

Intellectual Property Protection in the Transformation of Plant Protection Research Achievements: Present Situation, Challenges and Prospects

Liu Mingna

*Institute of Plant Protection, Chinese Academy of Agricultural Sciences, Beijing, 100000, China
liumingna@caas.cn*

Keywords: Plant protection; Transformation of achievements; Intellectual property protection; counter-measure

Abstract: This paper discusses the importance, current situation, challenges and future prospects of intellectual property protection in the transformation of plant protection research results. Intellectual property has a core position in the field of plant protection, which not only promotes technological innovation, but also protects the rights and interests of researchers and promotes the commercial application of research results. At present, the research results of plant protection are showing the growth trend of patent application, and technology transfer and licensing agreement are gradually becoming the mainstream, but at the same time, it is also accompanied by intellectual property disputes. In order to meet the challenge of globalization, international cooperation has become particularly critical in the maintenance of intellectual property rights. However, cross-border intellectual property protection, rapidly changing technological environment and the balance between public interests and individual rights and interests have brought new challenges to plant protection research. In particular, the collision between intellectual property rights and traditional knowledge is an urgent problem to be solved. Looking forward to the future, in order to adapt to the accelerating technological innovation, strengthening international cooperation and exchanges, raising public awareness of intellectual property rights, and encouraging the public-private cooperation model will be the key. Especially the public-private partnership model, its popularization and application is expected to further promote the innovation and development of plant protection technology.

1. Introduction

Plant protection, as a key part of maintaining agricultural ecological stability, increasing crop yield and ensuring food safety and quality, has been continuously concerned by all parties. In this field, the research and development of new technologies, new methods and new products not only involve a lot of time and money investment, but also involve the innovation of core technologies. In the era of globalization, intellectual property protection is not only to ensure the return of research investment, but also to protect the interests of researchers, enterprises and countries, and to avoid blind copying and unfair competition of technology ^[1].

Because of this, intellectual property rights are particularly important in the field of plant protection. Without adequate intellectual property protection, researchers and enterprises may face problems such as insufficient innovation motivation and difficult recovery of research investment ^[2]. Once the research results are fully protected, it can not only bring economic returns to innovators, but also promote the legal dissemination and promotion of technology and create value for the whole society.

The purpose of this paper is to discuss the current situation, existing challenges and future prospects of intellectual property protection in plant protection research results. We will deeply analyze the different ways of intellectual property protection, how to choose the appropriate protection strategy according to the specific situation of plant protection, and how to deal with the main challenges faced by intellectual property protection at present, so as to provide useful suggestions and references for plant protection researchers and enterprises.

2. Related Basis of Plant Protection Research and Intellectual Property Protection

In today's technological progress and globalization trend, intellectual property rights have become the key elements to realize innovation, promote economic growth and safeguard scientific research achievements. In this context, it is particularly important to understand the basic knowledge of intellectual property and its application in plant protection research.

2.1 The meaning and types of intellectual property rights

Intellectual property rights are not only terms in legal texts or contracts, but also the maintenance and encouragement of innovation, research and technological development. In some basic concepts, intellectual property is the legal recognition of creativity, invention and innovation, which provides a guarantee for creators and inventors to protect their contributions for a certain period of time and get economic returns from them ^[3].

Intellectual property includes a series of different rights. These rights, ranging from patents and copyrights to trademarks and geographical indications, have their own specific scope of application and protection purposes ^[4]. For example, patents protect new and original inventions, while copyrights care about the originality of literary, artistic and scientific works. These different types of intellectual property provide creators and inventors with a variety of protection ways to ensure that their work is not illegally used or copied.

2.2 Core principles of intellectual property rights

Although there are many types of intellectual property rights, the core principles behind them are similar. These principles include encouraging innovation, protecting the rights of creators and inventors, balancing public and private interests, and promoting the spread and exchange of technology and culture. These principles form the cornerstone of the intellectual property system and guide its implementation and application in law, economy and social culture.

