

Review Article

Potential Food Security Risks and Countermeasures under the Background of Seed Industry Innovation Based on Industry 4.0

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Industry 4.0, also known as the Fourth Industrial Revolution, is characterized by process automation and digitization and the use of technologies such as the Internet of things, cloud, big data, artificial intelligence (AI), and embedded systems, among others. The application of automation technology based on Industry 4.0 contributes to the realization of a sustainable food security regime. Based on the policy guidance of the “No.1 Document” of the Chinese government on seed industry innovation and the quantitative analysis of the application, authorization, research, and development data of new varieties of agricultural plants in China in recent years, as well as the data of food import and export, this paper studies the risks and challenges facing China’s food security at present and explores the significance, existing problems, and specific countermeasures of resolving food security risks through seed industry innovation.

1. Introduction

Food security is an important foundation for China’s security. At present, with the growth of population, the acceleration of urbanization, and the upgrading of consumer structure, the contradiction between the rigid reduction of arable land resources and the rigid increase in the number and quality of agricultural products has become increasingly prominent. China’s food security is facing the dual pressure and challenge of improving quality and increment. In 2022, the No.1 document of the Chinese government raised ‘keeping food security’ to the ‘bottom line’. Food makes the world stable, and seeds are the basis of food security. Seed is the ‘chip’ of agriculture. In the case of decreasing grain planting area, to ensure food security, it is urgent to vigorously promote seed industry innovation. In the past, food security was mostly studied from the aspects of policy, food production, and food governance, but this paper will provide a new perspective: that is, under the dual pressure and challenge of China’s food security, the current situation of seed industry innovation is analyzed and the countermeasures to resolve the hidden dangers of food security are provided under this background.

2. Literature Review

Food security is a matter of international people’s livelihood and social and political stability, in 2000–2014, China gradually built food security strategy, in 2017 the national security law of the People’s Republic of China will guarantee national food security to the height of the national security strategy, and food security has become the interest of many scholars, making more research results, at present, by reading the relevant literature, with many scholars in the study of food security issues, mainly concentrated in two aspects.

On the one hand, the weak link of food security points out the weak aspects of food security, including food trade and science and technology research; Zhang and Li [1] think China food security is affected by the international food market price volatility risk; the lack of international competitiveness of food industry makes it difficult to reverse the trade pattern [1]; Wei and Yu [2] believe that agricultural science and technology research and development application and innovation ability are insufficient [2]. And, on the other hand, in terms of influencing factors on food security,

such as the outbreak of the COVID-19, resource, and environmental constraints, for example, Zhang Jiaolong believes that under the background of the COVID-19, the outbreak of the Xinguan epidemic has exacerbated the driving factors such as global economic recession, conflict, and instability, and has a negative impact on global food security [3]. He and Song studied ensuring food security with resource constraints and environmental constraints [4].

It can be seen from the above that many scholars have made a quite comprehensive research on food security and have conducted a lot of research on the weak links of food security and the factors affecting food security. At the same time, some supporting technologies based on Industry 5.0 are conducive to increasing output and ensuring China's food security [5], and the Internet of things plays an important role in human life, such as applications in agriculture, climate, and so on [6]. However, under the background of seed industry innovation, there are relatively few studies to analyze food security and discuss the existing problems. It is worth noting that seed industry innovation is not only a weak link in food security in China, but also an important factor affecting food security. Therefore, it is very meaningful to analyze food security problems from the perspective of seed industry innovation.

3. Double Pressures and Challenges of Increasing and Quality of China's Food Security

Ensuring quantity safety is always the basis of food security [7]. General Secretary Xi [8] has pointed out that Chinese society has always been stable own to the stable supply of food and important agricultural and sideline products under the background of COVID-19 [8]. With the improvement of economic development, consumers put forward new requirements on food quality, variety, nutrition, and safety. Food consumption has changed from satisfying food and clothing to focusing on food consumption quality. On November 17, 2021, the Circular of the China Food and Materials Reserve Bureau on Printing and Issuing the Six Action Plans for Improving the Quality of Food Projects put forward the key tasks of the action for improving the quality of food varieties and brands, accelerating the transformation from "eating enough" to "eating well" and "eating nutritional health." However, China still faces the dual pressures and challenges of "quantity" and "quality" of food security in today's international and domestic situation.

Internationally, the food trade deficit is obvious and is greatly affected by uncertainties. First of all, as Figures 1 and 2 show, China's grain imports in 2017–2021 are large, its exports are small, and its net exports are large in terms of grain trade. In addition, among the main import and export agricultural products, soybean imports are large, while wheat and corn imports are relatively small, with a slow range. Secondly, in the import and export of seeds, the import volume is higher than the export volume, and the seed trade deficit is obvious. In 2021, China's import of crop seeds exceeded its export, and the trade volume of

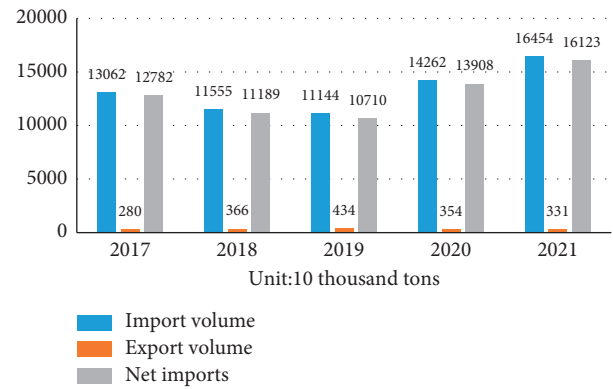


FIGURE 1: Grain imports and exports [9].

