

# Research on High-Quality Development Models of The Grain Industry Under the New Development Concept

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**Abstract.** Ensuring food security is fundamental to national stability, and agricultural stability is key to societal well-being. Under the guidance of the new development concept in this new era, the high-quality development of the grain industry has become a central goal for securing national food security, advancing agricultural modernization, and achieving sustainable development. This study aims to systematically review the existing literature, clarify the current state and primary challenges of high-quality development in the grain industry, and summarize and analyze the foundation of China's high-quality grain industry development model. Furthermore, it focuses on potential innovative models for high-quality development under the new development concept. This review offers a comprehensive perspective and strong support for the theoretical construction and practical innovation of the grain industry's high-quality development model. Additionally, the research findings will provide valuable references for future strategies and policy-making in the grain industry, assisting governments and relevant sectors in better understanding how to achieve the dual objectives of food security and sustainable development through innovation and coordinated growth.

**Keywords:** New Development Paradigm; Grain; High-Quality Development; Development Models.

## 1. Introduction

Food security has become a significant global challenge, particularly in the context of rapid population growth, accelerated urbanization, and the increasing impact of climate change. The pressure on the global food supply system continues to rise. According to the United Nations Food and Agriculture Organization (FAO), the global population is expected to reach 9.7 billion by 2050, and food demand will increase by nearly 50% to meet the needs resulting from population growth and rising living standards. However, food production faces numerous uncertainties, such as the scarcity of land resources, production fluctuations caused by climate change, and the overexploitation of agricultural resources. These factors further highlight the importance of the food industry in the global economy.

As an integral part of the economy, the food industry not only fulfills the basic survival needs of the population but also plays a vital role in promoting economic growth, reducing poverty, and ensuring social stability. In a globalized context, food security is no longer a domestic issue for individual countries. Instabilities in international food markets can have spillover effects on other nations. Therefore, food security has become a global concern, requiring countries to collaborate on policies, technologies, and resource management to address the growing food crisis.

In recent years, research on China's food industry development has shown diverse trends, covering topics such as spatial and temporal patterns, policy support, technological innovation, green production, and digital transformation. Several studies have analyzed the spatial and temporal changes in China's food production, demonstrating that policies and technological advancements are key drivers of these changes. For instance, one study on China's food production over the past 20 years suggests that spatial and temporal shifts were primarily driven by policy and technological innovation, although differences between crop types have not been thoroughly explored (Various, 2020). Furthermore, research indicates that climate change and agricultural support subsidy policies have significantly contributed to improving food production and quality, particularly in areas with high levels of mechanization where subsidy policies are more effective (Zhu et al., 2024). Fei and



Feng (2022) also identified technological innovation as a crucial factor in promoting high-quality development in China's food industry. From the perspective of rural revitalization, their study proposed a "three-in-one" model that integrates technological innovation, industrial chain consolidation, and green development to achieve sustainable growth in the food industry. Moreover, the impact of climate change on food production potential has been well-documented. Many scholars agree that technological advancements can mitigate the negative effects of climate change on food production to some extent (Various, 2020).

The promotion of green production models is also essential to the high-quality development of the food industry. Studies show that the implementation of agricultural environmental policies has achieved a balance between increasing food production and protecting the environment, although the long-term effects of these policies still need further observation. Regional differences in food production efficiency have emerged as another important factor affecting the high-quality development of the industry. Research reveals that the promotion of green technologies and government policies significantly enhances green production efficiency (Various, 2020). Additionally, digital transformation plays a crucial role in optimizing the food industry supply chain. The increase in digitalization has led to better integration of various links in the food industry, with notable progress in eastern regions, while the digital transformation in central and western regions remains relatively lagging (Huang et al., 2024). Furthermore, the development of the digital economy has greatly improved the efficiency and transparency of food supply chains, particularly in more advanced regions.

Despite these advancements, China's food industry still faces multiple challenges in its pursuit of high-quality development, impacting its overall efficiency and sustainability. Among these, regional disparities stand out as one of the most significant issues. The eastern regions, characterized by advanced technology and a developed economy, exhibit higher food production efficiency, while the central and western regions, constrained by underdeveloped infrastructure and lower technological capabilities, suffer from uneven production efficiency. This discrepancy extends to the adoption of digital and green technologies, which is also significantly delayed in the latter regions (Huang et al., 2024; Various, 2021). Such regional differences not only affect food production but also lead to varying degrees of policy implementation effectiveness. Another critical issue is the uneven dissemination of technology. While innovations such as precision agriculture and automated equipment have significantly improved food production efficiency, their adoption varies greatly across regions. Studies indicate that the promotion of technology has been faster in the eastern regions, whereas the application of new technologies in the central and western regions remains limited, exacerbating the regional gap in food production (Fei & Feng, 2022). These limitations in technological application not only hinder productivity growth but also impede the development of green agriculture.