2.3 Blending of Intellectual Property and Plant Protection

Plant protection, also known as plant protection, refers to the application of a series of methods and technologies to protect crops and plants from pests, diseases, weeds and other harmful organisms. If these pests are not controlled, they may lead to a sharp drop in crop yield and even a total loss of crops. The importance of plant protection lies not only in ensuring the stability and quality of food supply, but also in protecting the agricultural ecological balance, reducing the

improper use of pesticides and promoting the development of sustainable agriculture. Effective plant protection can help agricultural producers get higher income, and also help to ensure that consumers get healthier and safer food.

Plant protection research involves a lot of technical and methodological innovations, from new biological pesticides to gene editing technology, all of which need proper intellectual property protection^[5]. Understanding the basic knowledge of intellectual property provides researchers with a framework to help them protect their inventions, ensure their value is reflected, and promote their application and promotion in a wider range of fields.

3. Present situation of intellectual property rights of plant protection research results

With the deepening of scientific research and technological innovation, a large number of valuable research results have emerged in the field of plant protection. These achievements have played a key role in improving agricultural production efficiency, ensuring food safety and maintaining ecological balance. However, what is the current situation of these research results in intellectual property protection? This chapter will discuss this problem and make an in-depth analysis of the key points.

3.1 The growth trend of patent applications

In recent years, with the rapid development of plant protection technology, the number of related patent applications has also shown a significant growth trend. This not only reflects the improvement of research activity in this field, but also highlights the core position of intellectual property rights in ensuring the protection of technological innovation achievements.

In recent years, with the emergence of various new biotechnology and ecological management methods, the content and scope of plant protection patents are constantly expanding. From traditional pesticides and biological pesticides to new gene editing technology and pest monitoring technology, it reflects that the depth and breadth of plant protection are strengthening.

On the one hand, this growth trend means that researchers and institutions are more actively protecting their research results with intellectual property rights^[6]. This will not only bring them economic benefits, but also prevent technology from being illegally copied or stolen to some extent. On the other hand, it also implies that in the future, the patent competition in the field of plant protection may become more intense, and all parties are striving for greater market share and technological leadership for themselves.

It is worth noting that the growth trend of patent applications is accompanied by the adjustment and improvement of intellectual property policies by governments of various countries. Many countries have begun to strengthen the enforcement of intellectual property rights and intensify the crackdown on infringement, which is undoubtedly good news for plant protection researchers.

To sum up, the growing trend of patent application in the field of plant protection not only represents the research enthusiasm in this field, but also means that intellectual property rights will play a more important role in the future research and industrialization process.

3.2 Technology Transfer and License Agreement

In addition to direct patent application, technology transfer and licensing agreement are also important ways to protect intellectual property rights. Many research institutions and enterprises have established perfect technology transfer mechanisms, and realized technology sharing and commercialization by signing licensing agreements with external partners.

With the progress of science and technology and the continuous emergence of innovations in the

field of plant protection research, technology transfer has become a mainstream practice, pushing research results from the laboratory to the market. In this process, the licensing agreement of intellectual property rights plays a bridge role, providing a clear cooperation and benefit distribution mechanism for both parties.

Technology transfer, in short, refers to the transfer of technology from one entity to another in some way, so that it can be commercialized or applied in other forms ^[7]. In the field of plant protection, this may involve new pesticides, biological control methods, transgenic technology of pest-resistant genes and so on.

License agreement is a key link in technology transfer. This is because when a research institution or individual invents a new technology or method, they may not have enough resources or ability to commercialize it. At this point, they can authorize a company or institution to use this technology in exchange for a certain economic return. This authorization process is realized by signing a license agreement.

The agreements of plant protection research are frequently involved in many aspects, including detailed description of technology, scope of use, time limit, cost, payment method, technical support and subsequent improvement and so on. This provides a clear and transparent cooperation framework for technology holders and users.

However, this process is not always that simple. Sometimes, due to the distribution of benefits, unclear definition of technical scope or other reasons, disputes may arise. Therefore, it is very important to make a clear, fair and mutually acceptable license agreement.