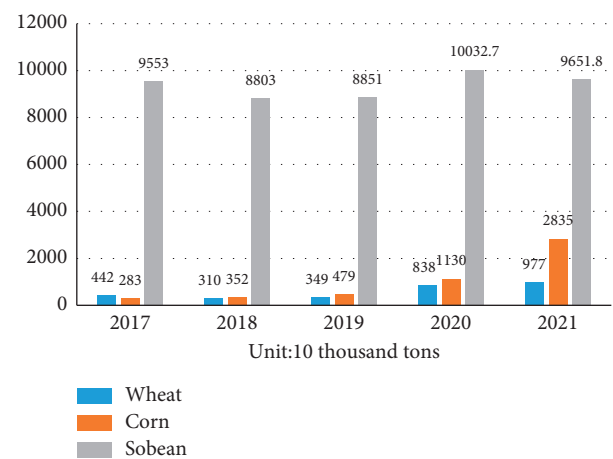


FIGURE 2: Import and export of main agricultural products [9].

crop seeds was USD 1.01 billion, nearly double that of 2011. There are almost no field crops in China's imports, because China's openness in the seed market is different. Since the implementation of the "Seed Law," field crops have been restricted in seed import because of their food security, and their market share is low. However, in the import and export of vegetable seeds, the seed market is fully open. In 2014–2019, the import volume of vegetable seeds generally showed a downward trend, but the import volume was still huge. Finally, food security is greatly affected by uncertainties. According to China and Global Food Report in 2021, the COVID-19 outbreak will worsen food security and nutrition prospects, weaken global trade, and at the same time reduce the efficiency and stability of international trade [10]. For example, Russia restricted the amount of food that can be exported from February 15 to June 30, 2021, and India banned wheat exports on May 13, 2022. However, the foreign trade of China's four staple foods has obvious trend of unidirectional import direction and centralized import area [11]. One of the reasons for the trade deficit of grain import and export is that the international competitiveness of agricultural products is insufficient, and the quality and added value are low, which leads to the dependence on foreign high-quality crops and seeds. However, the great dependence easily leads to the

problem that the grain supply is “constrained by people” and the seed sources are “stuck.”

Domestically, there are challenges in the quantity supply and quality assurance of grain. First, the adjustment of population policy increases the demand for food. According to China’s Population Development Plan (2016–2030), by 2030, the country’s total population will reach about 1.45 billion people, the urbanization of permanent residents will steadily increase, and the urbanization rate of registered residents will accelerate, as shown in Figure 3. The output of major crops in China has been relatively stable in the past five years, while the output of soybeans is relatively small. The increase of population and the decrease of the number of farmers will increase the pressure of food supply to a certain extent, resulting in a situation of short supply. Secondly, the cultivated land area is generally decreasing. In 2017–2021, the sown area of grain in China was 20.23, 17.56, 17.41, 17.52, and 1.764 billion mu, respectively [9]. Although China has set a red line of 1.8 billion cultivated lands, the overall downward trend of grain sown area has also brought challenges to the grain quantity supply. Finally, high-quality varieties are in short supply, and the demand for strong gluten wheat, high-quality rice, and high-oil protein soybean is strong, but the supply is insufficient. For example, China’s current production capacity of high-quality strong gluten wheat is only 2.5–4.5 million tons, but the total demand is as high as 6–8 million tons [12]. Moreover, there is no pricing for ordinary and high-quality grain in the purchase of agricultural products in China, which leads to the fact that grain planting only pays attention to the yield and ignores the quality. The planting area of high-quality grain is small, and the planting area of general grain is large; thus the supply of high-quality grain is insufficient and the common grain is surplus. Since 2012, China’s grain output has remained above 600 million tons, and the average grain output per person is above 450 kilograms, but it still cannot meet the demand. In the post-well-off era, the demand and consumption of high-quality food will continue to increase. With the industrial upgrading, enterprises’ demand for high-quality food increases. It is difficult for the existing grain quality to meet the needs of processing enterprises, and the structural contradiction of varieties and quality problems are becoming more and more obvious [13]. However, the grain supply cannot meet the increasing demand for high-quality food. Generally, there are still too many low-end products, and the supply of green high-quality products with excellent quality and distinctive features is still insufficient [14].

4. Seed Industry Innovation to Resolve Potential Food Security Problems

4.1. From “Quality” and “Quantity” to Ensuring Food Security. In the 2022 Chinese government work report, it is proposed to ensure China’s food security and ensure the supply of important agricultural products such as food. In the March 2021 report on the work of the Chinese Government, it was proposed that seeds and arable land were key to food security. On July 6, 2021, the Ministry of Agriculture and Rural

Affairs held a video conference on the special rectification of intellectual property rights in the seed industry and pointed out that, at present, the contribution rate of improved seeds to China’s grain production increase exceeded 45%. It can be seen that when the total grain planting rate drops, increasing the unit yield is beneficial to ensuring China’s grain security. In order to meet the domestic demand for high-quality food, the most basic thing is to improve the quality of seeds and cultivate high-quality varieties. As the “chip” of agriculture, good food varieties determine the quality of the national diet. Only by combining good seeds with appropriate cultivation techniques can high-quality food be obtained. Therefore, it is very important for China’s food security to improve the quality of seeds, strengthen the innovation of varieties, and cultivate good varieties.