In addition, the regional disparity in policy implementation has had far-reaching effects on the development of the food industry. Research shows that agricultural support policies are particularly effective in regions with higher levels of mechanization, leading to improved food production and quality. However, the effectiveness of these policies in less mechanized regions, such as the central and western areas, remains relatively weak, preventing them from fully realizing their potential (Zhu et al., 2024). Climate change and environmental pressures also pose challenges to the food industry. Although climate change has enhanced production potential in some areas, it has exacerbated the imbalance in production across regions. Extreme weather events, such as droughts and floods, have become more frequent in certain areas, increasing the uncertainty of food production (Various, 2020).

In summary, with the ongoing development of the economy and society, China's food industry faces numerous challenges. The high consumption of agricultural resources is increasingly at odds with environmental constraints. Issues such as soil degradation, water shortages, and agricultural non-point source pollution threaten the sustainable development of the food industry, and the need to improve production efficiency is becoming increasingly urgent. As the food industry continues to grapple with

regional disparities and uneven technological dissemination, the transformation and upgrading of China's food industry are imperative.

## **2. Overview of the High-Quality Development of the Grain Industry Under the New Development Concept**

### **2.1. Overview of High-Quality Development in the Grain Industry**

#### **2.1.1. Status of Grain Production in China**

As the world's largest producer and consumer of grain, China's grain production has a significant impact on global food security. According to data from the National Bureau of Statistics, China's total grain output reached a record high of 695 million tons in 2023, marking 20 consecutive years of increased production, with a consistently high self-sufficiency rate. However, despite the continuous growth in total production, China's grain production faces increasing structural problems and resource constraints. First, the distribution of output among major grain crops is uneven. The three main crops—rice, wheat, and corn—account for the vast majority of total grain production, while the area devoted to crops like soybeans and oilseeds remains relatively insufficient, resulting in a high level of dependence on foreign imports for these products. Additionally, as urbanization progresses and arable land resources continue to decrease, the trend toward large-scale and intensive grain production has become more pronounced. Table 1 shows China's grain production during the 13th Five-Year Plan period.

In terms of geographic distribution, China's major grain-producing areas are concentrated in the northeast, the Huang-Huai-Hai Plain, and the middle and lower reaches of the Yangtze River. These regions, benefiting from favorable natural conditions and agricultural infrastructure, form the core of the country's grain production. Yuan and Yu (2020) pointed out that over the past 20 years, China's grain production has exhibited significant spatial and temporal variations, primarily driven by regional economic factors, population growth, and policy interventions. Notably, grain output in the eastern coastal areas has gradually declined, while production in the central and western regions has increased due to policy support and advances in agricultural modernization. Li Ma et al. (2017) emphasized that from a spatial resilience perspective, the grain production system has become more adaptable to environmental changes, as evidenced by shifts in productivity distribution and management strategies.

However, the impact of climate change on these major grain-producing areas is becoming increasingly significant, especially with the frequent occurrence of extreme weather events such as droughts and floods, which threaten the stability of grain production. Wang Hong (2018) observed that climate change is altering the potential of China's grain production. Although overall climatic conditions have improved, the variation in climate across different regions continues to significantly affect the spatial distribution of grain production. In the central and northern regions, changing climate conditions may lead to fluctuations in productivity. Liu Peng (2021) further explored the negative impact of climate change on grain production in central China, highlighting that climate risk management will be critical for future production. For instance, the northeast region, which is China's primary producer of corn and soybeans, has been severely affected by climate fluctuations. Additionally, rising labor costs in China's grain production sector, along with a declining and aging rural population, have exacerbated labor shortages, further constraining the sustainability of grain production.

