

## Research Article

# An Evaluation Model of Plant Variety Rights Capitalization Operation Value Based on Big Data Analysis

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Plant variety rights are essential for agricultural development and food security. This paper mainly starts with the cost-benefit issue of plant variety rights that enterprises are concerned about, and introduces the cost-benefit analysis method into the research and development, application, and protection of plant variety rights. This research takes the new plant variety rights as the research object, clarifies the development status of the world plant variety rights from the perspective of time series development characteristics and spatial distribution pattern, explores the location of the variety rights in the world, and uses methods such as knowledge measurement and data mining, to carry out in-depth research on the application and authorization of plant variety rights, the scope of protection catalogues, the structure of variety rights, and the applicant unit. Finally, the regression model is tested from five aspects: regression model significance test, model goodness-of-fit test, Hosmer goodness-of-fit test, goodness-of-fit test, and overall accuracy test of model prediction. The regression coefficient of plant variety rights cooperation in the research process was 1.908, and the statistical test value was significant at the 5% level ( $P = 0.022 < 0.05$ ). Using system dynamics to evaluate its risks, it provides new ideas for the risk analysis and prevention of seed industry enterprises' variety rights capitalization operation.

## 1. Introduction

In the licensing of variety rights, the licensee of variety rights is highly dependent on the related varieties, and once monopoly occurs, the harm will be huge. In the process of variety rights licensing, the exclusiveness and monopoly of the variety rights make it possible for the variety rights holders to take advantage of this exclusive and monopolistic position to implement behaviors that restrict competition. At the international level, with the opening of China's seed market, foreign large-scale agricultural technology companies with abundant capital and advanced technology have expanded aggressively, threatening the living space of the domestic breeding industry, and challenging the development of China's seed industry and food security.

As a major agricultural country, agricultural, scientific, and technological achievements are produced in batches every year, and the task of promoting the smooth

transformation of these achievements is very important. Doing a good job in the evaluation of the value of agricultural, scientific, and technological achievements has an important role and significance in improving the efficiency of achievement transformation and accelerating the application of achievement transformation.

This paper mainly starts with the cost-benefit issue of plant variety rights that enterprises are concerned about, and introduces the cost-benefit analysis method into the research and development, application, and protection of plant variety rights. Based on the above research, it is found that the domestic research on the value evaluation of agricultural, scientific, and technological achievements, especially the value evaluation method of new plant variety rights, is still very much lacking. Most of them are limited to traditional value evaluation methods, which makes the reference significance and accuracy of the evaluation results very low, and it is impossible to evaluate the value of new plant variety

rights scientifically, reasonably, and pertinently. For the current scientific and technological achievements transformation trading market, the reference transaction value is of great significance for promoting the successful transaction of achievements. Therefore, it is indispensable to study the method of evaluating the value of new plant variety rights.

## 2. Related Work

The implementation of the new plant variety protection system has created a suitable legal environment for the healthy development of seed enterprises and scientific research units, promoted the breeding and innovation of new plant varieties, and found a breakthrough for the seed industry to face the world and improve its core competitiveness. The concept of an Essential Derivative Variety (EDV) under the 1991 UPOV Convention presents a number of challenges for both UPOV and users of the system. Bostyn believes that the concept of EDV is not only expressed in a rather difficult language in regulations but has proven equally difficult to apply. Furthermore, due to the lack of clarity in the provisions of the UPOV 1991 Convention, reaching a consensus on the exact interpretation of the concept, to be implemented later by courts and guidelines, is equally challenging. He has made novel and original contributions to research in the field of EDV. The approach presented here is inspired by other areas of (intellectual property) law. His careful study of the proposed solutions shows that at least some of them can effectively end at least some of the deadlock and legal uncertainty surrounding the concept of EDV [1]. Wijesundara et al. consider Plant Patents (PP) and Plant Breeders' Rights (PBR) as two forms of Intellectual Property Rights (IPR) granted to improved varieties of crops. Authoritative national governments issue PPs and PBRs after confirming the uniqueness of the breed identity. Uniqueness depends on the uniqueness, consistency, and stability of the new variety. In the presence of a large number of closely related breeds as a reference set, morphological, physiological, and biochemical descriptors are less able to obtain IPR in breed identification, but advanced molecular tools, such as DNA fingerprinting and sequencing, have a high potential to detect uniqueness. DNA fingerprinting and sequencing have identified varietal traits in many crops, such as rice, apple, wheat, and soybean, revealing the potential for the successful use of molecular descriptors in patenting or PBR. Novelty verification is the first step in the process of allowing a patent or PBR. The Patent or Plant Variety Protection Office requires breeders to submit an application that includes all the details of the plant variety [2]. Li et al. applied the  $^{15}\text{N}$  labeling methods to the leaves of *Arabidopsis* rosettes to characterize their protein degradation rates and understand their determinants. Stepwise labeling of new peptides with  $^{15}\text{N}$  and measuring the decrease in abundance over time of more than 60,000 existing peptides allowed him to determine the degradation rates of 1228 proteins in vivo [3]. High-yielding Spanish bunch peanut culture ICGV 00351 (cross-derivative of ICGV 87290  $\times$  ICGV 87846) developed by Vindhiyarman et al. at ICRISAT (International Crops Research

Institute for the Semi-Arid Tropics), Patancheru, Andhra Pradesh, with six other promising drought varieties were evaluated together. The overall average dry pod yield of cultivated ICGV 00351 under rainfed conditions was 2189 kg/ha. This cultivar with a duration of 105 to 110 days increased pod yield by 17% and 26%, respectively, over the region's popular varieties VRI (Gn) 6 and TMV (Gn) 13 [4]. As an important agricultural intellectual property rights, plant variety rights operate and develop worldwide, which can enhance the international competitiveness of plant variety rights and the ability to participate in international affairs. The securitization of plant variety rights is inseparable from the development of finance, economy, and society, and is an important way to protect plant variety rights and operate assets. Their research on plant variety rights lacks practical practice, and this study will further explore this issue.

## 3. Method of Evaluation Model of Capitalization Operation Value of Plant Variety Rights Based on Big Data

*3.1. Supply-Side Value Range Evaluation Model.* The construction of the value range evaluation model for the supply side of new plant variety rights should start from the perspective of producers, and consider two aspects of R&D and income: First, the supplier of new plant variety rights should not only maintain the simple reproduction of the enterprise's products but also provide funds for the enterprise to further expand its production scale. Therefore, the value of the new plant variety rights should not only compensate the consumption of the cost of the supply side but also distribute the benefits brought by the new plant variety rights, so as to provide effective financial support for the enterprise to further proceed anyway. Secondly, various risks and intangible losses of new plant variety rights should be considered in the value of new plant variety rights. This research is based on agricultural intellectual property rights, a hot issue of general concern, and takes plant variety rights, a unique intellectual property rights in the agricultural field, as the research object. Therefore, the main research line of the cost-benefit analysis of plant variety rights is shown in Figure 1.

*3.1.1. The Lower Limit of the Supply-Side Value Assessment Range.* The formula for the lower limit of the transfer value of the supplier of new plant variety rights in the study is:

$$P_{s-\min} = R + T + F * i + O. \quad (1)$$

In the formula,  $R$  is the research and development cost of new plant variety rights.

