

# Evolution and Empowerment of China's Chain Chief System toward Green and Low-Carbon Agricultural Value Chains

Wu Zhenlei<sup>1,2</sup>, Yao Xue<sup>3</sup>, and Gao Yang<sup>4,1\*</sup>

<sup>1</sup> Research Center of Western China Economic Development, Northwest University, Xi'an, China

<sup>2</sup> College of Economics and Management, Northwest University

<sup>3</sup> School of Economics and Management, Beijing Forestry University, Beijing, China

<sup>4</sup> College of Economic, Qufu Normal University, Shandong, China

**Abstract:** *The chain chief system, an innovation in industrial institutions led by local governments, is a cornerstone in the transition of agricultural value chains from “efficiency first” to “equal emphasis on efficiency, security, and green and low-carbon development”. In this paper, we review the origin of the chain chief system and its growing emphasis on the importance of capable chain chiefs. We identify the origin, implications and characteristics of green and low-carbon agricultural value chains and reveal the background of those chains. Green and low-carbon agricultural value chains should achieve “vigorous external competition, coordination between value chain stakeholders, increasing resilience, and value addition from an agribusiness ecosystem”. Based on this goal, we identify gaps in the competitiveness, coordination, resilience and value addition of green and low-carbon agricultural value chains. Focusing on the importance of capable chain chiefs, we suggest ways for the chain chief system to assist the innovation chain, the capital chain, the standardization chain, the information chain, and the value chain of green and low-carbon agriculture.*

**Keywords:** *Chain chief system, green and low-carbon agricultural value chains, capable chain chiefs, agricultural transition and upgrade*

JEL Classification Code: O38, Q18

DOI: 10.19602/j.chinaeconomist.2023.11.05

Agricultural value chains are central to the implementation of China's strategy to revitalize the countryside and develop into an agricultural powerhouse. They are also the basis for the achievement of carbon peak and carbon neutrality. As such, the 14<sup>th</sup> Five-Year Plan for National Green Agriculture Development has called for “cultivating green and low-carbon agricultural value chains”. However, China's green and low-carbon agricultural value chains lack competitiveness, coordination, resilience, and value addition. These constraints cannot be circumvented only through regulation of the market. Instead, the government's intervention is crucial to correct market failure and assure effective market-based resource allocation (Huang and Song, 2019). An integrated innovation of China's institutional strength and market-based factor allocation, the chain chief system combines an effective market with a capable government (Gao et al., 2022). In this context, the Ministry of Agriculture and Rural Affairs released the *Guiding Opinions for Expediting the Development of Agricultural Value Chains*, which called for the implementation of a pilot program of the agricultural chain chief system for green and

\* CONTACT: Gao Yang, email: koyo718@163.com.

Acknowledgement: General Projects of National Social Science Fund “Research on ‘Chain Chief’ Serving Low Carbon Agricultural Chain” (Approval No.: 22BGL164).

low-carbon development throughout the value chains. The question is how does the chain chief system contribute to the growth and development of green and low-carbon agricultural value chains?

To answer this question, this paper discusses the four stages in the development of the chain chief system to identify its evolving trend and future direction. We provide an analysis of the origin, implications and characteristics of green and low-carbon agricultural value chains, as well as challenges to their actualization. An in-depth investigation has been carried out to identify specific ways chain chiefs can improve the green and low-carbon agricultural value chains.

This paper is intended to make the following contributions: First, it is intended to deepen the theoretical understanding of and research on the chain chief system by identifying its evolving trend and future direction. There are four stages in the development of the chain chief system: Inception, adoption, development and sophistication. Second, it presents a discussion of the origin, implications, characteristics and background of green and low-carbon agricultural value chains, and examines challenges to the actualization of “vigorous external competition, orderly coordination among stakeholders, increasing resilience, and value addition”. How to achieve this goal is discussed in detail. Third, it suggests ways by which capable chain chiefs can improve green and low-carbon agricultural value chains in the innovation chain, the capital chain, the standardization chain, the information chain, the supply chain, and the value chain. Our findings and suggestions are of great relevance to practice and policymaking.

## **1. Formation of the Chain Chief System: Origin, Adoption, Development and Sophistication**

According to institutional economics, the chain chief system is a transformation of the traditional industrial system in response to internal and external forces. It is a new method of industrial administration led by local governments to compensate for the inadequacies of market development and maintain the normal functioning of market mechanisms (Liu and Kong, 2021). Based on the existing bureaucratic organizational structure, the chain chief system has created a flat coordination mechanism to facilitate horizontal multisectoral coordination that breaks through the internal bureaucratic structure, reduces the costs and increases the administration coverage (Liang and Hu, 2022). This section explores the origin of the chain chief system that was a result of institutional transformation.