In recent years, the Chinese government has implemented the "grain storage in land and technology" strategy, promoting agricultural technological innovation and farmland protection policies to continuously increase the technological content and resource efficiency of grain production. For example, the application of precision agriculture technologies has allowed for more precise management of water and fertilizer resources in agricultural production, reducing waste and increasing yields. Xiao Qiang Jiao et al. (2018) studied China's agricultural environmental policies

and found that policies promoting sustainable intensification have gradually shifted grain production from a high-input, high-pollution model to a “small yet refined” approach. Technological innovations, such as the promotion of “soil testing and formula fertilization,” have greatly improved resource utilization rates and reduced environmental pressure. Zhang Wei (2019) analyzed grain production patterns from 2005 to 2020 and noted that China is transitioning toward a sustainable agricultural model, which is being realized by reducing environmental pollution and improving production efficiency. The promotion of green agricultural technologies has also significantly reduced the use of chemical fertilizers and pesticides, improving the agricultural ecological environment. Overall, China’s grain production is steadily progressing toward a more efficient, green, and sustainable model, although challenges related to resource constraints and structural adjustments still need to be addressed.

**Table 1.** National grain output during the 13th Five-Year Plan period

Year	2016	2017	2018	2019	2020
Summer grain crops	14050.16	14174.46	13881.02	14160.23	14285.61
Autumn grain crops	48890.78	48999.1	49049.18	49597.58	49934.24
Early season rice	3102.57	2987.16	2859.02	2626.54	2729.31
Total grain	66043.51	66160.72	65789.22	66384.35	66949.16

### 2.1.2. Basic Structure of the Grain Industry Chain

The grain industry chain is a complex system involving multiple stages. The composition and operational efficiency of the grain industry chain play a vital role in ensuring food security and improving economic benefits. From cultivation to processing, transportation, and ultimately sales, the efficiency and quality at each stage determine the overall performance of the grain industry. In recent years, relevant literature has conducted in-depth analyses of various aspects of the grain supply chain, examining the impact of technological upgrades, risk management, environmental factors, and policy regulation on the overall performance of the grain supply chain.

The grain supply chain, which encompasses production, processing, storage, transportation, and sales, is highly complex. Mesterházy et al. (2020) highlighted that the storage and transportation stages are particularly prone to issues, especially in developing countries, where outdated technologies contribute to significant losses. Research indicates that technological upgrades and management optimization can effectively reduce these losses. For instance, the introduction of modern storage facilities and the optimization of transportation routes have significantly improved efficiency. Sun Y and Liu Y (2020) further demonstrated, through network analysis, that the globalization and complexity of supply chains have increased management challenges, particularly in the global wheat supply chain, where several key countries play a critical role in ensuring global food security.

Environmental issues within the grain supply chain have attracted widespread attention in recent years. Wang Y and Chen Z (2020) studied the environmental performance of China’s agricultural supply chain, noting that the introduction of green technologies and policies has significantly improved the efficiency of the supply chain. Their research used a DEA model to analyze the role of environmentally friendly technologies in enhancing the efficiency of agricultural supply chains, showing that the promotion of green technologies can significantly reduce carbon emissions and resource waste. Additionally, an MDPI (2021) study explored the application of circular economy principles in the grain supply chain and found that by promoting resource recycling and reducing waste emissions, the supply chain can achieve higher sustainability while maintaining production efficiency. The globalization of the grain supply chain has also introduced new risk challenges, particularly in terms of maintaining supply chain stability during unforeseen events. Cen Z and Zhuang Y (2020) emphasized that the resilience and diversification of the grain supply chain are

crucial for mitigating fluctuations in global food markets. By dispersing supply chain nodes and employing diversified strategies, companies can effectively reduce the impact of unforeseen events on the supply chain.

## **2.2. Existing Models of High-Quality Development in the Grain Industry**

As a fundamental national industry, the grain industry plays a strategic role in ensuring national stability and prosperity. In the face of complex domestic and international political and economic conditions, as well as the uncertainties brought about by the COVID-19 pandemic, advancing the grain industry toward a stage of high-quality development is not only essential for securing national food security but also for transitioning from a large grain-producing country to a strong grain industry powerhouse.

The high-quality development of the grain industry relies not only on technological progress and the integration of the industry chain but also on key factors such as government support and market orientation. Research on high-quality development models in the grain industry identifies technological innovation, policy support, green development, supply chain modernization, and regional coordination as crucial modes for driving this development. In recent years, multiple studies have examined these models from different perspectives, exploring their mechanisms and practical applications. These models complement each other, collectively advancing the modernization and sustainable development of the grain industry.