*3.1.2. The Upper Limit of the Supply-Side Value Assessment Range.* The upper limit of the price determined by the supplier for the transfer of new plant variety rights is:

$$P_{s-\max} = R + T + F * i + O + S + E. \quad (2)$$

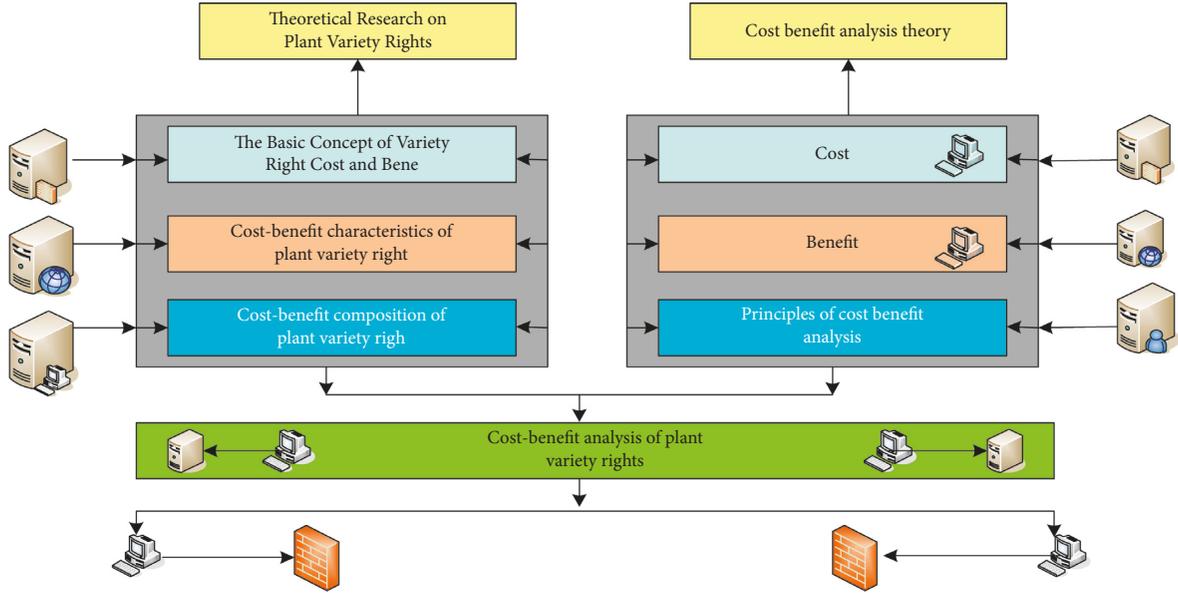


FIGURE 1: Research thread of plant variety rights cost-benefit analysis.

The sunk cost of research and development of new plant variety rights is  $S$ ; the expected benefit of the supplier is  $E$ .

$$E = \alpha \sum_{i=1}^k \alpha \sum_{j=1}^n \Delta M_{ij}, \quad (3)$$

$\Delta M_{ij}$  is the income increment generated by the  $k$ th enterprise purchasing the new plant variety right in the  $j$ th year [5].

$$P_{s-\max} = R + T + F * i + O + S + \alpha \sum_{i=2}^k \sum_{j=1}^n \Delta M_{ij}. \quad (4)$$

**3.2. Demand-Side Value Interval Assessment Model.** For the demand side, purchasing a new plant variety right is a productive investment of the enterprise. The expected return from the investment to the demander after deducting possible risks is greater than the average social capital return, or if the new plant variety can be developed by itself, the purchase price must be lower than the cost of self-development. The evaluation scheme is shown in Figure 2.

The evaluation formula for the value interval of the demand side of new plant variety rights is [6]:

$$P = \sum_{t=1}^n \frac{(1 - \alpha)\Delta M_t + \Delta Q}{(1 + R)}, \quad (5)$$

$P$  is the transfer price of new plant variety rights.

Consider the selection and operation strategy of dual-channel retailers' channel sales mode when consumers have free-riding behavior in pre-sales services in the market and the degree of free-riding is constantly changing. Then, the formula for the upper and lower limits of the transfer price of the new plant variety right on the demand side is [7]:

$$P_{D-\max} = \left( \sum_{T=1}^N \frac{(1 - \alpha)\Delta M_{\max}}{(1 + R)^T} - \sum_{T=1}^N \frac{P}{(1 + R)^T} - N \right)^{-1}, \quad (6)$$

$$P_{D-\min} = \left( \sum_{T=1}^N \frac{(1 - \alpha)\Delta M_{\min}}{(1 + R)^T} - \sum_{T=1}^N \frac{P}{(1 + R)^T} - N \right)^{-1}. \quad (7)$$

**3.3. Model Selection and Variable Description.** In logistic regression, assuming that the probability of  $M = 1$  is  $P$ , for  $M$ , its distribution function is [8]:

$$F(M) = P^M (1 - P)^{1-M}. \quad (8)$$

The binary logit model is now used, the value range of the dependent variable is  $[0, 1]$ , and the maximum likelihood method is used to evaluate its regression parameters.

$$P_i = F(M_i) = \frac{1}{1 + e^{-M_i}} = \frac{1}{1 + e^{-M_i}}. \quad (9)$$

Among them

$$M = B_0 + B_1 X_{1i} + \dots + B_p X_{pi}, \quad (10)$$

$P$  is the number of independent variables, and  $B_0$  is the regression intercept.

**3.4. Determination of Value Assessment Interval.** In this paper, the supply side and demand-side value evaluation interval models of a single new plant variety right are constructed, respectively [9]. The source of data is real data, and the expression of the proposed uncertainty measure is helpful to solve the current practical problems. The research on the uncertainty measure of knowledge is a hot

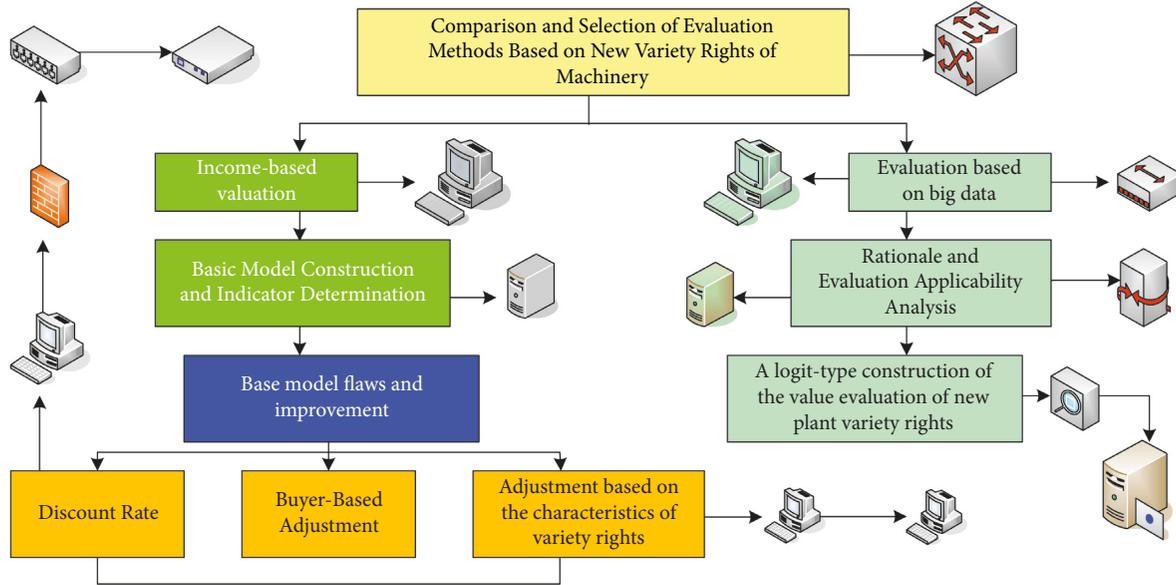


FIGURE 2: Evaluation scenario.

issue in the field of artificial intelligence. On the basis of reviewing several classical knowledge uncertainty measurement methods, the relationship and difference between these measurement methods are systematically studied. The results show that measures such as information granularity are equivalent to knowledge granularity, and collaborative entropy can be regarded as the derivation of information entropy, which can verify the correctness of the conclusion.

In the first case, if

$$P_{s-\min} > P_{d-\max}. \quad (11)$$

In this case, the equilibrium transfer price of new plant variety rights cannot be formed [10].

In the second case, if

$$P_{s-\max} > P_{d-\max} > P_{s-\min} > P_{d-\min}. \quad (12)$$

The intersection interval is  $[P_{s-\max}, P_{d-\min}]$ , which is the lowest price interval for both the supply and demand sides.

The third case, if [11]

$$P_{d-\max} > P_{s-\max} > P_{d-\min} > P_{s-\min}. \quad (13)$$

At this time, the intersection interval is  $[P_{d-\min}, P_{s-\max}]$ , and the equilibrium price of new plant variety rights may be formed.