4.2. Interpreting the Connotation of Seed Industry Innovation from the “No.1” Document of the Chinese Government. Over the years, the Chinese government has attached great importance to the development of seed industry innovation. Through sorting out the No.1 document of the Chinese government from 2018 to 2022, we have noticed that the policy support for seed industry innovation from the document contents is mainly manifested in four aspects: (1) support the leading seed industry enterprises to establish and improve the commercial breeding system and strengthen the protection of intellectual property rights in the breeding field [15]; (2) strengthen the enterprise as the main body of technological innovation, with the implementation of improved varieties of joint research, and promote variety cultivation, quality improvement, brand building, and standardized production [16]; (3) the implementation of characteristic advantages of agricultural products exports promotion action and expands the export of high value-added agricultural products [17]; (4) strengthen the protection of seed industry intellectual property rights, severely cracking down on illegal and criminal acts such as license infringement according to law [18].

The four aspects highlighted in the first document of the Chinese government show that the promotion of the development of China’s seed industry cannot rely solely on innovation in one aspect but is a kind of structural innovation, which includes the main structure of innovation, variety structure, seed industry market, and seed industry institutional mechanism. That is, in the development of seed industry, the innovation of seed industry is promoted from the aspect of optimizing the structure of seed industry innovation by reasonably optimizing the main structure of innovation, reasonably adjusting the variety structure, standardizing the seed industry market, and perfecting the seed industry institutional mechanism and other innovative behaviors.

5. Problems of Chinese Seed Industry Innovation in Food Security

Since 2012, China’s grain output has remained above 600 million tons, and the contribution rate of improved varieties to China’s grain production has exceeded 45%. Seed industry

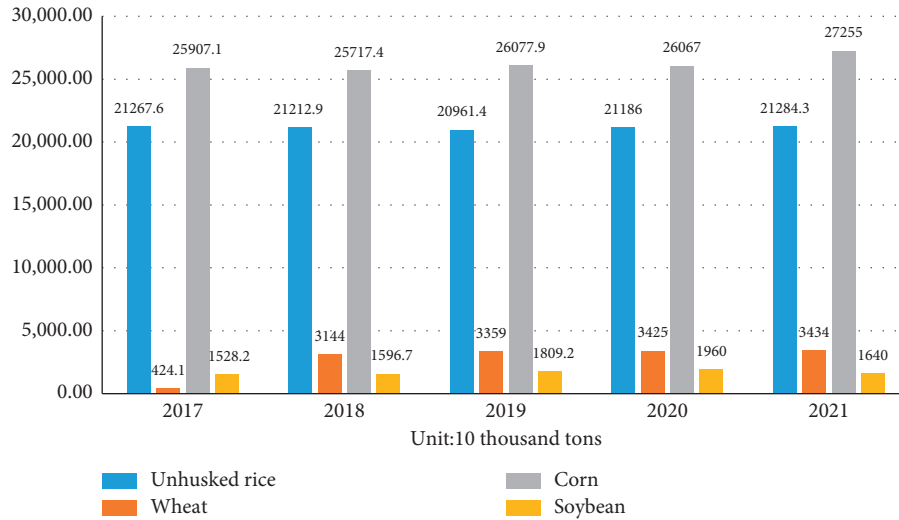


FIGURE 3: Output of major crops [9].

enterprises have developed vigorously. More seed industry enterprises, such as Syngenta and Longping Hi-Tech, have been among the world's top ten. They have actively participated in international market competition, and their ability to breed new varieties has been steadily improved, thus ensuring China's food security. However, at present, there are still problems in China's seed industry innovation, which have caused hidden dangers to the incremental improvement of China's food security.

5.1. Weak Innovation Ability of Seed Enterprises. Firstly, the agricultural intellectual property creation index of enterprises is low. Enterprise agricultural intellectual property creation ability is an important measure of independent innovation level and core competitiveness of enterprises, regions, and China. The higher the creation index, the stronger the level of independent innovation and core competitiveness. According to the 'China Agricultural Intellectual Property Creation Index Report (2020)', the agricultural intellectual property creation index of enterprises is far lower than that of teaching and research institutions. Compared with the Chinese Academy of Sciences, the agricultural intellectual property creation index of Syngenta is 47.37%, while that of the Chinese Academy of Sciences is 100%, which is more than doubled, reflecting the low level of independent innovation and core competitiveness of enterprises.