In addition, the technology transfer and licensing agreement also involves a series of legal and policy issues. For example, how to ensure that technology transfer will not lead to infringement of intellectual property rights? How can technical users ensure that they will not violate any license agreement during the use? This requires clear guidance and support from relevant laws and policies.

In short, technology transfer and licensing agreements play a key role in the intellectual property strategy of plant protection research. In order to ensure the smooth progress of this process, both parties need to have sufficient legal awareness and conduct full communication and negotiation before signing the agreement.

3.3 Intellectual property disputes and their settlement

Despite the growing awareness of intellectual property protection, at the same time, related disputes and disputes are also increasing. These disputes involve the validity of patents, the definition of rights and the application scope of technology, which bring many challenges to the field of plant protection. In the process of transformation of plant protection research results, intellectual property disputes are often an inevitable link. With the development of technology and the acceleration of globalization, these disputes have become more and more complicated. From patent right, trademark right to copyright, all kinds of intellectual property rights may cause disputes.

Intellectual property disputes usually come from several aspects. First of all, the unclear definition or ambiguous interpretation of patents may lead to multiple entities claiming patents for the same technology or product ^[8]. Secondly, it may be because the terms in the license agreement are unclear or misunderstood, which leads to differences between the two parties in the process of cooperation. Furthermore, with the rapid iteration of technology, new research results may conflict with existing intellectual property rights.

For these disputes, a timely, fair and efficient settlement mechanism is essential. On the one hand, extending the time of dispute resolution will increase the cost of both parties, which is not good for both parties. On the other hand, if disputes are not handled fairly, it may dampen the enthusiasm of

research and innovation.

At present, the main solutions to intellectual property disputes include judicial channels and non-judicial channels. Judicial approach usually involves the court, which is the most formal solution, but it may also be the one with the highest time and cost. On the contrary, non-judicial channels, such as mediation, arbitration and expert review, are usually faster, more flexible and less costly. Especially in international disputes, arbitration is often the preferred way for both parties, because it can cross the legal systems of different countries and avoid the uncertainty of the legal environment.

However, no matter which solution is chosen, both sides need to maintain an open and cooperative attitude. This is because the settlement of disputes is not only to solve current problems, but also to ensure future cooperation. This is particularly important in plant protection research, because this field needs long-term and in-depth cooperation, and short-sighted conflicts will harm the interests of both sides. Intellectual property disputes and their settlement are the key links in the transformation of plant protection research. Only by ensuring that disputes are handled in a timely and fair manner can we ensure the effective application and promotion of technology and realize its real value^[9].

3.4 International Cooperation and Globalization of Intellectual Property Rights

Under the background of globalization, the research on plant protection is increasingly transcending national boundaries, involving multinational cooperation and exchanges. This makes the issue of intellectual property protection more complicated, which needs to take into account the legal system, cultural background and economic interests of various countries. In this process, the protection of intellectual property rights is particularly critical, because it is not only related to the transformation and application of technology, but also related to economic and technological exchanges between countries.

International cooperation has played a vital role in technology research and development. Many plant protection technologies, such as the discovery of new biological pesticides and disease-resistant genes, need multinational teams to cooperate in research and development. This kind of cooperation can not only gather the global superior resources, but also avoid repeated research and development and improve the efficiency of research. However, with the deepening of technical cooperation, the problem of intellectual property rights has gradually surfaced. Due to the differences in culture, legal system and economic development level, there are great differences in the concept and practice of intellectual property protection in different countries and regions. This requires all parties to clarify their rights and obligations at the beginning of cooperation to avoid subsequent disputes.

In order to promote the global protection of intellectual property rights, a series of norms and agreements have been formed internationally. For example, the Patent Cooperation Treaty (PCT) issued by the World Intellectual Property Organization (WIPO) provides a unified platform⁽⁵⁴⁾ for transnational patent applications. The TRIPS Agreement defines the minimum standards for intellectual property protection of member countries. These agreements and norms provide a stable legal environment for international technical cooperation and guarantee the rational use and protection of intellectual property rights.