The fourth case, if [12]

$$P_{d-\min} > P_{s-\max}. \quad (14)$$

At this time, when the new plant variety rights are transferred, it is very easy for both parties to trade and negotiate.

The fifth case, if

$$P_{d-\max} > P_{s-\max} > P_{s-\min} > P_{d-\min}. \quad (15)$$

At this time, the trading price range is  $[P_{d-\max}, P_{d-\min}]$ , which may form an equilibrium price acceptable to both parties.

The sixth case, if [13]

$$P_{s-\max} > P_{d-\max} > P_{d-\min} > P_{s-\min}. \quad (16)$$

The intersection interval is  $[P_{d-\min}, P_{d-\max}]$ . When the new plant variety right is transferred, an equilibrium price may be formed after negotiation between the two parties.

After using big data to analyze basic information such as business conditions, capital flow, investor preferences, etc., the credit data, plant variety rights information, and plant variety rights future cash flow rating information of seed industry enterprises can be visualized and analyzed, which provides convenient conditions for enterprises to carry out the operation of plant variety rights securitization.

**3.5. Variable Setting.** The three variables of transaction mode factor, transaction operation factor, performance factor, and four variables of media factor are assigned as follows: 1 = selected this factor, 0 = not selected this factor. The statistics of some variables are shown in Table 1.

**3.6. Regression Result Processing.** Using SPSS16.0 statistical analysis software, logit regression analysis was carried out on the influencing factors of plant variety rights market-oriented operation satisfaction. Backward was adopted in the processing process, and the dependent variables in the research process were eliminated.

For [14],

$$\text{IVITFN}\alpha = ([a, b, c, d]; [\phi_1, \phi_2], [\beta_1, \beta_2]). \quad (17)$$

TABLE 1: Statistics of some variables.

Variable type	Variable name	Mean	Standard deviation
Market-oriented operation of plant variety rights main factor	Education level	2.52	0.912
	Unit nature	2.78	1.191
	Scientific research strength	3.21	0.797
Market-oriented operation of plant variety rights way factor	Transfer of plant variety rights	0.69	0.466
	Plant variety rights licensing	0.61	0.489
	Plant variety rights cooperation	0.13	0.334

Its score function and exact function are, respectively, [15]

$$W(\alpha) = \frac{1}{8}(a + b + c + d)(\phi_1 + \phi_2 + \beta_1 + \beta_2), \quad (18)$$

$$F(\alpha) = \frac{1}{8}(a + b + c + d)(\phi_1 + \phi_2 - \beta_1 - \beta_2), \quad (19)$$

As an important strategic resource for society and enterprises, intellectual property rights are only the subject of legal rights for their owners if they cannot be used effectively, and they do not have the ability to obtain benefits by virtue of their rights. Letting  $\alpha_1, \alpha_2$  be two IVITFNs whose collation is [16]

$$W(\alpha_1) > W(\alpha_2). \quad (20)$$

Then

$$\alpha_1 > \alpha_2. \quad (21)$$

If [17]

$$W(\alpha_1) = W(\alpha_2). \quad (22)$$

Then

$$F(\alpha_1) = F(\alpha_2). \quad (23)$$

The smooth operation of rights securitization creates favorable policy conditions. Participating in plant variety rights securitization through high-tech means such as big data, artificial intelligence, AI technology, and cloud computing can not only effectively control the infrastructure of plant variety rights securitization operations but also realize profit output with the latest technology [18]. Through the application of big data, cloud computing, and other technologies, plant variety rights securitization operations are under the supervision of laws, regulations, and policies, and through the smart contract mechanism, network identification and transmission technology is used to implement effective supervision in the form of encrypted codes [19]. Therefore, the formulation of relevant laws and regulations to standardize the application of regulatory technology for plant variety rights securitization is also an issue that needs to be focused on.

The income method does not take into account the many uncertainties in the process of achievement development, investment, and commercialization; the cost method ignores factors such as the value of the achievement after commercialization. In order to solve this series of difficult

problems and promote the smooth transformation of agricultural scientific and technological achievements, it is particularly important to find a value evaluation method suitable for new plant variety rights in agricultural scientific and technological achievements.

If for any  $\forall A, B \in P(X), A \cap B = \Phi$ , then [20]

$$\psi(A \cup B) = \psi(A) + \psi(B) + \rho\psi(A)\psi(B). \quad (24)$$

The limited set is

$$X = (x_1, x_2, x_3, \dots, x_n). \quad (25)$$

Then there is [21]

$$\Psi(X) = \frac{1}{\rho} \left( \prod_{i=1}^m [1 + \rho\Psi(x_i) - \chi] \right). \quad (26)$$

Among them,  $\rho \neq 0$ .

**3.7. Regression Model Test.** Financial technology (Table 2) and Internet technology based on big data can solve the problem of information asymmetry in breeding research and development, application and authorization of new plant varieties, and plant variety rights securitization (Table 3) transactions and operations [22]. In this paper, regression model testing is carried out from four perspectives: regression model significance test, model goodness-of-fit test, Hosmer & Lemeshow goodness-of-fit test, and overall accuracy test of model (Table 4) prediction [23].

- (1) Significance test of regression model: Chi-square is the likelihood ratio of the model, the larger the value of the chi-square statistic, the better; The  $P$  value corresponding to Sig is as small as possible. The comprehensive test results of the model coefficients are shown in Figure 2.
- (2) Model goodness of fit test: The larger the value of Cox & Snell R Square and Nagelkerke R Square, the better the overall fit of the model. SPSS16.0 statistical analysis software was used to conduct a comprehensive evaluation of prefectural and municipal agricultural academies, and principal component analysis was used to extract input-output factors, scientific and technological service contribution factors, and social and economic benefit factors, and then perform hierarchical clustering analysis on the samples. The classification and ranking of the innovation ability and comprehensive strength of the

TABLE 2: Comprehensive tests of model coefficients.

Comprehensive inspection	Chi-square	Df	Sig
Step	61.535	15	0.000
Block	61.535	15	0.000
Model	61.535	15	0.000

TABLE 3: Model goodness-of-fit evaluation.

Step	1
-2 log likelihood	183.279
Cox & Snell R square	1.191
Nagelkerke R square	0.373

prefecture-level agricultural research institutes were analyzed, and the quantitative basis was provided for the objective evaluation of the main body of plant variety rights licensing. The goodness-of-fit evaluation of the model is shown in Figure 3.

- (3) Hosmer & Lemeshow's goodness-of-fit test: Hosmer-Lemeshow is a fitting statistic, and its null hypothesis is that the equation fits the data well [24].
- (4) Overall, accuracy test of model prediction: As can be seen, the overall discriminant accuracy of the model for estimated samples is 78.7%. The final observations are classified, as shown in Table 4.

#### 4. Results of the Evaluation Model for the Capitalization of Plant Variety Rights

- (1) From the perspective of the main factors of plant variety right marketization, the degree of education and the nature of the unit have different degrees of influence on the satisfaction of plant variety right marketization. The regression coefficient of education level is 0.489, and the statistical test value is significant at the level of 5% ( $P = 0.040 < 0.05$ ), indicating that education level has an obvious impact on the satisfaction of plant variety right marketization. The more years of education the plant variety rights holders have, the more they can calmly analyze, predict, and make decisions on the plant variety rights market. More importantly, they can accurately evaluate the effect of plant variety rights marketization, and try to make the actual effect of plant variety rights marketization consistent with their prediction, so as to ensure that the plant variety rights marketization can achieve high satisfaction. The regression coefficient of unit property is  $-0.383$ , and the statistical test value is significant at the level of 5% ( $P = 0.032 < 0.05$ ), indicating that unit property is another significant factor affecting the satisfaction of plant variety right marketization. The nature of the different units determines the different priorities of the marketization of plant variety rights. Seed companies mainly focus on the

commercialization and marketization of plant variety rights, while agricultural academies and universities often focus on the research and development and promotion of new plant varieties.