### **(1) Technological Innovation Model**

Technological innovation plays a crucial role in promoting high-quality development in the grain industry, particularly with the widespread application of intelligent and information technology, which has significantly improved agricultural production efficiency. Studies have shown that the digital economy has greatly boosted total factor productivity and accelerated the modernization of the grain industry. For example, Fei and Feng (2022) demonstrated that the application of intelligent technology enhances agricultural efficiency and resource utilization, making it a core driving force for grain industry development. Qin and Chen (2024) further noted that the application of technological innovation in the grain industry not only increases yield but also improves the overall quality of agricultural production. Additionally, the combination of the digital economy and technological innovation is considered key to boosting total factor productivity in agriculture (Zhu et al., 2024).

### **(2) Policy Support and Subsidy Model**

Agricultural subsidy policies play a critical role in promoting the high-quality development of the grain industry. Research shows that subsidy policies have achieved remarkable results in improving agricultural mechanization and production efficiency, particularly in resource utilization and food security. For instance, Zhu et al. (2024), using a multi-period difference-in-differences model, found that agricultural subsidy policies significantly enhanced grain production efficiency, with even greater effects in regions with higher mechanization levels. Moreover, policies for constructing high-standard farmland have positively impacted grain yield and the sustainable utilization of agricultural resources by improving farmland quality and optimizing resource allocation.

### **(3) Green Development Model**

As global environmental issues become increasingly severe, the green development model has gained prominence in the grain industry. The promotion of green agricultural technologies and ecological agriculture enables high-yield grain production while reducing environmental pollution. Wu and Chen (2022) noted that reducing the use of chemical fertilizers and pesticides and promoting organic and ecological circular agriculture significantly improved the sustainability of grain production and reduced its ecological burden. Furthermore, the green development concept has gained recognition not only in China but also globally. The application of green technologies has substantially increased grain production efficiency while dramatically reducing environmental impact (Various, 2021).

#### (4) Regional Coordination Development Model

The development of the grain industry exhibits significant regional disparities, making the regional coordination development model essential for achieving balanced growth across the industry. The eastern regions, with their advanced technology, demonstrate significantly higher grain production efficiency compared to the central and western regions. However, through region-specific policies and technology promotion, the production levels in the central and western regions are gradually improving. Wei and Song (2021) observed that regional differences in grain production not only affect overall production efficiency but also have profound implications for food security and resource allocation. Hence, the strategy of regional coordination is critical. By implementing a regional coordination development model, it is possible to narrow the production efficiency gap between different areas and enhance national food security.

#### (5) Supply Chain Modernization Model

The modernization of the grain supply chain is another important model for promoting high-quality development in the grain industry. Research indicates that the introduction of modern supply chain management, particularly through information technology, has significantly improved the efficiency and transparency of grain production. Li and Zhao (2022), in their study on supply chain modernization, found that digitalized supply chain management effectively reduces grain losses and enhances the collaborative operational efficiency of the supply chain. Additionally, supply chain modernization strengthens the grain industry's resilience to risk, enhancing its ability to cope with market fluctuations and external shocks. This has become particularly important in the context of increasing global supply chain disruption risks (Sun & Liu, 2023).

The high-quality development of the grain industry depends on the collective influence of various models, including technological innovation, policy support, green development, regional coordination, and supply chain modernization. By integrating these different models, the grain industry can improve production efficiency and resource utilization while achieving sustainability goals, thus ensuring a balance between global food security and economic development. Future research and practice should focus on enhancing the synergy between these models, especially in terms of regional coordination and supply chain modernization, to promote the overall development of the grain industry.

### **3. Research on Obstacles to High-Quality Development in the Grain Industry**

Despite significant progress toward high-quality development, the grain industry still faces many complex challenges. Existing research indicates that these issues mainly stem from resource constraints, imbalanced technological application, underdeveloped supply chain management, and market fluctuations. These problems directly affect the sustainability and overall efficiency of the grain industry.

#### (1) Incomplete Grain Industry Chain

The high-quality development of the grain industry faces obstacles at various stages, including production, distribution, processing, foreign trade, and consumption.