Secondly, the dominant position of enterprises as seed industry innovation needs to be improved. As shown in Figure 1, the application authorization for new varieties of agricultural plants in China shows a wavy upward trend. However, the difference between the application amount and the authorization amount of new varieties has been widening since 2016. One of the influencing factors is that the application fee, review fee, and annual fee for new varieties have been cancelled since 2017, resulting in an increasing number of applications, and the breeding of new varieties is a long-term process. Therefore, among the large

number of applications for variety rights, the quality of varieties is low and the authorization amount is low. At present, the application and authorization subjects of the new variety right are mainly teaching and research units, enterprises, and individuals. As shown in Figure 2, before 2011, the number of applications for teaching and research institutions was before enterprises and individuals, and then the number of applications for enterprises and individuals exceeded that of teaching and research institutions, with the largest difference between the two in 2019; from the perspective of the authorized subject of variety rights, as shown in Figure 3, the teaching and research units were ahead of enterprises and individuals before 2017, and the authorization of enterprises and individuals exceeded the teaching and research units after 2018. According to the trend of new variety right application, authorization, and related subjects over the years, the trend of new variety right application and authorization is steadily increasing, and the position of enterprises in new variety application and authorization has been improved. However, the innovation ability of enterprises is still weaker than that of scientific research units, as shown in Figures 4 and 5. The proportion of variety authorization in the application amount is lower than that of scientific research units, and the difference between the application amount and the authorization amount is large. In 2019, Chinese enterprises and individuals have reached 4000 in the application amount of new varieties, while the authorization amount is less than 1200.

Finally, the number of China's seed industry enterprises and seed market concentration is not high. Since 2010, Chinese seed enterprises have made great progress. From 2000 to 2010, the number of Chinese seed enterprises surged, but the overall scale was small. As the number of seed companies has surged in the past decade, since 2010, China's seed industry policies have been introduced, industry thresholds have increased, and industry competition has intensified. Figure 6 shows that the number of seed companies reached its lowest level in recent years in 2016, with only 4516, a decrease of nearly half compared with 8,700 in

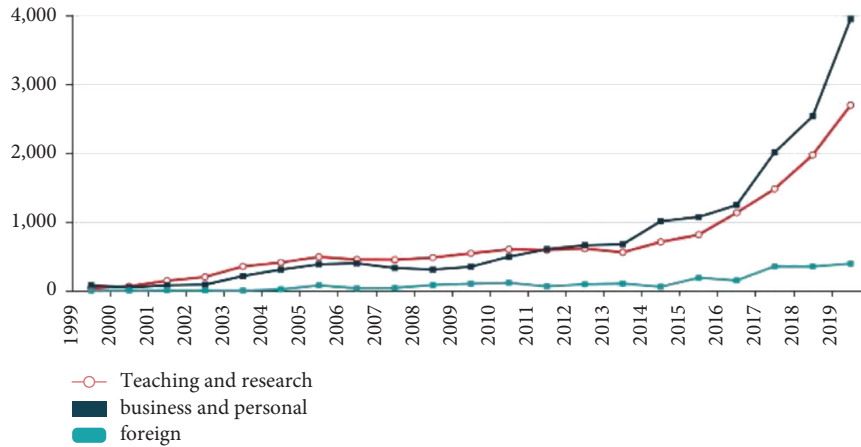


FIGURE 4: Annual trend of application volume (applicant type) [19].

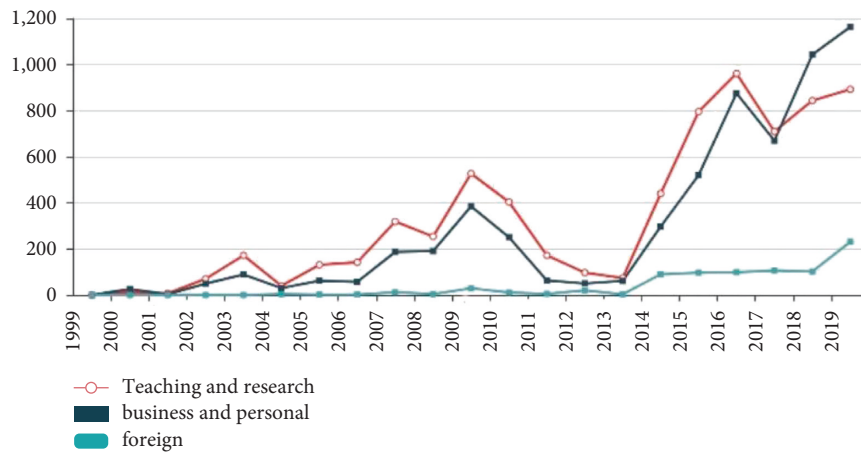


FIGURE 5: Annual trend of authorization volume (type of variety rights holder) [19].

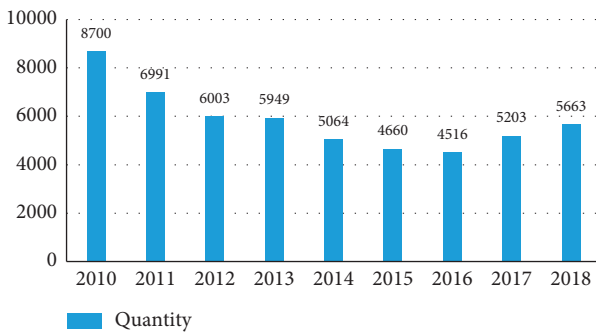


FIGURE 6: Number of seed enterprises [20].

