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Artificial Intelligence Empowers High-Quality Development of Guangxi's Seed Industry: Advantages, Challenges, and Recommendations

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Abstract: As a core engine for the development of new quality productive forces in agriculture, artificial intelligence (AI) is of great significance for driving the high-quality development of Guangxi's seed industry. This paper systematically analyzes the potential advantages, practical challenges, and corresponding strategies of AI empowering the high-quality development of Guangxi's seed industry. Research shows that while Guangxi possesses potential advantages such as strong policy support, abundant germplasm resources, steady growth of seed enterprises, and continuous improvement of breeding bases, it also faces three core challenges: weak data foundation, insufficient R&D investment, and a severe shortage of interdisciplinary talents. To address these bottlenecks, this paper proposes countermeasures including constructing a distinctive seed industry data platform for Guangxi, guiding diversified capital investment, and strengthening the talent introduction and cultivation system, aiming to provide support for the high-quality development of Guangxi's seed industry.

Keywords: Artificial Intelligence; Guangxi; Seed Industry; High-Quality Development

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1.Introduction

Food is the foundation of society, and seeds are the cornerstone of agriculture. As the "chip" of agriculture, the seed industry is crucial for ensuring national food security and serves as an important foundation for promoting agricultural modernization and developing new quality productive forces in agriculture [1]. The state attaches great importance to the development of the seed industry. In recent years, it has continuously emphasized key tasks such as safeguarding food security, strengthening the protection, development, and utilization of agricultural germplasm resources, and further implementing the seed industry revitalization initiative. According to data from the Ministry of Agriculture and Rural Affairs, as of 2023, the coverage rate of improved crop varieties in China has remained above 96%, contributing over 45% to agricultural yield growth, with independently cultivated varieties accounting for more than 95% of the sown area.

Located in a subtropical monsoon climate zone with diverse and complex terrain, Guangxi is one of the provinces with the richest germplasm resources in China, ranking third in the country in terms of biodiversity richness [2]. Its seed industry

development plays an important role in promoting national agricultural modernization and ensuring food security. After years of development, Guangxi's seed industry has achieved certain results in variety innovation, technology promotion, and industrial system construction, but there is still a gap compared with the national advanced level. Currently, Guangxi's agriculture is in a critical stage of transformation towards high-quality development and modernization. As the "chip" of agriculture, cultivating high-quality seeds that meet the needs of modern high-quality agricultural development is the key to enhancing Guangxi's agricultural competitiveness. Promoting the high-quality development of the seed industry is both important and urgent.

As the core driving force of the new round of technological revolution and industrial transformation, the rapid development of AI is reshaping the production relations of various industries, forming a dynamic network system through the collaborative linkage of various subjects, resources, and environments. Currently, the application of AI in the agricultural field is deepening, becoming an important force for promoting agricultural modernization [3]. From seed industry, planting, and breeding to storage, processing, circulation, sales and other links, the application of AI not only improves the efficiency and quality of agricultural production, but also promotes the intelligent upgrading of all links in the agricultural industrial chain. In the field of seed industry, AI can accelerate the breeding process, improve breeding accuracy, optimize resource allocation, and reduce production costs [4]. Therefore, exploring the application and development path of AI in Guangxi's seed industry is of great practical significance for promoting regional agricultural modernization and ensuring food security.

2.Pathways Through Which AI Empowers High-Quality Development of the Seed Industry

2.1 Expanding Breeding Genetic Resources

A major bottleneck in traditional breeding lies in the lack of genetic resources and insufficient excavation of excellent genes. By analyzing big data with omics technologies and deep learning algorithms, AI can comprehensively and in-depth analyze crop biological characteristics, gene expression rules, and metabolic processes, helping to construct a more complete crop trait map, break through cognitive boundaries, and discover more undiscovered and unvalidated excellent genes. For example, through pan-genome analysis of more than 1,000 wheat varieties, a long-neglected "ancestral subpopulation" was found, which contains excellent genes such as disease resistance and drought tolerance, opening up a new resource pool for wheat breeding [5]. "Fengdeng Gene Scientist", China's first independent scientific discovery system in the field of biological breeding, can simulate molecular biologists to independently carry out crop gene function research, showing strong capabilities in gene mining and function prediction. Using this system, researchers have successfully discovered and verified dozens of previously unreported functional genes in food crops, providing valuable genetic resources for crop improvement [6].