In the production stage, grain production heavily relies on natural resources, particularly arable land and water. However, the global scarcity of arable land and water resources exacerbates the pressure on the grain industry. Fei et al. pointed out that, with the rapid urbanization process, arable land continues to shrink, reducing the available space for agricultural production. Additionally, the long-term, excessive use of chemical fertilizers and pesticides has polluted China's arable land to varying degrees, causing an increasingly severe pollution problem in agriculture. With only about 7% of the world's arable land, China must feed 20% of the world's population. This imbalance in resources, coupled with environmental constraints, means that China cannot rely solely on domestic resources to meet the demand for all grain and agricultural products. The low profitability of grain cultivation and the difficulty in increasing farmers' incomes also expose grain farmers to significant market risks

(Zhang Lu & Luo Biliang, 2020). Furthermore, extreme weather events caused by climate change, such as droughts and floods, frequently threaten the stability of grain production. Environmental degradation and declining soil quality are particularly serious issues in many regions, not only affecting grain yields but also exacerbating the unsustainability of agricultural production.

In the distribution stage, grain storage technology poses a major challenge to the high-quality development of China's grain industry. During the storage process, grain experiences dry matter loss, and it is difficult to intervene with current technologies. Moreover, some stored grain contains high moisture content, making it susceptible to mold, which in turn threatens storage safety (Song Chenyang, 2023). A significant portion of China's grain is temporarily stored by farmers immediately after harvest, during which the high moisture content requires specific processing and storage conditions. However, traditional drying and storage methods used by farmers often lead to insect infestations, rodent damage, and spoilage due to the lack of scientific storage tools and techniques (Pu Tongsuan, 2022).

In the processing stage, constraints related to capital and talent present significant barriers to high-quality development. Grain and oil procurement and processing are capital-intensive industries, requiring large amounts of financing for bulk transactions. In the Greater Bay Area, for example, over 80% of enterprises are private, making it difficult for them to access policy bank loans. These companies face limited financing channels and high financing costs. Additionally, rising production costs in grain processing have eroded profit margins for grain and oil enterprises. Compared to non-agricultural industries, grain and oil companies struggle to attract talent, particularly advanced technical personnel (Zhang Lei et al., 2023).

In the consumption stage, the mismatch between grain supply and consumer demand for quality food is a key issue. Since the economic reforms, Chinese consumers' material and cultural demands have grown, with increasing demand for high-quality, green grain products. However, the supply of grain products in China lacks branding, greening, high-end positioning, and specialization, making it difficult to meet the consumption needs of the population (Zhang Lei, 2023). Additionally, the domestic grain market is plagued by counterfeit and inferior products, including a significant amount of aging grain. Some unscrupulous merchants, in pursuit of higher profits, process aged industrial or feed-grade grain into flour and rice. Others soak straw in water mixed with colorants and salt to produce counterfeit soy sauce (Tong Fang, 2018).

## (2) Underdeveloped Grain Supply Chain

Numerous studies have explored the inefficiencies of China's grain supply chain, particularly in its value chain, lack of resilience, weak risk management, and limited ability to respond to external shocks. The grain industry supply chain is lengthy, spanning production, processing, transportation, and sales. Inefficiencies at any stage can undermine the overall effectiveness of the supply chain. Current research indicates that the modernization of the grain supply chain is still insufficient. Fei et al. identified issues such as information asymmetry and inadequate infrastructure in various stages of the supply chain, leading to high losses during grain transportation and storage, especially in developing countries and remote areas. Additionally, the lack of cold-chain logistics and poor storage management further increases grain loss, negatively impacting the efficiency and sustainability of the grain industry.

Zheng et al. (2024) highlighted the vulnerability of China's grain supply chain to global external shocks, such as the COVID-19 pandemic and fluctuations in international food prices. Their research revealed increased risks of supply chain disruption, threatening the continuity and stability of the supply chain. Cen and Zhuang (2021) emphasized that the risk assessment mechanisms in the grain supply chain remain inadequate, particularly in grain distribution and logistics, where management shortcomings lead to inefficiencies and potential supply chain interruptions. Liu and Zhao (2022) pointed out the insufficient coupling between supply chain resilience and sustainability, with many regions lacking the flexibility to respond to environmental and market fluctuations, resulting in reduced stability during actual supply chain operations.

Grain price volatility and market uncertainty have heightened risks for grain producers. Global market uncertainties, such as sudden policy changes, international trade conflicts, and natural disasters, often lead to dramatic price fluctuations. Zhang et al. noted that frequent price fluctuations not only directly affect farmers' incomes but also increase the risks and uncertainties in grain production, which in turn affects the stability of the grain industry. Furthermore, instability in global supply chains and the rise of trade protectionism have compounded this issue.

