protection Regulation of Plant Variety Right, safeguarding the public interests and ensuring national food security.

7. Conclusion

Internet of things technology plays an increasingly important role in improving the digital and intelligent level of grain industry and ensuring national food security [24]. In this paper, promoting agricultural science and technology innovation through improving the legal system of grain-related intellectual property right is of great significance for China to cope with the global food crisis. The protection and restriction measures for the grain-related intellectual property right system should be taken in parallel: first, we should strengthen the protection of grain-related intellectual property rights (patents, trademarks, trade secrets and geographical indication rights, etc.), establish or improve the intellectual property protection system and operation mechanism of agricultural technology in the whole process of R & D and transformation; second, we should prevent the food-related intellectual property rights system from being alienated as a means to control the market, restrict competition, hinder innovation and seek improper benefits, coordinate the relationship between intellectual property rights and food rights and farmers' rights [25], and moderately restrict the application and promotion of genetic utilization restriction technologies (GURT). Grain-related technologies should be flexibly applied to the patent compulsory licensing system [26]. At the same time, we should also pay attention to improving the legal literacy of agricultural IPR law enforcement officers and further strengthening the law enforcement of agricultural IPR protection in order to effectively safeguard the food security and nutrition level of Chinese residents, promote the building of a community with a shared future for mankind, and achieve the UN Sustainable Development Goals.

Data Availability

The data sets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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