2010. After 2016, the number of seed enterprises increased slowly, and the concentration of enterprises began to increase. However, the proportion of integrated enterprises of crop seeds breeding promotion in China was relatively low, and the market share of the top five seed enterprises in China was less than 10% [21]. This shows that China’s seed industry is a fully competitive and decentralized market with low concentration, which is not conducive to the agglomeration of talents, funds, technology, and other resources. To a certain extent, it is not conducive to the formation of a joint

force of scientific research to promote the enhancement of R&D strength and the improvement of breeding efficiency, hindering the cultivation of improved varieties, and creating hidden dangers for the incremental improvement of food security.

5.2. Unreasonable Distribution Structure of New Variety Breeding. It is emphasized that the modernization of agriculture is based on seeds. To get rid of the limitation, we must cultivate excellent varieties with independent intellectual property rights, and food security depends on continuous breeding innovation of plants [22]. In China’s variety innovation, such as Figures 7 and 8, the application and authorization of new agricultural plant varieties are mainly concentrated in field crops, and other varieties are far lower than field crops in the application and authorization, and the application and authorization are quite different. From 1999 to 2019, the application amount of new variety rights showed an upward trend, while the authorization amount showed a wave trend, especially in field crops. The fluctuation of authorization was large, and the gap between annual application and authorization was large. According to the report of China Agricultural Intellectual Property

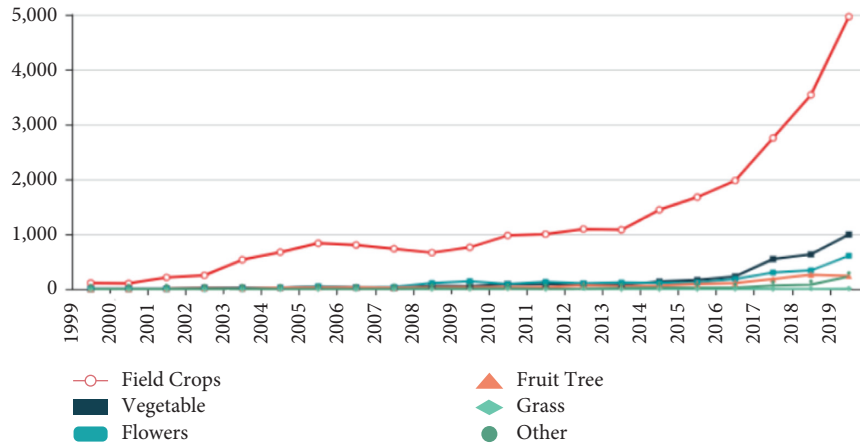


FIGURE 7: Annual trend of application volume (variety type) [19].

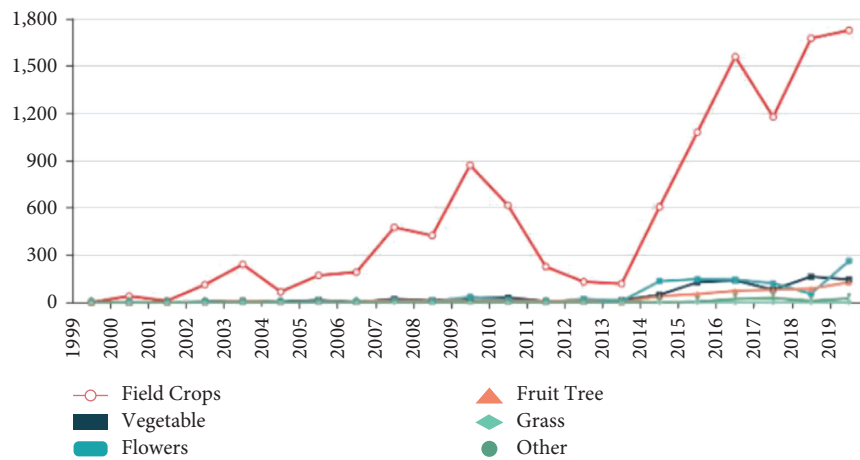


FIGURE 8: Annual trend of authorization volume (variety type) [19].

Creation Index (2020), in the composition of application types, field crops accounted for 77.39%, accounting for the highest proportion, followed by vegetables accounting for 10.17%. In the application of specific variety rights, corn and rice accounted for 41.18% and 33.96%, respectively, and the concentration of variety application was obvious. In the authorization of varieties over the years, the authorization proportion of field crops is much higher than that of other varieties. In specific authorized varieties, the authorization proportion of maize and rice is 40.11% and 35.4%, respectively, and the authorization concentration is obvious. Through the analysis of the types of application and authorization varieties from 1999 to 2019, the types of application and authorization varieties were concentrated, and the authorization of other varieties was relatively low. According to the No.1 document of the Chinese government, China continues to organize and implement joint research on improved varieties of rice, wheat, maize, soybean, and livestock, accelerate the breeding and promotion of high-quality grass varieties, and promote the improvement of varieties and quality. At present, the application and authorization of new varieties are concentrated in maize and rice varieties, and the proportion of application and

authorization of wheat and soybean is low. The distribution structure of new varieties breeding is not reasonable; to a certain extent, it also increases China's demand for foreign high-quality varieties. The shortage of high-quality varieties and high breeding concentration lead to the lack of high-quality varieties of some grains, which cannot meet the needs of China's food security quality and quantity.