In addition, in order to adapt to the globalization trend of intellectual property rights, countries are constantly adjusting their legal systems and policy orientations. For example, strengthen the protection of foreign intellectual property rights, simplify the examination and approval process of foreign technology introduction, and encourage domestic enterprises to go abroad and participate in international technical cooperation.

Generally speaking, international cooperation and the globalization of intellectual property rights have become an indispensable trend in the transformation of plant protection research. Only by ensuring fair and effective protection of intellectual property rights of all parties can we ensure the smooth transformation and application of technology and further promote the development of global plant protection.

4. Challenges of intellectual property protection

Under the background of globalization and rapid technological development, the protection of intellectual property rights is not only a simple legal issue, but also a complex issue involving many aspects of technology, economy, society and policy. For the field of plant protection, these challenges are particularly obvious. This chapter will explore these challenges and the reasons behind them in depth.

4.1 Cross-border intellectual property protection

With the globalization of science and technology and the in-depth development of international trade, cross-border intellectual property protection has become a core issue of concern to countries and enterprises. This transnational nature has brought many challenges, making the protection and enforcement of intellectual property rights more complicated.

First of all, there are significant differences in intellectual property system, legal environment and enforcement among countries. Although many countries have signed international agreements such as TRIPS Agreement, in the specific implementation process, countries are different according to their own economic, cultural and legal backgrounds. For example, some countries may have stricter patent protection for certain technical fields, while others may be relatively relaxed.

Moreover, it is difficult to detect and obtain evidence of cross-border intellectual property infringement. Because technology transfer, product production and sales often involve many countries, it is often a big problem to determine tort, collect evidence and determine tort liability among many countries^[10].

In addition, the transnational intellectual property dispute settlement mechanism is not perfect. When intellectual property disputes involving many countries are involved, the parties often face problems such as how to choose the arbitration place and which country's law to apply, which undoubtedly increases the complexity and uncertainty of dispute resolution.

To meet these challenges, the international community has taken a series of measures. For example, through international organizations such as the World Intellectual Property Organization (WIPO), international cooperation is promoted and unified intellectual property standards and countermeasures are established. At the same time, more and more international organizations and enterprises choose to clearly choose the applicable law and arbitration place in their contracts, so as to provide advance solutions for possible intellectual property disputes.

4.2 The rapidly changing technical environment

With the rapid development of plant protection technology, especially the application of cutting-edge technologies such as gene editing, big data and artificial intelligence, the definition and scope of intellectual property rights often change. How to ensure the stability and predictability of intellectual property rights in such an environment is a continuous challenge.

The rapid change of technology means that intellectual property protection must keep pace with the times. The traditional intellectual property system may not be able to fully adapt to the new technological form and mode^[11]. For example, the emergence of new technologies, such as cloud

computing, artificial intelligence and gene editing, makes the definition, ownership and application scope of technologies blurred, which brings difficulties to the determination and implementation of intellectual property rights. The rapid iteration of technology greatly shortens the life cycle of some intellectual property rights. In some high-tech fields, when a technology or product is protected, new technologies may have appeared and replaced it. This puts forward new requirements for the formulation of intellectual property strategy, patent application and commercialization strategy of technology.

Secondly, the promotion and application of new technologies are often accompanied by new intellectual property infringement risks. For example, digital and networked technologies make it easier and faster to copy and spread intellectual property rights, which brings greater pressure to the protection and enforcement of intellectual property rights.

In order to meet these challenges, countries and enterprises need to constantly adjust and improve their intellectual property strategies. This includes keeping abreast of technological development trends, strengthening frontier research on intellectual property rights, ensuring the synchronization of intellectual property rights system and technological progress, and strengthening communication with technology research and development departments to ensure the close integration of technological innovation and intellectual property strategies.