### **1.1 Inception Stage (2017-2018): Focus on Efficiency and Industrial Development**

In the reform era since 1978, China has established development zones to attract foreign capital, technology and managerial experience, stimulating international industrial relocation, which has facilitated its rapid economic development (Sheng, 2022). According to the industry agglomeration theory, development zones lead reform and development, and create positive externalities for the region under economies of scale and learning effects (Liu, 2009). However, the pursuit of industrial efficiency and rapid development has resulted in development zones having a homogeneous industrial structure, with excessive industrial concentration (Tu and Gong, 2022).

In the context of limitations to the consumption of land and energy and fierce industrial competition, development zones are focal points for industrial convergence, coordination and synergy at a higher level. According to Porter’s competitive advantage theory (Porter, 1990), a country must be able to integrate regional production factors such as labor, capital and land in order to turn them into competitive strengths. Under this rationale, the government should integrate and coordinate regional production factors by means of administrative decrees and laws and regulations in order to bring about institutional transformation. This is the role of chain chiefs.

At the end of 2017, the Changsha City government called upon local officials to “serve as industrial chain chiefs for development zones at the provincial level or above” in order to “propel high-quality

economic development through industrial chain development.”<sup>1</sup> This marked the first appearance of the term “chain chief” in an official document. In April 2018, Xiangtan City of Hunan Province initiated the chain chief system led by local governments to promote high-quality regional industrial development. Officials of the Hunan provincial government began to serve as chain chiefs. Their involvement was a catalyst for the chain chief system. Not only did the officials-turned chain chiefs help lower the cost of cross-sectoral and cross-regional consultation and cooperation, they also played a central role in coordinating production factors and developing synergic forces for various sectors and regions, cultivating high-quality regional industrial chains. Panjin City of Liaoning Province also launched the chain chief system to guide industrial development.

In the inception stage, with a priority on efficiency, the chain chief system was implemented in development zones to boost manufacturing competitiveness, smooth industrial transition and stimulate high-quality development. Senior officials were appointed to ensure the success of the chain chief system.

## **1.2 Adoption Stage (2019-2020): Rapid Permeation into Other Industries with Equal Emphasis on Efficiency and Security**

### *1.2.1 External challenge: Contradiction between self-reliance and efficiency*

Increasing backlash against globalization and escalating China-US trade frictions have interrupted and restrained industrial chains. Chinese companies, highly dependent on the US market, are faced with higher tariffs and export costs that may cause an industrial relocation. Falling foreign direct investment (FDI) in China’s labor-intensive industries also trigger industrial and trade relocation, causing gaps throughout industrial chains. In addition, China’s industrial chains are faced with external constraints. At the heart of the China-US trade conflict is the fight for the high ground of science and technology and top-notch professionals, in which the United States has imposed a technology export ban to curb China’s high-tech development (Liu and Ling, 2021). The export ban has forced numerous Chinese firms to turn to domestic sources of constricted technologies.

No company is immune to the consequences of industrial chain disruptions. Security and stability have played a central role in China’s efforts to reshape its industrial chains. However, efficiency may suffer in the quest for self-sufficiency. It is strategically important to investigate ways for China to take full advantage of its whole-nation system under the socialist market economy and leverage its strength of an ultra-large market to overcome disruptions, develop more competitive and resilient industrial chains, and achieve a balance between security and efficiency. In this context, the government should adopt a series of policies and promote institutional transformation to meet evolving international situations.

In August 2019, Zhejiang Province initiated the province-wide implementation of the chain chief system in response to the China-US trade conflict in fulfillment of the policy priority to “stabilize employment, finance, trade, foreign capital, domestic investment, and market expectations”. Party and government officials in the cities, counties or districts of development zones were appointed as “chain chiefs” to facilitate coordination. The chain chief system proved to be a great success in Zhejiang Province, where the system was a catalyst for industrial chain development in the development zones as it played a pivotal role in the coordination of upstream and downstream industrial sectors to bring about synergy.

The success of the chain chief system in Zhejiang encouraged other provinces and municipalities to emulate them. Among these provincial-level regions and cities were some prefectures and leagues of Guangxi and Inner Mongolia, which took similar steps at the end of 2019. This marked the beginning of the nationwide implementation of the chain chief system.

<sup>1</sup> Source: After the industrial cluster, how does the “chain chief system” help the regional fashion upgrade? <https://new.qq.com/rain/a/20220301A01UTZ00>.