5.3. Large Seed Import and Export Deficit and Weak Market Competitiveness. In recent years, China's crop seed import and export deficit is obvious. As shown in Figure 9, from 2014 to 2019, the import volume of seeds is much higher than the export volume. Seeds are obviously dependent on foreign countries, and the import volume is also higher than the export volume. According to China Seed Trade Association's "Analysis of China's Crop Seeds Import and Export Trade Data in 2019": From 2014 to 2019, in the import and export of specific crop seeds, Ryegrass seeds, *Festuca arundinacea* seeds, and vegetable seeds ranked the top three in seed imports in 2019, while rice seeds, herbaceous flower seeds, and corn seed ranked the top three in exports, respectively. The export volume of rice seeds showed an

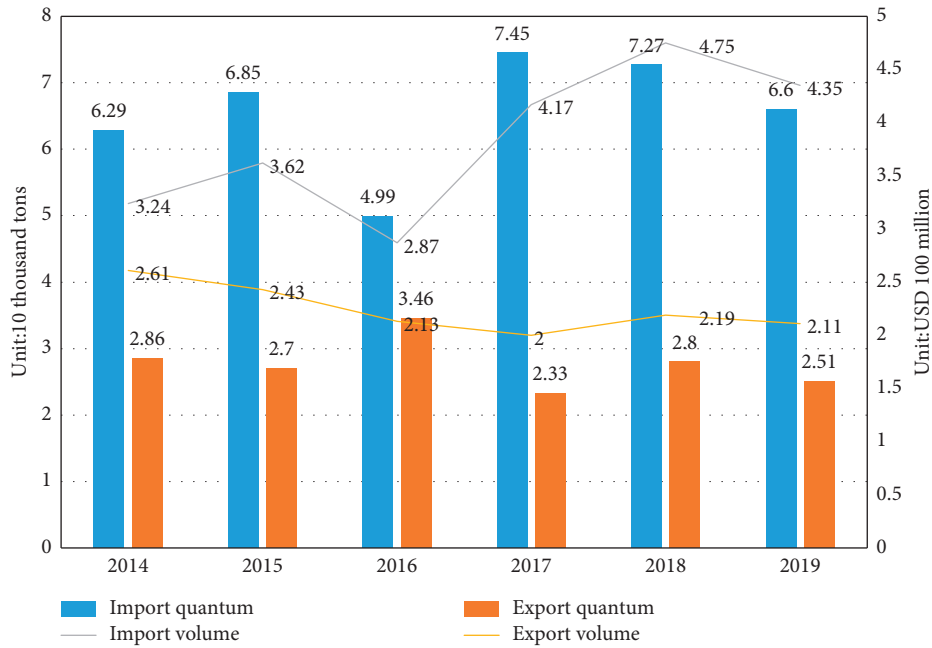


FIGURE 9: Import and export of crop seeds [23].

unbalanced state, and the export volume of rice seeds was much higher than that of other seeds. For specific crops such as vegetables, the import volume of vegetable seeds was higher than the export volume in 2014–2019. Judging from the import and export of seeds, China’s seeds are more dependent on the outside world, and its competitiveness in the international market is weak. It has a large demand for high-quality seeds from abroad, while the domestic production of high-quality seeds is small. To a certain extent, this has also led to the problem of “sticking neck” of Chinese seed sources.

5.4. Imperfect Mechanism. The sound development of seed industry is inseparable from the perfect mechanism guarantee, and the relevant mechanism guarantee in China needs to be improved urgently. It focuses on the protection of variety rights, the administrative system, and the integration process of Industry-University-Research. Taking new plant varieties as an example, firstly, the protection mechanism of variety rights needs to be improved, the original innovation of varieties is the lifeline of enterprises, innovation is an important factor of agricultural sustainable development, and intellectual property is the key driving force of innovation [24]. In order to stimulate continuous innovation in variety development, a system needs to improve incentives for breeders to develop excellent varieties [25], and the protection of plant variety rights can positively stimulate the willingness of breeding research and development [26]. However, in the process of new variety innovation, there are a large number of variety right infringement problems in China. According to the annual report of the Intellectual Property Court of the People’s Court of China in 2020 and the summary of the intellectual property case of the Supreme People’s Court in 2020, there are 44 disputes and 51 cases of

new varieties of plants, and the characteristics of new varieties cases are mainly rich varieties involved, concentrated types of cases, diversified infringers, various types of infringements, and difficult trials, which hinder the protection of variety rights. Secondly, at present, China adopts a relatively centralized intellectual property “two-in-one” administrative management mode [27]. However, the management of variety rights is not unified, and an authorized organization for legal person examination is set up according to the Regulations on the Protection of New Plant Varieties. According to the division of functions, the administrative departments of agriculture and forestry under the State Council are responsible for the acceptance, examination, and authorization of new varieties, respectively. However, the lack of centralized management of new varieties leads to low administrative efficiency and poor communication between departments. The Ministry of Agriculture and the Ministry of Forestry have, respectively, set up official website such as the Science and Technology Development Center of the Ministry of Agriculture and the Forestry Intellectual Property Network to publish information. However, there is no unified data center between departments, and in official website, where the departments are responsible for each other, the information is scattered and the data integration is difficult. Finally, the goal of Industry-University-Research cooperation mode is inconsistent, and the problem of “two aspects” between scientific research and industry has not been fundamentally solved. Western scholars believe that the lack of sharing of technical knowledge, cultural differences, and unclear ownership of intellectual property rights between industry and university are also factors that hinder cooperation [28]. In 2019, the No.1 document of the Chinese government clearly pointed out that strengthening innovation drives development and strengthening the dominant position of technological