2.2 Precisely Optimizing Variety Traits

The observation of variety traits in traditional breeding relies on subjective evaluation of phenotypes, which has great limitations. With its powerful computing power and algorithm advantages, AI explores the correlation between genes and traits, identifies key genes and regulatory pathways related to important traits such as yield and stress resistance, and helps researchers more accurately predict the potential paths of crop improvement. Gene editing technology can accurately and efficiently modify the crop genome, endowing crops with new resistance or improving bad traits, thereby enhancing crop yield, quality, and disease resistance [7]. Currently, CRISPR-based gene editing technology has expanded from single-gene knockout to megabase-scale chromosome rearrangement, enabling efficient, precise, and targeted modification of crop genomes, and effectively solving the trade-off between disease resistance and yield [8]. Taking "Ningxiang" pigs as an example, after gene detection, sequencing analysis, and gene editing, their lean meat percentage increased by 11%, and their reproductive capacity and disease resistance were also enhanced to a certain extent.

2.3 Significantly Shortening the Breeding Cycle

Traditional breeding methods have long cycles and high costs, making it difficult to meet the demand for high-quality and high-yield crops in agricultural modernization. Combining AI technology with breeding work can accurately and efficiently improve key crop traits and environmental adaptability through gene network recombination and big data optimization, significantly improving breeding efficiency. In terms of breeding scheme design, introducing machine learning to build

prediction models, importing relevant gene data and knowledge graphs for big data analysis, can screen out excellent parent combinations and the most potential breeding paths, transforming breeding from "selecting after seeing" to "predicting first and then verifying", and greatly improving breeding efficiency. In the seed selection link, image recognition technology can efficiently screen individuals that meet specific standards from thousands of seeds, significantly improving screening efficiency and accuracy, and shortening the breeding cycle.

2.4 Enabling Intelligent Cultivation Management and Monitoring

In the experimental fields for new variety cultivation, AI plays a key role in seed planting and trait monitoring. In terms of variety performance monitoring, intelligent platforms such as robots can replace researchers to observe and judge crops, and conduct preliminary screening of target plants with excellent traits; in terms of field management, through deep learning and IoT technology, intelligent monitoring of experimental fields can independently detect indicators such as soil temperature, humidity, and nutrient content, realizing automatic irrigation or fertilization, and providing an optimal environment for seed growth. In addition, AI algorithms can analyze the occurrence of diseases and insect pests, issue early warnings and provide prevention and control suggestions. For example, deploying intelligent breeding robots to observe field crops and screen plants with excellent genes such as high yield and disease resistance, a single robot can inspect 2.5 mu of farmland per hour, significantly improving screening efficiency.

3.Potential Advantages of AI in Empowering the High-Quality Development of Guangxi's Seed Industry

3.1 Strengthening Policy Support

Policy guidance is an important driving force for the application of AI in the seed industry. In February 2025, Guangxi established a special AI task force, listing the development and application of AI as a key work, and subsequently issued a series of policy documents such as the "Decision on Accelerating the High-Quality Development of Artificial Intelligence" and the "Guangxi 'AI + Manufacturing' Action Plan (2025-2027)", clearly supporting the development of AI through seven major actions, with the goal of achieving an output value of 100 billion yuan for AI-related industries by 2027. Guangxi focuses on the development path of "R&D in Beijing/Shanghai/Guangdong + Integration in Guangxi + Application in ASEAN", and strives to create a fertile ground for AI development. In July 2025, the exhibition center of China-ASEAN AI Innovation Cooperation Center was put into trial operation; universities in Guangxi have successively established AI colleges or research institutes, and piloted the opening of AI general education courses; the "AI Empowers All Industries Super League" was held to stimulate the vitality of various fields to innovate and develop with the help of AI.