- (2) From the perspective of the factors of market-oriented transaction of plant variety rights, plant variety rights licensing and plant variety rights cooperation have a significant impact on the satisfaction of plant variety rights. The regression coefficient of plant variety right license is 1.055, and the statistical test value ( $P = 0.010$ ) is significant at the level of 1%, indicating that plant variety right license significantly affects the satisfaction of plant variety right marketization, which benefits from the advantages of plant variety right license itself. Because the license of plant variety right only transfers the use right, the biggest advantage of this transaction mode is that the owner of plant variety right can transfer the use right of plant variety right to multiple people for many times, which is conducive to the owner of plant variety right to recover the funds quickly and expand the market-oriented scope of plant variety right, so as to improve the market-oriented satisfaction of plant variety right. With the improvement of China's property rights trading market, plant variety rights licensing will be more and more applied to the market-oriented practice of plant variety rights. The regression coefficient of plant variety right cooperation is 1.908, and the statistical test value is significant at the level of 5% ( $P = 0.022 < 0.05$ ), indicating that plant variety right cooperation has a significant impact on the satisfaction of plant variety right marketization. The reason is closely related to the structure of plant variety rights holders in China. Most of China's variety rights holders are subordinate to agricultural research institutes and colleges and universities. Plant variety rights accounted for 62.8% of the total authorization, and seed industry enterprises only accounted for 33.1% of the total authorization. In addition, most of the seed industry enterprises in my country are small in scale and do not have the necessary conditions for self-implementation. They need to rely on the support of external resources such as capital, technology, and information.

According to the development report of China's seed industry [25], in 2021, the top 10 seed industry companies in terms of sales invested a total of 483.43 million yuan in breeding research and development, an increase of 48% over

TABLE 4: Final observation classification.

Observed	Predicted		Percentage Correct
	Satisfaction with market-oriented operation of plant variety rights (Satisfied = 1; Dissatisfied = 0)		
Satisfaction with market-oriented operation of plant variety rights (Satisfied = 1; Dissatisfied = 0)	0	1	52.5
	1	123	90.4
Overall percentage	78.7		

2020 (251.37 million yuan). The applicant and variety rights types are shown in Figure 3.

Figure 4 shows the total number of applications for variety rights, the total number of grants, and the total number of effective variety rights at the end of the period in UPOV member countries.

Only 5.53% of the 4,808 variety rights authorized in 2018 were transferred, and only 3% of the varieties authorized by teaching, scientific, and educational units were implemented. The authorized variety plant types are shown in Figure 5.

However, only 19.40% of the 3,278 variety rights authorized for these five field crops have been promoted, and only 26.95% of the authorized varieties of commercial crop cotton have been promoted. The authorized promotion of field crops is shown in Figure 6.

Among the surveyed units, there are 23 individual units, 16 private enterprises, 14 collective units, 21 joint-stock units, 12 private enterprises, 12 state-owned enterprises, 2 cooperative enterprises, 1 institution of higher learning, and 7 other units, a total of 108. The top three in terms of quantity are: individual enterprises, joint-stock enterprises, and private enterprises, accounting for 22%, 19%, and 15% of all units, respectively. The specific distribution is shown in Figure 7.

The mean scores from high to low are: the R&D capability of the enterprise, the mean value is 4.18; the degree of technological innovation, the mean value is 4.07; the complexity of plant variety rights, the mean value is 3.96; the ability of enterprises to control R&D costs, the mean value is 3.94; the experimental scale of R&D, the mean value is 3.67. Based on this, it can be inferred that among all the factors affecting the R&D cost of plant variety rights, the R&D capability of the enterprise has the greatest impact on the R&D cost, while the experimental scale of R&D has the least impact on the R&D cost of plant variety rights. Figure 8 shows the statistics of factors affecting the R&D cost of plant variety rights.

The complexity score of plant variety rights is concentrated on 3, 4, and 5, which are important, very important, and extremely important, as reflected in Figure 8. The selection of these three items accounts for 97.2% of the total selection. The importance evaluation of the scale of plant variety rights R&D trials is shown in Figure 9.

It can be seen from Figure 10 that the respondents' recognition of the scale of R&D trials is mainly focused on "very important." The distribution of the scores of the remaining items is also relatively uniform, with 10 people who think that this factor has an average degree of influence, 29 people who think that the degree of influence is important, and 17 people who think it is extremely important. According to this, it can be inferred that the scale of research and development has a certain impact on the research and development costs of plant variety rights. The technical innovation evaluation of plant variety rights is shown in Figure 10.

### 5. Discussion

China's securitization development continues to advance, and the balance structure of the financial market is also under certain pressure. Due to the falling interest rate level, the financial market under macro-control and government policies cannot achieve equilibrium, resulting in abnormal financial institutions such as shadow banking. With the investment in research and development of new plant varieties and the continuous development of high-tech agricultural production, many breeding scientific research institutions and seed industry enterprises have begun to seek various ways to absorb social funds to obtain corporate financing, which makes the form of plant variety rights securitization developed. Breeding scientific research institutions and seed industry enterprises can cooperate with financial institutions, use computers and the Internet for securitization financing, and introduce concepts such as financial technology, Internet finance, and blockchain smart contracts for project innovation. Through the establishment of an open and transparent trust network in the untrusted cooperation, the plant variety rights securitization transactions involving multiple parties can be recognized. In this process, it is necessary to strengthen the financial supervision of the entire market and operation links [26].

From a functional point of view, intellectual property protection and anti-monopoly regulation are complementary in function. First, intellectual property protection and anti-monopoly law adjustment methods are complementary. On the one hand, intellectual property rights, as a legal

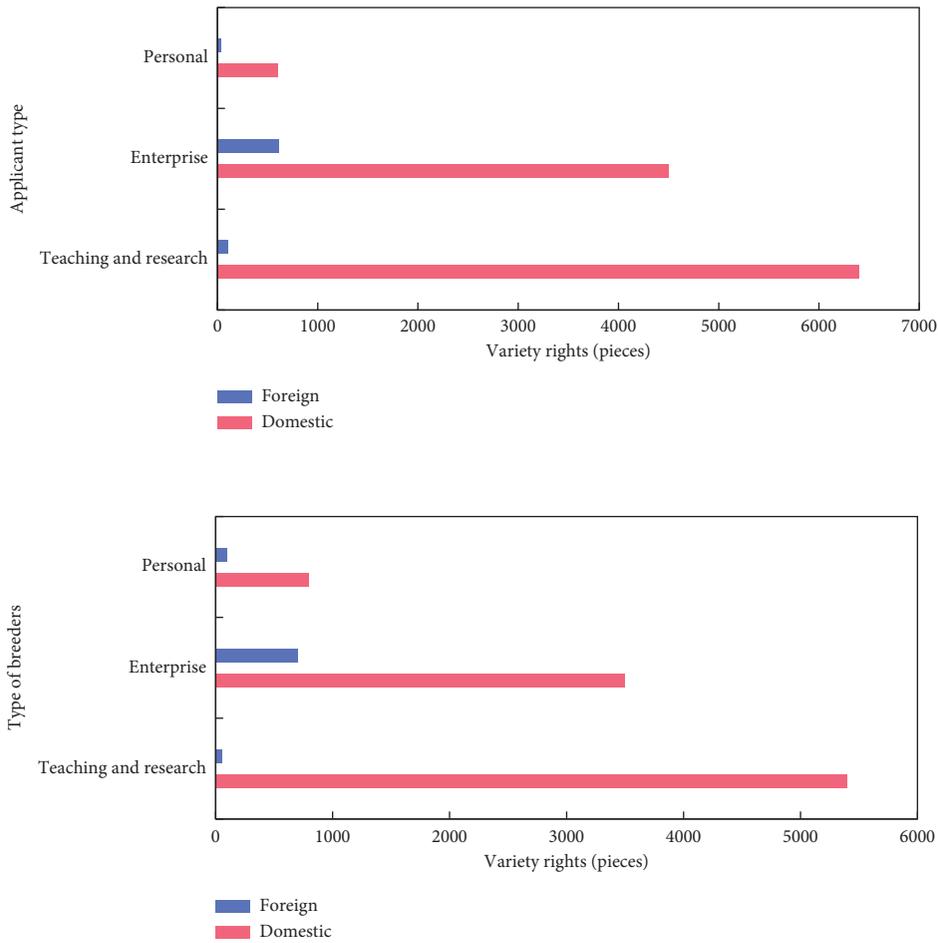


FIGURE 3: Applicants and types of variety rights.