innovation of enterprises. However, the government's investment system in seed science and technology is more inclined to support scientific research institutes and universities to carry out public welfare and basic research, and the reward mechanism for R&D and production of seed enterprises is in a vague position [29]. Different seed enterprises have different proportion of scientific research investment due to their own technology, market size, and other factors. According to the report of China's seed industry development, the total investment in scientific research among the top 50 seed industry enterprises in China is 1.366 billion yuan, accounting for only 7% of the sales of commercial seeds of enterprises, and the general level of multinational companies in developed China is 10%. In the development process of seed enterprises with "breeding and pushing" integration, the development is relatively slow, with a small increase in quantity and a small quantity. According to statistics, from 2012 to 2016, China's seed industry authorities issued 80 breeding and promotion integrated enterprises in 12 batches. Among them, the number of the first batch was 32. After that, the number of breeding and integration enterprises increased slowly, and the number was small. From 2016 to 2020, due to the implementation of the new Seed Law in China on January 1, 2016, the Department of Seed Industry of the Ministry of Agriculture delegated the examination and approval of integrated breeding enterprises to the provincial agricultural and forestry authorities, and 32 enterprises passed the examination and approval, totaling 112. Thus, the overall strength of China's seed enterprises is weak, while scientific research institutions are included in the scientific and technological evaluation system with papers, patents, and professional and technical positions as the core, focusing on the foundation, frontier, and innovation of science and technology [30]. Although the government has issued many documents to promote the integration and development of Industry-University-Research, the process of Industry-University-Research is slow due to the lack of common interests.

6. Suggestions on Solving Potential Food Security Risks under Seed Industry Innovation

6.1. Strengthening the Support for Seed Enterprises. To ensure food security, we must increase support for seed industry enterprises, so as to promote seed industry enterprises to become bigger and stronger and become the backbone of seed industry revitalization.

First of all, to speed up the process of Industry-University-Research integration and increase the scientific research and technical support for enterprises, the government should play the role of guide and promoter. In the current process of seed industry-university-institute integration, due to the inconsistent goals of all parties and the lack of common interests, the healthy development of industry-university-institute integration is affected to some extent. As the management and service personnel in seed industry innovation, the government should constantly guide all

parties to advance towards common goals and promote the integration of multiple interests. On the one hand, the government should guide the parties to establish common goals and clear division of labor. In the new era when scientific research evaluation focuses on "breaking the five principles," it is necessary to redefine the content of scientific research evaluation, guide universities, scientific research institutes, and seed industry enterprises to conduct in-depth cooperation, and reasonably transform basic and theoretical scientific research achievements. On the other hand, the government promotes the formation of multiparty common interests foundation. Through the reform of mixed ownership of job-related scientific and technological achievements, the intellectual property rights of job-related scientific and technological achievements are allowed to be jointly owned by job inventors and units, and the barriers of universities, research institutes, and seed enterprises are opened up, so that multiple parties can not only maintain their advantages, but also make up for their shortcomings and encourage the circulation of talents, technology, and other elements among multiple parties, so as to form a good innovation ecology of seed industry.

Finally, encourage mergers and acquisitions between enterprises, grow and cultivate a number of seed industry leading enterprises to adapt to the market, and increase financial support and guarantee. Seed industry enterprises are scattered and not concentrated to a certain extent, resulting in capital, talent, technology, and other resource elements not being concentrated. The noncirculation of information between enterprises affects the efficiency of seed industry innovation. There is a certain gap in competition with foreign dominant seed enterprises. Therefore, it is necessary to further promote the merger and integration of enterprises in an appropriate way, promote resource sharing and information exchange, and attract excellent talents, and according to their own characteristics, to form the own advantages of seed industry enterprises to become bigger and stronger; At the same time, increase the financial support and guarantee for seed industry enterprises to reduce the survival pressure of enterprises. Only, on the one hand, through mergers and integration to enhance their internal power and, on the other hand, by increasing financial support and guarantee to change their survival and development environment, can we better promote the development of seed industry enterprises and improve their innovation ability.