3.2 Abundant Germplasm Resource Reserves

Germplasm resources are the foundation for the application of AI in the seed industry. Through large-scale agricultural germplasm resource surveys, Guangxi has submitted 3,912 crop germplasm resources to the national repository, and initially established a protection system connecting the national and provincial levels. Among them, the reserves of wild rice, sugarcane, and waxy corn germplasm resources account for 50%, 50%, and 33% of the national total respectively, and the number of rice seed resources ranks first in the country; 132 livestock and poultry breeds have been identified, with a stock of about 14 million heads (pieces); 319 germplasm resources have been registered and included in the "National Catalog of Aquaculture Germplasm Resources (2023 Edition)", ranking third in the country; a comprehensive four-year forest and grass germplasm resource survey was carried out for the first time in the region, registering more than 18,500 excellent individual plants and specific germplasm resources. Currently, Guangxi has built 9 national-level agricultural germplasm resource banks (nurseries, farms), identified 97 provincial-level agricultural germplasm resource protection units, and preserved more than 100,000 copies of crop germplasm resources and intermediate materials, more than 110,000 copies of livestock and poultry genetic resources, more than 320,000 copies of aquatic germplasm resources, and more than 700 silkworm variety resources. In addition, Guangxi's first national-level livestock and poultry genetic resource gene bank has been built, becoming one of the three major live gene banks for local chicken breeds in China.

3.3 Gradual Growth of Seed Enterprises

Enterprises are the main body for the application of AI in the seed industry. Guangxi has continuously introduced policies

and measures to support the development of seed enterprises: first, financial subsidies help the development of high-quality enterprises. In recent years, 20 million yuan has been arranged to carry out the action of cultivating superior seed enterprises, supporting enterprises through project funds, financial incentives such as "Guangxi Preferential Loans", and Guangxi Rural Investment Group invested 5 billion yuan to establish Guangxi Seed Industry Group Co., Ltd., striving to build a leading seed enterprise in Guangxi; second, scientific research institutes provide technical support, guiding enterprises to strengthen cooperation with scientific research institutes, jointly carry out research on variety breeding technology, promote the commercialization and industrialization of seed industry achievements, form an effective scientific research achievement transformation system, and help build a sound commercial breeding system; third, build platforms to help enterprises "go global". Since 2020, four sessions of the China (Guangxi)-ASEAN Modern Seed Industry Development Conference have been successfully held, establishing an "aid-construction + operation" model to support enterprises in building crop variety testing stations in ASEAN countries. As of October 2023, 5 overseas testing stations have been built in 5 countries, introducing more than 750 excellent new varieties such as vegetables and rice for trial planting in ASEAN, with a cumulative demonstration and promotion area exceeding 4 million mu. As of April 2024, there are 970 seed enterprises holding valid production and operation licenses in Guangxi, of which 12 are selected as national core seed enterprises, ranking tenth in the country.

3.4 Steady Development of Breeding Bases

Bases are the carriers for the application of AI in the seed industry. According to relevant reports [9-11], as of November 2024, Guangxi has designated 4 provincial-level major seed production counties, among which Bobai County is the only national major seed production county (for rice) in Guangxi, with a seed production area of 42,000 mu in 2024. The total area of rice and corn seed production bases in Guangxi increased from 47,500 mu in 2020 to 137,500 mu in 2024, and the coverage rate of improved varieties of major crops reached about 97%; Mashan County and Zhongshan County have built corn and rice seed production bases respectively, with a total area of more than 70,000 mu in 2024; 15 national-level livestock and poultry core breeding farms (multiplication bases) have been built, including the largest buffalo improved variety multiplication base in China; 2 national-level and 34 provincial-level aquatic fry farms have been built, producing more than 100 billion freshwater fish fries annually, ranking among the top three in the country. Since 2021, 19 Guangxi Modern Characteristic Agricultural Demonstration Zones with the seed industry as the leading industry have been newly recognized. Great importance is attached to the construction of Guangxi Southern Breeding Base, and it is planned to invest 120 million yuan to implement the upgrading project, expanding 500 mu on the basis of the original 793 mu.