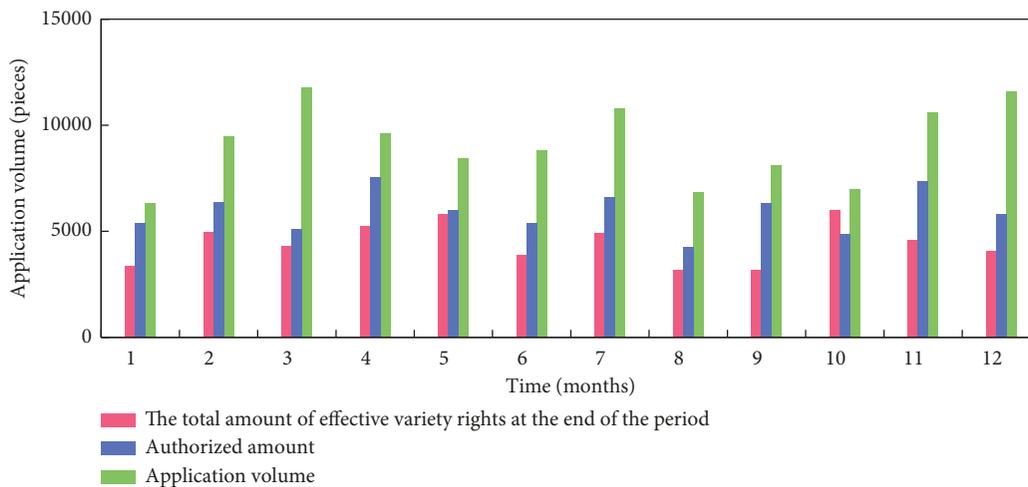


FIGURE 4: The total number of applications for variety rights, the total number of grants, and the total number of effective variety rights at the end of the period in UPOV member countries.

monopoly right, endow the right holder with exclusive rights and exclusive rights, guarantee profits and promote innovation; on the other hand, the anti-monopoly law prohibits behaviors that restrict competition and harm the interests of consumers. An intellectual property licensing act is

undoubtedly legal in the scope of intellectual property law, but it is subject to anti-monopoly regulation because it may harm competition. Similarly, a market operation behavior that does not violate the anti-monopoly law may be prohibited by the intellectual property law because it infringes

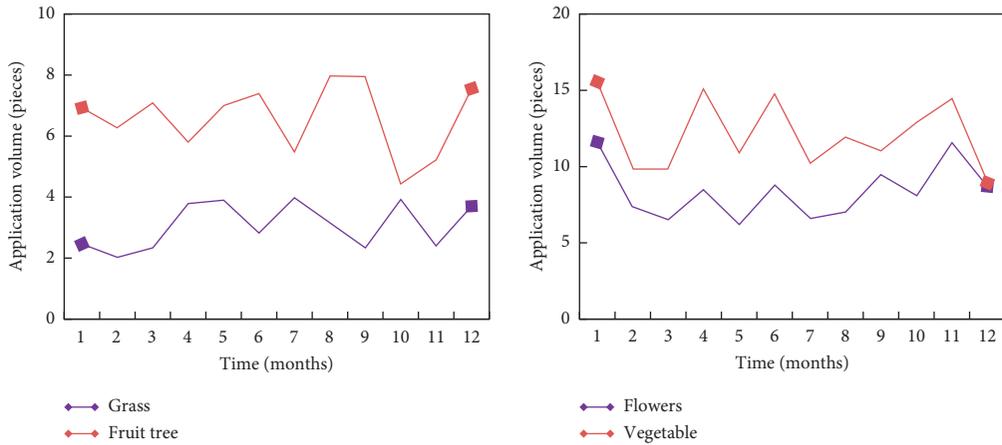


FIGURE 5: Authorized variety plant types.

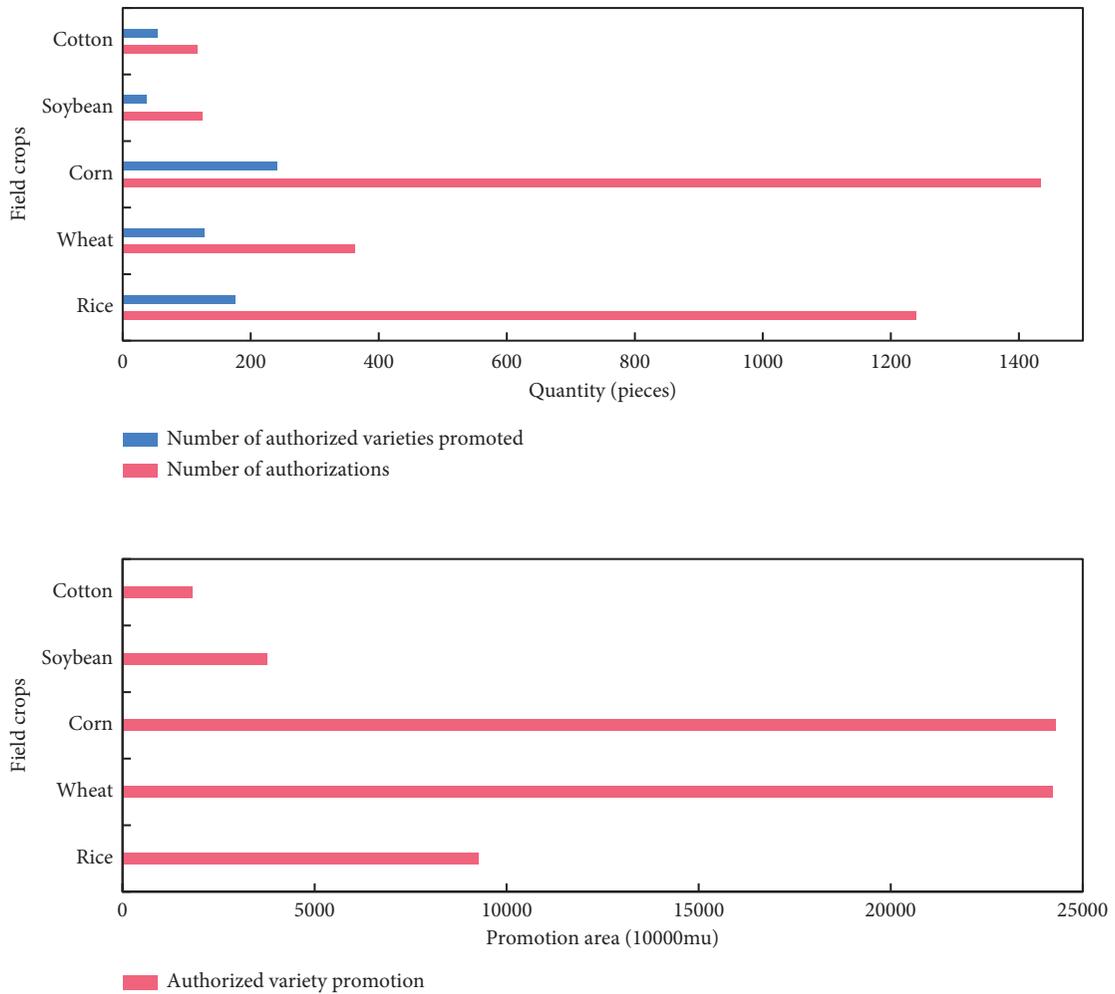


FIGURE 6: Authorized promotion of field crops.

the intellectual property rights of others. Second, the ways of intellectual property protection and anti-monopoly to regulate the abuse of intellectual property rights and safeguard the overall interests of society are complementary. For the anti-monopoly regulation of intellectual property restricting

competition behavior, the anti-monopoly law mainly regulates from the outside, and takes measures by assessing the harm of behavior to competition. The intellectual property protection legal system evaluates the abuse of intellectual property from the perspective of rights restriction, and