### 1.2.2 Domestic concerns: Market failures

The COVID-19 pandemic in 2020 caused a severe setback for China's supply chains. Industrial operations ceased during the initial phase of nationwide lockdowns. Despite initial triumph in the containment of the pandemic, the resumption of factory operations was hampered by labor shortages and logistical complications. "The absence of a single component calls for the shutdown of the entire production line."<sup>2</sup> Every operation within an industrial chain is interconnected. Market failure may ensue when any process within an industrial chain is disrupted, as this can have cascading effects on downstream businesses.

As COVID-19 spread across the world, Chinese companies faced severe challenges of COVID-related supply chain disruptions. The slump in external demand and logistical issues had a negative effect on global supply chains. Wild demand volatility had repercussions in upstream industries, seriously disrupting China's industrial chain circulation. In addition, international logistical disruptions during the COVID-19 pandemic shook the foundation of just-in-time delivery systems. Uncertainties compelled multinational companies to maintain a certain level of surplus production and distribute this surplus in their domestic market and neighboring regions. The localization of cross-border supply chains mirrors a decline in the level of economic globalization, which can cause widespread global supply chain decoupling and rupture (Liu and Kong, 2021).

The COVID-19 pandemic, in addition to crippling market-based resource allocation, worsened the backlash against globalization and increased the localization of China's supply chains. In order to improve the resilience and security of the industrial chain, it is necessary for the government to guide the coordination of the industrial chain and ensure security through the implementation of industrial policy. The chain chief system, a new institutional arrangement to cope with the changing international situation, became widely adopted across China during the COVID-19 pandemic.

In 2020, 168 prefecture-level cities in 20 provinces, including Shandong, Shaanxi, Hebei and Jiangxi, implemented the chain chief system. In a circular released in 2021, the Ministry of Commerce vowed to encourage implementation of the chain chief system in state-level economic and technological development zones. As a result, the chain chief system became implemented in 30 provinces, municipalities and autonomous regions across China. Two factors contributed greatly to the rapid implementation of the chain chief system across the country: The implementation of the river chief system and the forest chief system shortened the explorative stage of the chain chief system and chain chiefs proved to be capable of coordinating resources across sectors and regions to cope with market failures, increase the resilience of supply chains, and avoid significant risks in provinces such as Hunan and Zhejiang.

The chain chief system shifted priority from "industrial competitiveness" to "industrial chain self-reliance, security and stability", placing equal emphasis on efficiency and security. As a problem-solving mechanism with Chinese characteristics, the chain chief system is characterized by the appointment of high-ranking officials to be responsible for supply chain coordination.

### 1.3 Development Stage (2021-2022): Emphasis on Efficiency, Security, and Green and Low-Carbon Development

China's recent pattern of GDP-centric development has resulted in worsening environmental problems, making the country the largest CO<sub>2</sub> emitter in the world for many consecutive years (Fan et al., 2021). To alleviate these environmental problems, the Chinese government has unveiled a new stage of high-quality and sustainable economic development. It has made the achievement of ecological civilization into a national strategy, implementing the concept that "lucid waters and lush mountains are

---

<sup>2</sup> Source: "More than 20 provinces have promoted the 'chain chief system': to avoid the absence of a single component calls for the shutdown of the entire production line", <https://baijiahao.baidu.com/s?id=1700995003697741973&wfr=spider&for=pc>.

invaluable assets”, and committing to the achievement of carbon peak and carbon neutrality goals. This requires both emerging and traditional industries to embrace green and low-carbon development amid the transformation of the economic development mode. Green and low-carbon development under the guidance of the chain chief system is essential to China’s industrial transformation and upgrade. The desirability of green and low-carbon development has become a firmly established concept. Increasing market demand for green goods and services has turbocharged the green movement, prompting the chain chief system to prioritize green and low-carbon development. However, market mechanisms are subject to a lag effect and occasional market failures in regulating the behaviors of supply chain stakeholders due to externalities and information asymmetry. Hence, for environmental protection and eco-friendly development, it is important to increase the institutional supply.

Zhejiang Province was the first to implement the chain chief system to promote industrial chain security and development under the rationale of green and low-carbon transition. In Zhejiang Province, the chain chief system is designed to foster green industries and technologies and facilitate the R&D and application of green and low-carbon technologies. Pilot projects have been undertaken to explore green development modes for manufacturing and other energy-intensive industries, conserve energy, reduce carbon emissions, and develop the clean energy industry.<sup>3</sup>

In the development stage, policy adjustment was necessary to ensure the implementation of the chain chief system on a broader scale (Wang et al., 2020). In this implementation process, priority was shifted from “industrial chain competitiveness” to “industrial chain self-reliance, security, stability, and green and low-carbon transition” with an equal emphasis on efficiency, security and green and low-carbon development.