### (3) Incomplete Pathways for High-Quality Development of the Grain Industry

The development of the grain industry requires not only an increase in quantity but also a focus on improving the quality of grain products. However, the mechanisms for achieving high-quality development in China's grain industry are incomplete, with insufficient momentum in technological advancement and inadequate machinery and storage facilities.

First, the level of investment in agricultural technology is relatively low, which hinders sustained technological progress and obstructs the pathway to high-quality development through innovation. On one hand, agricultural R&D intensity in China remains below 1%, significantly lagging behind most developed countries (Chen Ming, 2017). On the other hand, technological innovation often does not align with actual grain production needs. R&D may be disconnected from real-world production, and limitations in technology applicability, cost-effectiveness, and farmers' technical awareness prevent the full adoption of new technologies (Mu Yueying, 2022). Additionally, the promotion of modern agricultural technologies is uneven. Wu et al. found that advanced technologies such as precision agriculture, smart irrigation, and automated equipment are primarily concentrated in developed countries and economically advanced regions, while farmers in central and western regions and impoverished rural areas have lower acceptance and application of new technologies. This disparity in technological adoption has resulted in significant regional differences in grain production efficiency and quality, restricting the comprehensive high-quality development of the entire industry.

Second, the quality of agricultural machinery is difficult to guarantee, which presents an obstacle to achieving high-quality development through efficient mechanized harvesting. The degree of compatibility between agricultural machinery and farming practices directly affects post-harvest losses. Inadequate precision in harvesting machinery and mismatched agricultural machinery and agronomy practices often lead to significant grain damage during harvest (Gao Ming et al., 2022).

Lastly, inadequate storage facilities hinder the achievement of high-quality grain development in terms of "quality." In some regions, drying equipment is insufficient, and storage facilities are subpar. Farmers' limited understanding of scientific grain storage methods further exacerbates the problem. Many still rely on traditional open-air drying methods to dehydrate grain and use simple tools such as woven bags for storage, which fail to prevent mold, pests, and other quality issues effectively.

Although the grain industry has made considerable progress in many areas, it still faces challenges such as resource constraints, uneven technology dissemination, underdeveloped supply chain management, and market volatility. These challenges not only impede the modernization of the grain industry but also pose long-term threats to food security and sustainable development. Future research and policy efforts should address these issues to ensure the sustainable, high-quality development of the grain industry.

## 4. Innovative Models for High-Quality Development in the Grain Industry

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In China's push for high-quality development of the grain industry, the exploration of innovative models has become a key driver for promoting sustainability and modernization. Figure 1 shows the main ways of high-quality development and innovation mode of the grain industry under the new development concept.

### (1) Technology-Driven Modern Agricultural Model

Under the backdrop of high-quality development, technological innovation has become the core driving factor for the development of the grain industry. The introduction of intelligent and information technology has led to significant advancements in production efficiency and resource utilization. For instance, a study by Liu Yang et al. on new agricultural business entities in Shandong Province shows that through intensive land management and the application of advanced technologies, the scale and efficiency of grain production have improved significantly. This model leverages the extensive application of precision agriculture, information technology, and mechanized equipment to drive the automation and intelligence of the entire production process, effectively improving efficiency, reducing labor dependence, and enhancing product quality. Similarly, research in Henan Province indicates that the widespread adoption of new agricultural machinery has greatly improved production efficiency and standardization levels.

### (2) Green Development and Ecological Agricultural Model

Within the policy framework promoting green development, ecological agriculture has emerged as an important innovative model for the grain industry. Henan Province, by promoting green agricultural technologies, has reduced the use of chemical fertilizers and pesticides, achieving a balance between environmental protection and production efficiency. In Gushi County, the rice industry has developed a circular economy model by recycling by-products of rice production, enhancing resource utilization and increasing the added value of agricultural production. This green circular model not only maximizes economic benefits but also reduces environmental pollution and promotes the sustainable development of agricultural ecosystems. The integration of this green agricultural model with the grain industry ecosystem aligns closely with the goals of the new development concept, particularly the principles of green and shared development.