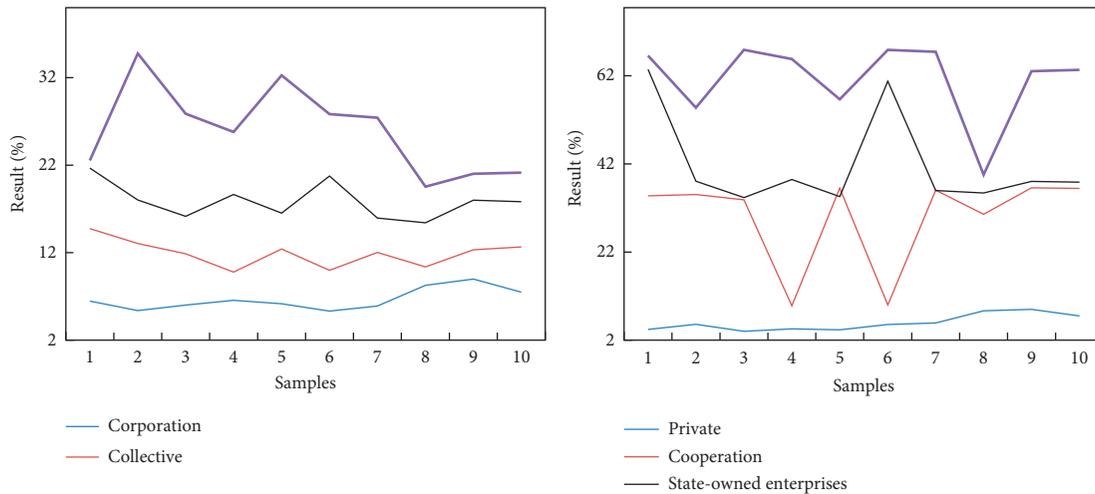


FIGURE 7: Distribution of specific surveys.

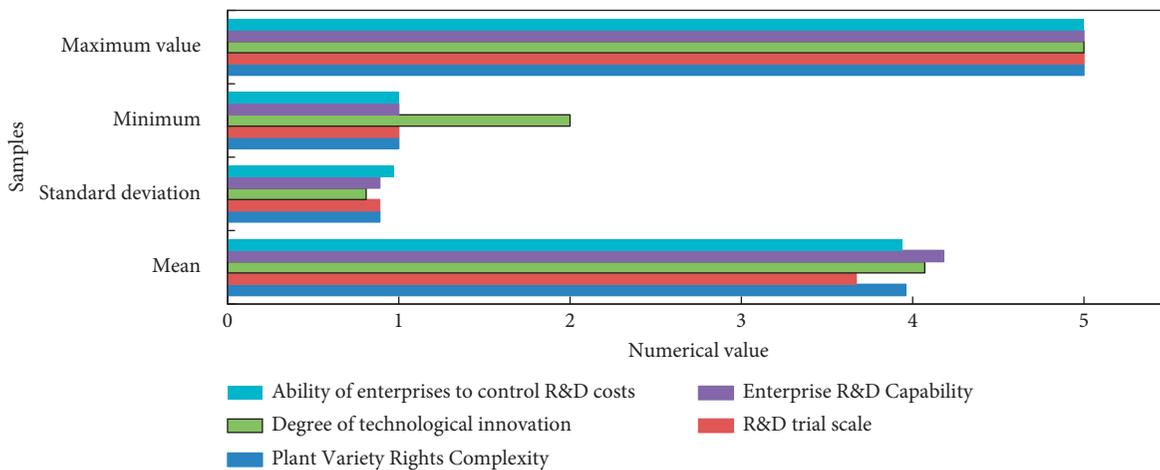


FIGURE 8: Statistics of factors affecting R&D costs of plant variety rights.

establishes a series of internal restriction systems of intellectual property, which self-regulate from the inside and balance the relationship between intellectual property rights and social public interests.

At the same time, a major difference between plant breeding work and industrial invention is that the former is highly dependent on existing reproductive materials and biological genetic information. If subsequent innovators cannot obtain relevant materials or genetic information, breeding work is useless. In addition, other than the exclusivity, temporality, and regionality of traditional intellectual property rights, variety rights have both self-replication, agriculture-related attributes, and seasonality and regionality of crop planting. Special consideration should be given to its protection and regulation; not only should it be given exclusive rights to maintain breeding innovation and profits but also to protect the normal competition in the seed industry market and the supply of agricultural products.

The general license for the implementation of variety rights means that the variety rights holder authorizes the

licensee to implement the variety within a certain time and territory. At the same time, within this scope, the breeder can implement the breed by himself or herself or allow others to implement the breed. This model is conducive to the variety rights holders to adjust their licensing strategy in real time according to market changes, and at the same time, the variety is more widely spread, the breeding cost can be quickly recovered, and the commercial benefits can be maximized quickly. Also, the dispersion of implementation rights makes it difficult to restrict competition in the market, which is conducive to technological progress and increasing production and income. The disadvantage of this model is that the variety rights are licensed too widely, and vicious competition occurs in the relevant market, which damages the interests of both parties.

The anti-monopoly regulation of variety rights licensing is the specific application of the theory of limitation of rights in the field of variety rights. In order to maintain the research and development motivation of breeders, the breed rights protection system gives them sufficient exclusive protection, and any use without legal authorization or the consent of the

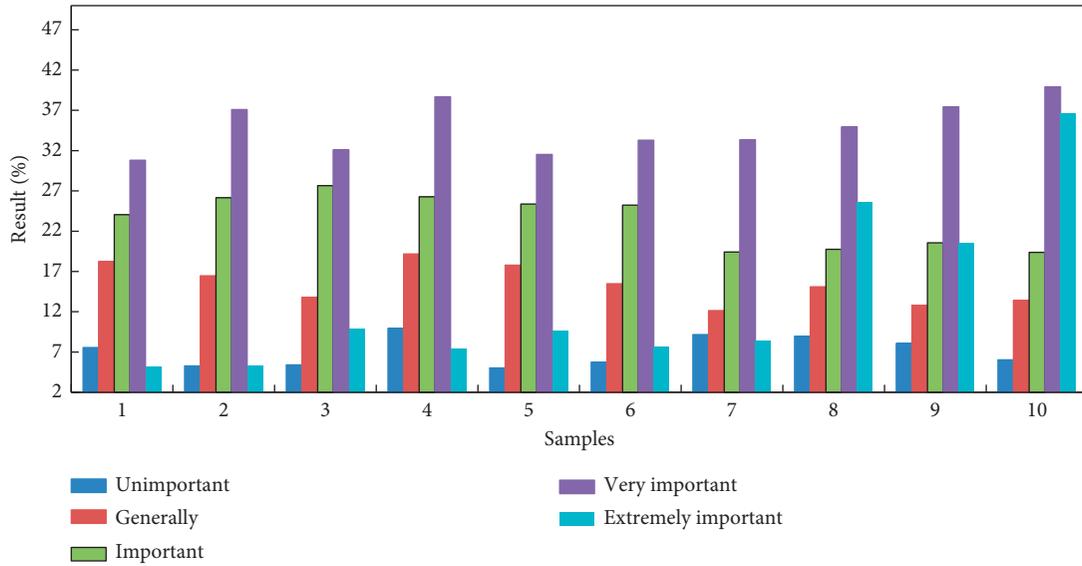


FIGURE 9: Evaluation of the importance of the scale of plant variety rights R&D trials.