Following the identification of key stakeholders, local governments implemented the chain chief system according to local conditions and priorities. The scope of the implementation was expanded from manufacturing to agriculture, emerging green industries, energy, and artificial intelligence (AI).

#### **1.4 Sophistication Stage (since 2023): Capable Chain Chiefs plus an Effective Market**

During its implementation nationwide, the chain chief system is being confronted with challenges from an evolving external environment. In some localities, protectionism is on the rise; in others, the chain chief system is implemented with little consideration of local conditions, which could be risky. In implementing the chain chief system, local governments may easily fall into the trap of an “omnipotent government”. Generally speaking, the relationship between chain chiefs and chain owners is comparable to a government-market relationship, and effective government-market coordination undergirds the well-functioning of industrial chains (Lin and Ni, 2022). As a result of the vague boundary between the government and the market, however, it is tempting for the government to supplant supply chain owners and act as a market participant. Some local governments pick winners by flooding certain businesses with resources and policy allowances, setting unrealistic green and low-carbon targets (Zhang, 2021).

The chain chief system should be a beginning and not an endpoint. The question is how can the chain chief system keep up with the times while advancing industrial development? New structural economic theories provide justification for the above question. In order for the chain chief system to evolve from a government initiative during special times into a system of complete, long-term and sustainable institutional development, it must follow the rationale that “a capable government is the premise for an effective market, and an effective market is the foundation of a well-functioning government.”<sup>4</sup> Capable chain chiefs play a pivotal role in achieving this goal.

It is necessary to define the functional boundary of chain chiefs in view of the constraints on

<sup>3</sup> Wang Qi: “34 Development Zones on the List! Zhejiang ‘Chain Chief System’ Bearing Fruit”, *International Business Daily*, January 25, 2022.

<sup>4</sup> Source: “We made solid efforts to implement the principles of the Fifth Plenary Session”, <https://www.ddgx.cn/show/40909.html>.



industrial chain development in order to avoid the enlargement of the role of the government and promote efficient, safe, and eco-friendly industrial transformation and upgrade.

The chain chief system, initiated under government mandate, became widely accepted through the involvement of market forces, and, more recently, became impelled by a combination of government mandates and market forces. Initially intended to promote efficiency, the chain chief system subsequently gave equal priority to security and more recently, green and low-carbon development.

## **2. Green and Low-Carbon Agricultural Industrial Chain: Origin, Connotations and Characteristics**

### **2.1 Origin**

In the Agriculture 1.0 era, traditional agriculture relied on manual labor and farming experience; in the Agriculture 2.0 era, agricultural value chains took form to increase efficiency through the application of industrial technology; in the Agriculture 3.0 era, the integration of agriculture and the tertiary industry extended the agricultural industrial chains; in the Agriculture 4.0 era, green agriculture has become a key priority (Wen et al., 2021). In the international community, the role of agriculture has shifted from economic development to sustainability. In this context, the revitalization of China's countryside must follow the path of green development in order to achieve the goal of ecological civilization and carbon peak and carbon capture, which are the priorities of the Chinese government (Jin and Liu, 2019). With agricultural reforms entering uncharted waters, it is essential to develop a sustainable mechanism driven by endogenous motivations. Only in this way will green and low-carbon development be meaningful and replicable. Instead of isolated concepts, green and low-carbon development should be reflected in each process of development of the agricultural value chains in order to turn green mountains into gold mountains<sup>5</sup>. In the Agriculture 4.0 era, green agricultural development should focus on the green and low-carbon transformation of agricultural production chains.

The shift in priority of the chain chief system from prioritizing efficiency to placing an equal emphasis on efficiency, security and eco-friendliness coincides with the evolving direction of China's agricultural development. Faced with turbulent changes unseen in a century, industrial security has become the top priority of the division of labor and cooperation of the global industrial chain (Sheng, 2022). China aims to create green and low-carbon agricultural value chains that are self-reliant, resilient and sustainable, and develop long-term mechanisms for efficient, secure and sustainable agriculture. In May 2021, based on the decision of the Chinese government to develop secure and efficient agricultural value chains, promote green and low-carbon development, and achieve countryside revitalization and carbon peak and carbon neutrality goals, the Ministry of Agriculture and Rural Affairs released the *Guidelines for Accelerating the Development of Agricultural Whole Supply Chains*, calling for piloting the chain chief system in the development of green and low-carbon agricultural value chains.