4.Practical Challenges of AI in Empowering the High-Quality Development of Guangxi's Seed Industry

4.1 Weak Data Foundation Restricting Model Training

Data is the core production factor of AI, but the data foundation of Guangxi's seed industry is still relatively weak. First, data collection is difficult. Guangxi is dominated by mountainous and hilly terrain. Although it is rich in germplasm resources, the fragmentation of mountainous plots is serious, and the cost of sensor deployment is high, resulting in incomplete collection of key data such as soil conditions, crop growth, and phenotypes; second, there are data barriers. Restricted by the scientific research management system, data sharing between scientific research institutions and enterprises, and between enterprises is not smooth, which restricts the whole-chain optimization of AI-assisted breeding in Guangxi; third, there is a lack of local characteristic sample data. Guangxi has many characteristic agricultural products such as sugarcane, mango, and buffalo. At present, mainstream big data models in China (such as "Fengdeng") have insufficient pertinence to these characteristic crops. Guangxi has not yet formed sufficient data accumulation, and lacks sufficient data samples for training exclusive models of local key agricultural products.

4.2 Insufficient Investment in R&D and Operational Funding

Enterprises are the main body of AI application, while most seed enterprises and AI enterprises in Guangxi are small and medium-sized, with prominent capital shortage problems. First, the government subsidy funds are insufficient. Guangxi arranges 30 million yuan of AI-related subsidies every year, which is far lower than 5 billion yuan in Hunan and 1.75 billion

yuan in Hangzhou; second, insufficient funds lead to the lack of basic equipment. The equipment and operation costs of AI R&D are relatively high, and enterprises lack sufficient hardware conditions for AI R&D; third, the shortage of funds delays the progress of breeding R&D. A large amount of upfront investment is required for seed industry gene prediction, genetic improvement and other work. At present, there are few AI enterprises in Guangxi focusing on algorithm and software development, and the research and development of new varieties mainly rely on big data models outside the province.

4.3 Significant Shortage in the Supply of Interdisciplinary Talents

The overall strength of AI enterprises in Guangxi is weak, and the talent shortage is prominent. First, there is a lack of comprehensive high-end talents. Biological breeding involves multidisciplinary knowledge such as biology, meteorology, genetics, soil science, and molecular biology. Meanwhile, computing power, as the core support of AI, has high requirements for technological innovation, which puts forward higher requirements for the comprehensive ability of practitioners; second, the talent attraction is insufficient. Adjacent to the Guangdong-Hong Kong-Macao Greater Bay Area, Guangxi is at a relative disadvantage in terms of talent policies, making it difficult to introduce external talents and retain local talents; third, the quality of locally trained talents is insufficient. Although universities in Guangxi have begun to set up AI colleges and related courses, limited by the strength of teachers and platform conditions, it is difficult to cultivate high-end talents needed in the AI field.

5.Policy Recommendations for Empowering the High-Quality Development of Guangxi's Seed Industry with AI

5.1 Constructing a Characteristic Seed Industry Data Resource Platform for Guangxi

First, do a good job in strategic planning and infrastructure construction. Building a seed industry big data platform requires a lot of human, material and financial resources. First of all, it is necessary to comprehensively investigate and evaluate the development status of Guangxi's seed industry, organize relevant enterprises and industry experts to discuss the platform construction plan, and formulate a scientific, forward-looking, detailed and perfect overall plan and blueprint; implement a number of major "AI + Agriculture" infrastructure projects to provide support for the research and development of industry-specific large models and the construction of computing power infrastructure.

Second, integrate resources to achieve data sharing. Relying on existing carriers such as regional shared exchange platforms and public data platforms, authorize scientific research institutions, enterprises, and grass-roots agricultural technology promotion departments to exchange and share data, build a seed industry knowledge base and data set, realize the real-time aggregation of multi-dimensional data such as soil moisture, meteorological monitoring, and germplasm resources, generate a dynamically visualized "seed production industry map", and break data barriers. At the same time, pay attention to data classification and grading, standardize the authorized use of core data, and strengthen data security protection.