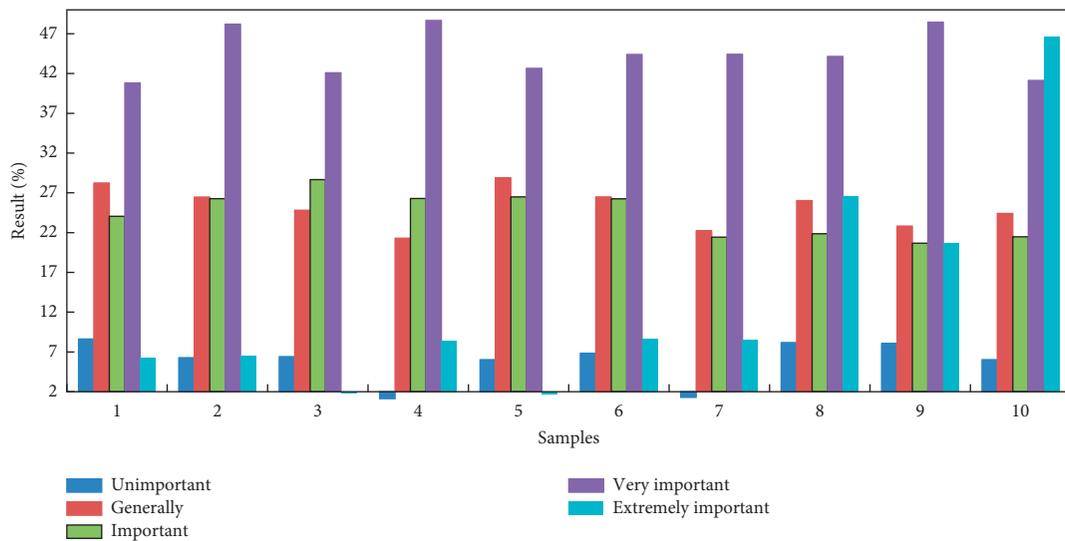


FIGURE 10: Evaluation of plant variety rights technology innovation.

rights holder is an infringement. At the same time, the advancement of breeding technology and the development of the agricultural industry require that the relevant plant breeding achievements can be fully disclosed, disseminated, and implemented in the field of agricultural production. Huge contradictions need to be reconciled by setting up a system through the theory of rights limitation. On the one hand, the variety rights self-restriction system, such as the variety rights licensing system (voluntary license and compulsory license), regulates the abuse of rights from within; on the other hand, while fully respecting and recognizing the variety rights, the anti-monopoly law should also restrict the variety rights through reasonable means and regulate the monopoly behavior of the variety rights. Relevant crop varieties produced, sold, and promoted by breeding companies and agricultural technology companies are often plant varieties with specific traits cultivated

through scientific and technological means, such as traits suitable for specific soils, specific chemical fertilizers, or specific farming methods. After long-term production and planting, the soil composition has been basically fixed, and a certain variety has gradually adapted to the soil environment of this plot, and can obtain higher yields. Agricultural producers will gradually form a heavy dependence on the specific variety, and eventually evolve into a situation where it is difficult to carry out agricultural production if the seeds cultivated and provided by relevant breeding companies cannot be obtained. When the relevant variety rights and crop seeds are controlled by the breeding enterprise and the variety rights holder, the relevant competitors cannot copy or obtain them, and the controller has the ability and conditions to license but refuses to license the relevant rights, seed-related variety rights, and crop seeds; such variety rights and crop seeds should be identified as “critical

facilities” and become a factor to consider whether to regulate related behaviors. The tying behavior in intellectual property licensing means that the right holder in a dominant market position requires the licensee to accept other unrelated intellectual property rights and products, or the act of purchasing unnecessary goods or services from the right holder or a third party designated by it. The tying sale, which is covered by the Anti-monopoly Law, requires the right holder to have a dominant market position and abuse it; such a dominant market position may be possessed by the right holder itself or it may be the dominant market position formed by the horizontal joint agreement between operators. Secondly, it is required that the tying product can be independently licensed or sold. If the right holder does not have a dominant market position, or the licensed intellectual property rights and property rights or products and services are inseparable and cannot be licensed and sold separately, this behavior is not subject to anti-monopoly laws.

It should be noted that it is necessary to avoid the balance between the compulsory license and the interests of the variety rights holder, and avoid excessive restrictions on the interests of the variety rights holder due to the abuse of compulsory license, so as to conform to the original intention of the establishment of the variety rights protection system. The anti-monopoly legal system and the variety rights protection system are the legal norms to adjust the rights and obligations between the variety owner and the licensee, agricultural producers, and even the consumers of agricultural products, and are the balancer of the interests of all parties. The anti-monopoly regulation of variety rights licensing has practical significance and an important role in the development of China’s agricultural industry and the guarantee of food security; it is mainly manifested in the functions of prevention, regulation, and relief of monopoly behavior in variety rights licensing, which in turn promotes the continuous progress of breeding technology, the improvement of consumer welfare, the development of agricultural industry, and the maintenance of food security. Nowadays, China’s breeding technology has made great progress, the proportion of foreign capital in China’s breeding industry is also increasing year by year, and the impact of variety rights on the economy and trade is becoming more and more important. However, there are few academic studies in this field, which leads to many problems in the current anti-monopoly regulation of variety rights licensing that need to be solved urgently. Therefore, it is necessary to strengthen the research on anti-monopoly regulation of variety rights licensing, analyze and examine the interest relationship in variety rights licensing, and systematically sort out existing problems and propose solutions, in order to play its due function of preventive regulation and relief, and help the development of the seed industry [27].

This topic needs to be studied from a broader perspective. For example, economic growth is one of the purposes of improving the legal system, so it is equally important to use economic indicators to analyze the effectiveness of the legal system and to assist the implementation of the law. When conducting anti-monopoly analysis on

behaviors that restrict competition by variety rights licensing, economic analysis methods can be used to evaluate the impact of relevant behaviors on competition and innovation. In the process of implementing and remedying the anti-monopoly system of variety rights licensing, the analytical method of economics can also play an important role. Enterprises may have infringement risks, commercial disclosure risks, technical risks, and product counterfeiting risks in the process of intellectual property operation. Based on this, the concept of intellectual property management is proposed to prevent these specific risks in intellectual property rights, and reduce the possibility of risk management.

The modernization of agriculture and rural areas is inseparable from science and technology. The continuous progress of breeding technology and the healthy development of agricultural industry are the powerful starting points of rural revitalization. The progress of seed industry is the basic element to promote the modernization of agriculture and rural areas. To realize technology-led rural revitalization and agricultural and rural modernization, the relationship between variety rights holders, licensees, agricultural producers, agricultural product consumers, and social public interests should be well balanced. Through the interpretation of the basic issues of anti-monopoly of variety rights licensing, this paper sorts out the system status quo of anti-monopoly regulations on variety rights licensing outside the territory. Based on the existing problems in China, a systematic research and demonstration has been carried out on the improvement of the anti-monopoly regulatory system for variety rights licensing [28].

## 6. Conclusion

With the widespread popularity of the Internet, mobile phones, the Internet of Things and artificial intelligence, information data have grown exponentially, generating massive data (Big Data). How to quickly and efficiently extract and display invisible data in these unstructured big data knowledge is very important. Visualization technology can solve this problem very well. The plant variety rights pricing model mainly involves technical risk, value assessment risk, operational risk, variety rights own risk, legal policy risk, and market risk. Risk warning is an important part of risk management. Collect relevant data through big data technology, collect and analyze indicators, look for potential risks, and timely warn and control risks for the plant variety rights pricing model. Western countries first put forward the concept of capitalized operation, and intellectual property capitalization is also a hot topic, but most of them are limited to the field of law. There is almost no systematic research on the capitalization of plant variety rights. Scholars have mainly discussed the three aspects of the capitalization operation of plant variety rights: pledge, capital contribution, and securitization. Few of them have studied the capitalization operation risks. Therefore, there is a lot of room for discussion in this field. From the perspective of management, this paper will make more beneficial attempts to

capitalize the operational risk of plant variety rights. Based on the big data, this paper discusses and analyzes the key words of the classic literature, which provides a reference for the research on the securitization pricing of plant variety rights. The bibliometric and knowledge map analysis of securitization pricing, the use of financial big data, data collection technology and learning analysis methods, combined with cross-field and multi-disciplinary characteristics, provide a direction for the research and development of plant variety rights securitization, lay a foundation for the theoretical discussion on the securitization and pricing of plant variety rights, and also point out the way for the securitization and capitalization of plant variety rights under big data. The research on the capitalization operation risk of plant variety rights can not only help identify various risks in the capitalization operation of plant variety rights, to provide advice on risk prevention and control, and to promote the development of China's variety rights capitalization theory, but also provide guidance for seed industry enterprises to carry out the capitalization operation of plant variety rights. Therefore, this research has practical value and significance. Due to the broad development prospects of plant variety rights, seed industry enterprises and scientific research institutions urgently need to meet the financing needs of enterprises by developing the economic potential of plant variety rights. Previous studies by scholars have mainly focused on the demonstration and analysis of plant variety rights commercial bank financing, listed company financing, government behavior finance, securities investment funds, etc., but there is no comprehensive analysis of plant variety rights securitization. The risk evaluation index of plant variety rights capitalization operation of seed industry enterprises is selected, and all the risk factors in the capitalization operation system of variety rights cannot be considered, and there is a certain subjectivity. Therefore, in the future research work, the risk factors can be further studied to form more objective, systematic, and comprehensive indicators.