4.3 Balance between public interests and individual rights and interests

The fundamental purpose of intellectual property rights is to encourage innovation, but at the same time, it should also protect the interests of the public and prevent technological monopoly or improper exercise of rights. In the field of plant protection, how to protect the rights and interests of researchers and enterprises while ensuring the wide spread and application of technology is an important issue.

On the one hand, public interest refers to the interests gained by the broad masses of people when they enjoy new technologies and products. For example, when a new plant protection technology is developed, it can effectively prevent and control crop diseases and insect pests, so farmers and consumers can benefit from it. However, if the use of this technology is restricted or the price is too high because of intellectual property rights, the public interest may be harmed.

On the other hand, intellectual property rights holders, such as research institutions, enterprises or individuals, have spent a lot of time, money and efforts to develop this new technology. Therefore, they have the right to get a reasonable return from it to ensure continuous R&D motivation and capital investment.

How to balance the interests between the two is a challenge that every country and region needs to face. By formulating fair and transparent intellectual property policies, some countries encourage cooperation and negotiation between intellectual property holders and users, and reach mutually acceptable licensing fees and terms of use, thus ensuring the wide dissemination and application of new technologies and protecting the rights and interests of intellectual property holders.

4.4 The collision between intellectual property rights and traditional knowledge

Many methods and techniques of plant protection are derived from traditional agricultural practices and local knowledge. How to give these traditional knowledge proper protection and respect and avoid cultural plagiarism and improper use under the modern intellectual property system is the focus of a long-term debate.

Traditional knowledge refers to the knowledge, innovation and practice related to natural resources and cultural practices that have been circulated in a cultural group or community for a long time. This knowledge is often not recorded in writing, but passed down through word of mouth

or practical operation. For example, some traditional plant preparations, agricultural practices or crop cultivation techniques belong to the category of traditional knowledge.

However, under the framework of intellectual property rights, traditional knowledge is often in a vague position. Because it is not completely consistent with the requirements of "novelty" and "invention creativity" in the modern intellectual property system, it is difficult for traditional knowledge to obtain formal intellectual property protection.

The following points are the main collision points between intellectual property rights and traditional knowledge in the field of plant protection research:

(1) Cultural plagiarism and unfair sharing: Sometimes, some enterprises or research institutions may apply for patents or other intellectual property rights after slightly improving some traditional knowledge. This leads to the original holders of traditional knowledge being deprived of their knowledge rights and interests and unable to get a reasonable return from it.

(2) Mismatch of protection period: Traditional knowledge is often accumulated for a long time, while modern intellectual property rights such as patents and trademarks usually have a fixed protection period. How to set an appropriate protection period for these long-circulating knowledge is a difficult problem.

(3) The fuzziness of knowledge ownership: traditional knowledge is often shared by the whole community, while modern intellectual property rights emphasize the rights and interests of individuals or enterprises. This leads to great difficulties in the division of rights and interests.

To solve these problems, many countries and international organizations are exploring how to provide more reasonable protection for traditional knowledge. For example, by setting up a special traditional knowledge database, we can ensure that the original knowledge holders can get reasonable benefits from it, and also provide a formal reference for researchers.

5. Sustained prospects and suggestions

With the continuous progress of global economy and technology, the role of intellectual property rights in plant protection research is increasingly prominent. Facing the increasingly severe challenges, how can we ensure that the innovation and achievements of plant protection research can be properly protected by law and lay a solid foundation for the future? This chapter will look forward to the sustainable prospect of intellectual property rights in the field of plant protection, and put forward some suggestions for the current problems.

5.1 To adapt to the speed of technological innovation

The rapid development of plant protection technology requires that the intellectual property system must keep pace with the times to adapt to the changes of new technologies and research methods. Law and policy makers should pay more attention to the direction of technological development, predict possible intellectual property problems in the future, and formulate corresponding strategies in advance.

First of all, the application and review process of intellectual property rights need to keep pace with the times and speed up the review to adapt to the rapid evolution of technology. Otherwise, when the patent is approved, the relevant technology may be outdated or replaced by new technology.