### (3) Modernization and Integration of the Full Industry Chain Model

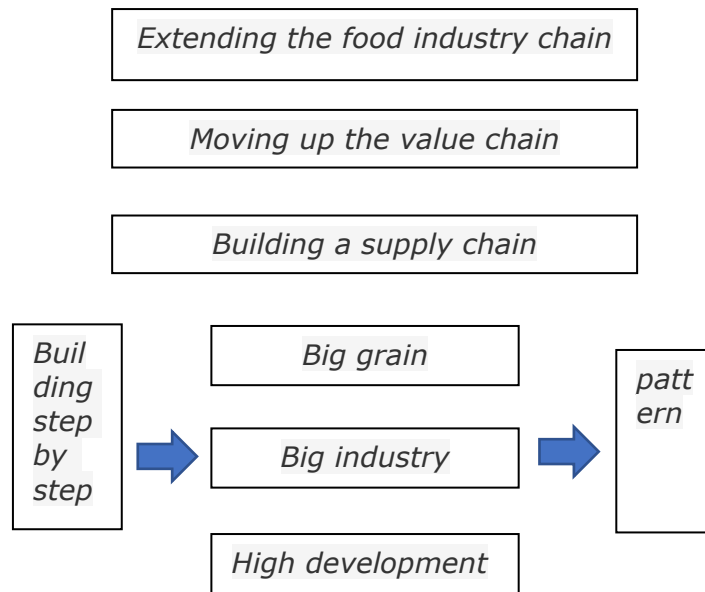
The modernization and integration of the grain industry chain is another important model for achieving high-quality development. Historically, China's grain industry chain has been fragmented and inefficient, especially in terms of weak linkages between production, processing, and distribution. By integrating the entire industry chain, the grain industry has realized seamless connections between production, processing, transportation, and sales. Henan Province has demonstrated an innovative model in this regard, exemplified by the "Four-Chain Synergy" model, which integrates the industry chain, supply chain, value chain, and ecological chain to optimize the entire grain production process and foster coordinated development across all links. Additionally, Xinjin County in Sichuan Province has implemented an industrialized linkage model for premium rice production through contract farming, tightly connecting large-scale grain farmers, agricultural cooperatives, and enterprises. This has promoted the scale and branding of grain production, further enhancing the market competitiveness and stability of the grain industry.

### (4) Market-Oriented and Policy-Supported Integrated Model

A market-driven innovation model plays a significant role in the high-quality development of China's grain industry. The introduction of market mechanisms has gradually shifted the grain industry from a production-driven model to a demand-driven one, making production models more flexible with market demand as the core driving force. For instance, in Xinjin County, Sichuan, contract farming has established close ties between enterprises and farmers, forming a complete grain industry supply chain system. At the same time, policy support has played a crucial role in driving industry upgrades. Henan Province, by combining policy subsidies for new agricultural business entities with market-oriented approaches, has improved the efficiency and market adaptability of grain production. This model not only ensures sustained policy support but also enhances the flexibility and adaptability of the grain industry through market regulation.

### (5) Risk Management and Supply Chain Resilience Enhancement Model

As global supply chains become increasingly complex, risk management and resilience building within the grain industry chain have become important issues. Scholars have proposed various risk prevention measures through analyses of supply chain risks within the grain industry. For example, Zhu Huying et al. found that the risks associated with supply chain disruptions and market volatility pose a threat to the stability of the entire grain industry chain. Enhancing collaborative innovation across the supply chain is essential for improving the industry's risk resilience, particularly in the face of global climate change and market fluctuations. This model emphasizes the importance of establishing robust supply chain monitoring and early warning mechanisms to ensure the continuous development of the grain industry and the security of food supplies.



**Fig. 1** The main ways of high-quality development and innovation mode of the grain industry under the new development concept.

## 5. Summary and Outlook

The study of high-quality development of the grain industry under the new development paradigm holds significant practical importance. As global food security issues become increasingly severe, exploring development models that meet the needs of the new era will help enhance China's influence within the global food system, while also contributing China's wisdom and experience to the sustainable development of the global grain industry.

In conclusion, the high-quality development of China's grain industry still requires comprehensive innovation through various models, including technology-driven modern agriculture, green development and ecological agriculture, full industrial chain modernization and integration, market-oriented policies and support, and enhanced risk management and supply chain resilience. These models not only improve production efficiency and market competitiveness, but also promote ecological sustainability and the resilience of the industrial chain. Future research and practice should further strengthen the synergy between different models, particularly in promoting green technology and improving market mechanisms, to provide more innovative pathways for global food security.

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