## Data Availability

No data were used to support this study.

## Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this article.

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2022, tracking research on building a model place for Rural Revitalization in the new era in Jiangxi, (22SQ06), 2018 decision support collaborative innovation center project for the Sustainable Development of Modern Agriculture and Its Advantageous Industries in Jiangxi, research on the measurement and improvement of China's agricultural total factor productivity, (2018B02).

## References

- [1] S. J. R. Bostyn, "Plant variety rights protection and essentially derived varieties: a fresh proposal to untie the gordian knot," *GRUR International*, vol. 69, no. 8, pp. 785–802, 2020.
- [2] W. W. M. U. K. Wijesundara, G. K. S. Ananda, L. T. Ranaweera, U. A. K. S. Udawela, C. K. Weebadde, and S. D. S. S. Sooriyapathirana, "Intellectual property rights (IPRs) for plant breeders: a review on theoretical framework and employment of DNA-based varietal authentication for claiming IPR," *Sri Lanka Journal of Food and Agriculture*, vol. 4, no. 2, pp. 53–70, 2018.
- [3] L. Li, C. J. Nelson, J. Trösch, I. Castleden, S. Huang, and A. H. Millar, "Protein degradation rate in *Arabidopsis thaliana* leaf growth and development," *The Plant Cell Online*, vol. 29, no. 2, pp. 207–228, 2017.
- [4] P. Vindhiyavarman, S. Nigam, P. Janila et al., "A new high yielding Spanish bunch groundnut variety CO 7 (ICGV 00351) for the drought prone areas of Tamil Nadu," *Electronic Journal of Plant Breeding*, vol. 10, no. 1, pp. 307–311, 2019.
- [5] T. Adebola, "Examining plant variety protection in Nigeria: realities, obligations and prospects," *Journal of World Intellectual Property*, vol. 22, no. 1-2, pp. 36–58, 2019.
- [6] C. R. Nhemachena and B. Muchara, "Structure of the sunflower plant breeders' rights landscape in South Africa," *South African Journal of Science*, vol. 116, no. 9-10, pp. 1–6, 2020.
- [7] S. H. Jamali, J. Cockram, and L. T. Hickey, "Is plant variety registration keeping pace with speed breeding techniques?" *Euphytica*, vol. 216, no. 8, p. 131, 2020.
- [8] K. Fister, I. Fister, J. Murovec, and B. Bohanec, "DNA labelling of varieties covered by patent protection: a new solution for managing intellectual property rights in the seed industry," *Transgenic Research*, vol. 26, no. 1, pp. 87–95, 2017.
- [9] Y. V. Juk, "Appropriability conditions and the plant variety protection law in Brazil," *Journal of Technology Management and Innovation*, vol. 15, no. 3, pp. 74–82, 2020.
- [10] R. Moonka and S. Mukherjee, "Trips flexibilities and India's plant variety protection regime: the way forward," *BRICS Law Journal*, vol. 5, no. 1, pp. 117–139, 2018.
- [11] O. O. Olusegun and I. A. Olubiyi, "Implications of genetically modified crops and intellectual property rights on agriculture in developing countries," *Journal of African Law*, vol. 61, no. 2, pp. 253–271, 2017.
- [12] M. Blakeney, "Plants, people and practices: the nature and history of the UPOV convention," *European Intellectual Property Review*, vol. 39, no. 12, pp. 801–802, 2017.
- [13] M. B. N. Alves and A. E. A. Paixão, "Intellectual property in the Brazilian agricultural sector," *International Journal for Innovation Education and Research*, vol. 7, no. 2, pp. 54–67, 2019.
- [14] O. Gavrilova, "Breeders' and farmers' exceptions: how valuable are they for the world and are they a necessity for the BRICS countries?" *BRICS Law Journal*, vol. 7, no. 3, pp. 4–28, 2020.

- [15] S. Natesan, G. Murugesan, N. Murugan, S. Chandran, and N. Angamuthu, "DNA fingerprinting of foxtail millet (*Setaria italica* L.) variety ATL 1 using SSR and RAPD markers along with morphological descriptors," *Tropical Plant Research*, vol. 7, no. 3, pp. 587–593, 2020.
- [16] N. J. Page and R. G. Stelpflug, "Plants and seeds of corn variety CV334995," *Monsanto Technology Llc Missouri*, vol. 12, no. 7, pp. 583–586, 2017.
- [17] K. Short and G. J. Holland, "Plants and seeds of hybrid corn variety CH071844," *Monsanto Technology Llc Missouri*, vol. 12, no. 7, pp. 583–586, 2017.
- [18] Y. Hirakawa, K. U. Torii, and N. Uchida, "Mechanisms and strategies shaping plant peptide hormones," *Plant and Cell Physiology*, vol. 58, no. 8, pp. 1313–1318, 2017.
- [19] H. Hu, Y. Wen, T. S. Chua, and X. Li, "Toward scalable systems for big data analytics: a technology tutorial," *IEEE Access*, vol. 2, no. 2, pp. 652–687, 2014.
- [20] Z. Lv, R. Lou, J. Li, A. K. Singh, and H. Song, "Big data analytics for 6G-enabled massive internet of things," *IEEE Internet of Things Journal*, vol. 8, no. 7, pp. 5350–5359, 2021.
- [21] N. Metawa and S. Metawa, "Internet financial risk early warning based on big data analysis," *American Journal of Business and Operations Research*, vol. 3, no. 1, pp. 48–60, 2021.
- [22] S. Athey, "Beyond prediction: using big data for policy problems," *Science*, vol. 355, no. 6324, pp. 483–485, 2017.
- [23] L. Kuang, F. Hao, L. T. Yang, M. Lin, C. Luo, and G. Min, "A tensor-based approach for big data representation and dimensionality reduction," *IEEE Transactions on Emerging Topics in Computing*, vol. 2, no. 3, pp. 280–291, 2014.
- [24] X. Li, H. Liu, Y. Zhang, H. Lv, and Z. Lv, "Big data analysis of the internet of things in the digital twins of smart city based on deep learning," *Future Generation Computer Systems*, vol. 128, pp. 167–177, 2021.
- [25] Y. Zheng, "Urban computing: enabling urban intelligence with big data," *Frontiers of Computer Science*, vol. 11, no. 1, pp. 1–3, 2017.
- [26] Y. Zhang, M. Qiu, C. W. Tsai, M. M. Hassan, and A. Alamri, "Health-CPS: healthcare cyber-physical system Assisted by cloud and big data," *IEEE Systems Journal*, vol. 11, no. 1, pp. 88–95, 2017.
- [27] H. Xing, A. Qian, R. C. Qiu, W. Huang, L. Piao, and H. Liu, "A big data architecture design for smart grids based on random matrix theory," *IEEE Transactions on Smart Grid*, vol. 8, no. 2, pp. 674–686, 2017.
- [28] C. S. Calude and G. Longo, "The deluge of spurious correlations in big data," *Foundations of Science*, vol. 22, no. 3, pp. 595–612, 2017.