6.2. Optimizing Administrative Services and Strengthening the Protection of Intellectual Property Rights. First of all, to set up an efficient and centralized administrative management organization, change the decentralized management mode of variety rights and centralized management of variety rights and promote the improvement of administrative efficiency; secondly, we should provide quality services and establish national and provincial seed industry big data centers to promote information disclosure; thirdly, make use of the Internet network platform to manage the variety rights, handle the relevant affairs on the network, simplify the relevant process, and improve the work efficiency;

finally, efforts should be made to continuously strengthen the protection of intellectual property rights. The new variety intellectual property rights system ensures the return on research and development investment of breeding enterprises, thus stimulating the increase of research and development investment and further improving the level of breeding innovation [31]. First, it is necessary to improve relevant laws, regulations, and rules, establish a substantial derivative variety system, and pay attention to the protection of the original innovation of seeds; second, increase the punishment for the infringement of variety rights and, at the same time, improve the convergence mechanism of administrative law enforcement and judicial protection, so that the infringer can pay more tort costs; third, we should pay attention to the protection of the rights and interests of variety owners, expand the scope of the rights and interests of variety owners, and improve the enthusiasm of breeders; fourth, it is necessary to continuously enhance the judgment and trial ability of the infringement of variety rights and to be able to fairly and properly protect the relevant stakeholders in the case of relevant disputes and to take relevant punishment for the infringer.

6.3. Strengthening Policy Guidance and Increasing Incentives.

In terms of variety innovation, there is a phenomenon of concentration of variety innovation. In the application and authorization of variety rights, the number of applications and authorizations for maize and rice is large, while the number of applications and authorizations for ordinary wheat and soybean is small. In addition, domestic demand for strong gluten and weak gluten wheat, high-quality rice, and high-oil protein soybean is increasingly strong, and the supply of high-quality varieties is in short supply; at the same time, in terms of structural changes, the production structure of corn, wheat, and rice is still unbalanced [32]. Therefore, it is necessary to strengthen policy guidance and increase incentives. First of all, guide the direction of variety innovation and change the unbalanced situation of variety innovation. Secondly, in view of the domestic market demand for grain varieties, strengthen the policy guidance for the innovation of key varieties, strengthen the research and development and cultivation of high-yield and high-quality seeds, change the current situation of dependence on overimport of foreign seeds, and firmly hold the provenance in their own hands. Thirdly, we should strengthen the guidance of sowing high-quality varieties, expand the planting area of improved varieties, and ease the tense situation of domestic demand for improved varieties and high-quality grain. Finally, we should increase the incentives for variety innovation. First, set up relevant subsidies and increase incentives for innovation of key varieties. Second, we should increase the intensity of bonuses and variety innovation to increase the enthusiasm of breeders. Third, to strengthen the publicity of breeding achievements of breeders, increase the spiritual reward. Only by constantly improving the rewards and mobilizing the enthusiasm of innovation, can we cultivate more superior varieties, meet

the market demand, promote the high yield and high quality of grain output, and alleviate the hidden dangers of food security.

7. Conclusion

China's grain needs China's seeds, and the cornerstone of the seed industry must be firmly established to ensure food security. As the "chip" of agriculture, seed is the "source" to ensure the safety of China's grain situation and the high-quality development of agriculture. Based on the analysis of the dual pressures and challenges of increasing and improving the quality of China's food security, this paper points out that seed industry innovation is an important focus to resolve the hidden dangers of China's food security. It is proposed that seed industry innovation is an important starting point to resolve the hidden danger of food security in China, and by conducting the analysis of the policies over the years and refining the key points, the seed industry innovation is explained from four aspects and by analyzing the seed industry in China innovation ability is not strong. The distribution structure of new breed breeding is not reasonable, with weak market competitiveness, strong external dependence on the seeds, and imperfect relevant mechanisms, and based on the current status of seed industry innovation and development, some suggestions are put forward, such as strengthening the support of seed enterprises, optimizing administrative services, strengthening the protection of intellectual property rights, strengthening policy guidance, and improving incentives, etc., in order to change the problems of weak innovation ability, limited capital, limited talents, and large and scattered number of seed enterprises, so as to promote enterprises to better participate in market competition, provide a better ecological environment for seed industry innovation, guarantee the sound development of seed industry, mobilize the enthusiasm of variety innovation, improve the current innovation status of seed industry in China, and resolve the potential food safety hazard in China from the root.

7.1. Challenges and Future Directions. Under the influence of various factors, this study has challenges and deficiencies: this study is based on the current situation of China's seed industry innovation, analyzes the hidden dangers of China's food security, and puts forward relevant countermeasures. Therefore, it is necessary to analyze whether food security exists from a specific perspective. In addition, this paper is based on the policy text over the years and extracts four key points of policy support for seed industry innovation and explains the concept of seed industry innovation on this basis; the current situation of seed industry innovation is analyzed, so the interpretation and refining of seed industry policy still need further research. Finally, this paper analyzes the unbalanced structure of variety innovation in China with the data of new agricultural plant varieties. However, because the latest

application and authorization of new agricultural plant varieties have not been published, there are difficulties in data acquisition. Many questions require further investigation.

Therefore, for the current existing problems and challenges, in the future research process, the following work will focus on the following: First, it should further explore the hidden dangers of food security and understand and analyze the current situation of seed industry innovation in China from many aspects, in order to achieve a profound understanding of the current situation of seed industry innovation; next, we will continue reading the relevant literature, draw on knowledge from the research results of others, and continue to study the relevant policy documents, extracting its key points to achieve a deep understanding of seed industry innovation. The concept of seed industry innovation is constantly enriched and improved; last, we will continue to collect data on the applications and authorization of new agricultural plant varieties and follow the pace of research in related research areas.

Data Availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflicts of Interest

The authors declare no conflicts of interest.

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