Secondly, the intellectual property system should consider how to better protect those technologies that are in the initial stage of research and development and have great potential but have not yet been commercialized. This requires more flexible protection mechanisms, such as temporary patents and fast review channels, to encourage innovation.

In a word, the intellectual property system and practice need to adapt to the speed of

technological innovation flexibly, not only to protect the rights and interests of creators and researchers, but also to promote the progress and application of technology.

5.2 Strengthen international cooperation and exchanges

Under the background of globalization, the problem of plant protection is no longer a problem of a certain country or region, but a global problem. Strengthening international cooperation and exchange is the key to solving intellectual property problems. Countries should establish a closer cooperation mechanism and jointly formulate international rules to ensure that plant protection research results can be protected fairly and effectively on a global scale. With the cross-border flow of technology and knowledge, the protection and utilization of intellectual property rights also need to strengthen international cooperation and coordination from the following aspects.

(1) Unified intellectual property standards: It is necessary to promote international unified intellectual property protection standards and practices. For example, by participating in international organizations such as the World Intellectual Property Organization (WIPO), we will strengthen cooperation with other countries in intellectual property to ensure the global development of plant protection research.

(2) Technology transfer and sharing: encourage international technology transfer and sharing to ensure the fair, just and sustainable use of technology. This will not only contribute to the popularization of technology, but also promote technical cooperation and innovation among countries.

(3) Coping with intellectual property disputes: In intellectual property disputes, international cooperation and exchanges are particularly important. By establishing a multilateral or bilateral dispute settlement mechanism, we will ensure the timely, fair and effective settlement of intellectual property disputes.

(4) Training and education: Strengthen international intellectual property training and education exchanges, and improve the ability and level of countries in the field of intellectual property.

5.3 Raise public awareness of intellectual property rights

In addition to the improvement of laws and policies, it is also essential to raise public awareness and respect for intellectual property rights. All walks of life should carry out extensive publicity and education to make the public understand the value of intellectual property rights and realize the internal relationship between protecting intellectual property rights and promoting scientific and technological progress.

Educational institutions at all levels should incorporate intellectual property education into the curriculum system to ensure that students can have a basic understanding of intellectual property from the beginning of basic education. At the same time, the government should provide policy and financial support for intellectual property publicity and education, encourage all sectors of society to participate together, and form a good atmosphere for intellectual property protection. Popularize the basic knowledge of intellectual property rights to the public through media, public lectures, exhibitions and other forms.

Only when the public has enough knowledge and understanding of intellectual property rights can it be effectively protected and utilized, thus supporting the healthy development of plant protection research.

5.4 Encourage public-private partnership model

Future intellectual property protection will rely more on the public-private cooperation model.

The government, academic institutions and enterprises should establish closer cooperative relations to jointly promote the innovation and development of intellectual property protection. In the field of plant protection, research and development needs a lot of funds, facilities and expert knowledge. Public-private partnership model can combine public resources such as research institutions and universities with private sector capital and market experience, and effectively promote technological innovation.

Through the company cooperation mode, the research results of the public sector can be transferred to the private sector for commercial production and promotion more smoothly, which is helpful to quickly transform scientific research results into practical products. And in the process of application, maintenance and dispute resolution of intellectual property rights. Public-private partnership can help the public sector obtain patents, provide policy support and guarantee for the private sector, obtain professional knowledge and financial support, and jointly safeguard intellectual property rights.

In the process of pursuing profits in the private sector, the public sector can provide necessary supervision in cooperation to ensure that the research, development and application of plant protection technologies are in line with the long-term interests of society and the environment. Therefore, encouraging public-private cooperation mode and making it widely used in this field can further promote the sustainable innovation and development of plant protection technology.

Acknowledgement

Fund project: 2022 Academy of Agricultural Sciences' special project of coordinating basic scientific research business expenses "Integration and demonstration of green prevention and control technology for late sowing strain diseases, pests and weeds in wheat" (Y2022PT03).

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