Third, focus on data collection of local characteristic crops. Construct an integrated "Space-Air-Ground" data collection and intelligent decision-making system, accelerate the promotion and application of satellite remote sensing technology in the agricultural field, and accurately collect environmental data such as soil moisture, meteorological factors, and crop phenotypes; concentrate scientific research forces to carry out data collection related to Guangxi's characteristic crops in a planned and step-by-step manner, establish a gene map database of characteristic crop germplasm resources, and formulate unified data collection standards to ensure data quality.

5.2 Guiding a Diversified Funding Investment Mechanism

First, optimize government financial support. Incorporate the subsidy funds supporting the construction of the seed industry data platform and the development of AI into the annual budget of local governments to ensure the stability and continuity of funds; formulate policies supporting the application of AI in the seed industry such as tax incentives and AI innovation awards to encourage enterprises to increase R&D investment.

Second, increase scientific research investment. In the national, autonomous region, and municipal-level science and technology projects, strengthen the support for AI-related projects in the seed industry, and set up special scientific research project funds to give key support to promising research directions and teams.

Third, integrate social capital participation. Actively guide social capital to participate in AI and seed industry integration

projects, attract various capitals such as angel investment and venture capital to flow into the seed industry AI field by establishing industrial investment funds and risk compensation mechanisms; build a docking platform for enterprises and financial institutions, regularly organize exchange activities between seed enterprises and financial institutions, enhance mutual understanding and trust, and improve financing efficiency; encourage insurance institutions to develop insurance products suitable for seed industry AI innovation, such as R&D failure insurance and technology application risk insurance, to reduce enterprise innovation risks and enhance their confidence in R&D investment. Through the above diversified fund measures, form a stable and sustainable source of funds, provide solid financial support for the wide application and high-quality development of AI in Guangxi's seed industry, and promote the steady progress of Guangxi's seed industry in the wave of intelligent transformation.

5.3 Strengthening the Talent Introduction and Local Cultivation System

First, implement a "Flexible Talent Introduction" plan. Focus on introducing high-end talents and innovative teams in fields such as AI algorithm R&D, bioinformatics analysis, and seed industry big data mining from domestic and foreign universities, scientific research institutions, and leading industry enterprises, and solve the key technical problems in the field of AI in Guangxi's seed industry through project cooperation, technical consulting, short-term assignment and other methods.

Second, strengthen the cultivation of local talents. Set up interdisciplinary majors combining AI and seed industry in universities and scientific research institutes in Guangxi, offer courses such as bioinformatics and intelligent breeding technology, and cultivate interdisciplinary talents who understand both basic seed industry knowledge and AI technology; encourage enterprises and universities to jointly build internship and training bases, provide practical platforms for students, integrate theory with practice, and improve the quality of talent training.

Third, improve the talent service guarantee system. Establish and improve the talent evaluation and incentive mechanism, and include the application achievements of AI technology in the seed industry into the evaluation index system of professional title evaluation and project application; provide research funding support, housing subsidies, children's education assistance and other guarantees for outstanding contributors to attract and retain excellent talents; regularly organize activities such as seed industry AI innovation competitions and academic seminars, build a platform for talent exchange and cooperation, stimulate innovation vitality, and provide solid intellectual support for the intelligent development of Guangxi's seed industry.

Fourth, deepen the joint talent training between universities and enterprises. Give play to the role of enterprises as the main body of seed industry AI technology application, and encourage enterprises to deeply participate in the talent training process. Enterprises can clarify their talent needs and training directions to universities and scientific research institutes according to their own development needs; at the same time, enterprises can set up scholarships and grants to support excellent students to engage in the field of seed industry AI, and give priority to employment after graduation, so as to achieve seamless connection between talent training and enterprise needs. Through the above series of measures, build a high-quality and multi-level seed industry AI talent team, and inject continuous motivation into the high-quality development of Guangxi's seed industry.

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