The chain chief system has been implemented in the agricultural sector in provinces and autonomous regions such as Liaoning, Inner Mongolia, Jiangxi, Guangdong, Anhui, Zhejiang, Hubei, Hainan, Qinghai, Shaanxi, and Hunan. Most of these regions have implemented the chain chief system for green agriculture. Anhui Province has focused on the green food industry in implementing the chain chief system. Situated in the northeastern part of the Qinghai-Xizang Plateau, Xining City has implemented the chain chief system to promote intensive agricultural processing, enhance, complement and extend agricultural value chains, and develop unique green agricultural products based on the pristine fauna and flora on the plateau.

---

<sup>5</sup> Source: "Fostering the endogenous dynamism of green agricultural and livestock industries", <http://qh.people.com.cn/GB/n2/2020/0112/c182775-33709320.html>.

## 2.2 Connotation

Albert O. Hirschman introduced the notion of agricultural value chains in 1958; they encompass the entire range of agricultural operations, including cultivation, processing, production, and marketing. Following the contributions of Mighell et al. (1963), Fu (1996), Wang and Han (2002), and Cheng et al. (2019), agricultural value chains have become widely recognized as being a network structure and operational mechanism dedicated to enhancing the benefit to various different economic sectors. Expanding on this, Chinese scholars introduced the concept of green and low-carbon agricultural value chains. Qi and Wang (2010) and Yang (2012) consider that low-carbon agricultural value chains represent an innovative model of industrial organization in which farmer households, cooperatives, and businesses collaborate to form value chains like the production, consumption, decomposition, and restoration processes in the natural ecosystem. Green agricultural value chains, as identified by Liu and Xiao (2022), form a system of operation in the agricultural sector that incorporates cutting-edge technology and management principles that prioritize ecological preservation, efficiency enhancement, and agricultural product safety. Green and low-carbon agriculture follow sustainable agricultural practices that incorporate circular economy and low-carbon economy principles into their interconnected and coordinated agribusiness links, including research and development, production, processing, transportation, marketing, consumption, and services.

## 2.3 Characteristics

Green and low-carbon agricultural value chains show the following traits, in addition to being systematic, coordinated, and complex (Huang et al., 2018): First, green and low-carbon agriculture's eco-friendliness makes it unique. Due to the growing public awareness of the benefits of green and low-carbon consumption it makes sense for agribusinesses to actively practice green development and encourage green and low-carbon behaviors. Second, positive externalities are generated from low-carbon and green agriculture value chains, which prioritize long-term ecological benefits over immediate economic gain. Not only are positive externalities created by resource conservation, environmental protection, and the provision of environmental public goods, but these positive externalities can also be passed down to future generations, resulting in agricultural production having long-lasting positive spillover effects. Third, the circular economy typifies low-carbon and eco-friendly agricultural value chains. Circular design has been employed by green and low-carbon agricultural value chains to boost energy and resource efficiency, encourage centralized waste treatment and recycling, and make the carbon footprint smaller.

## 2.4 Current Status

In July 2021, the Ministry of Agriculture and Rural Affairs initiated a national campaign to encourage the creation of agricultural value chains in demonstration counties. The current practice of green agriculture was one of the criteria used in choosing demonstration counties. The first wave of agricultural value chains and demonstration counties, which was comprised of 63 demonstration counties and 31 supply chains, were announced in November of that same year. Currently, 31 agricultural value chains in 63 demonstration counties are in the initial phase of development. One such is the agricultural value chain of rice-crab coculture in Liaoning Province. For customers prepared to pay more for better quality agricultural products, green farming has emerged as a selling point. Modern agriculture and revitalization of the countryside are undergirded by the creation of comprehensive, self-sustaining green agricultural value chains.

In 2022, some local governments named select provincial demonstration counties for modern agricultural value chains. Among these, Shaanxi Province nominated several demonstration counties for green agricultural chains, including fruit-livestock coculture for apple farms in Luochuan, a national standardized green food production center for kiwi fruit in Meixian County, Baoji, and green and organic food and agricultural geolabel for grape farming in Huxian County. These programs opened the road for

all-round revitalization of the countryside. Despite making progress, China's development of green and low-carbon agricultural value chains faces several challenges.

### 3. Challenges to Creating Green and Low-Carbon Agricultural Value Chains

Developing green and low-carbon agricultural value chains that are characterized by external competition, coordination among stakeholders, resilience, and value addition is the ultimate goal. The creation of green and low-carbon agricultural value chain is a cumulative process and cannot be accomplished instantaneously. It includes exploring the challenges and identifying solutions gleaned from the chain chief system, as well as defining the functional boundaries of chain chiefs and identifying paths by which chain chiefs can support green and low-carbon agricultural value chains.

#### 3.1 Low Competitiveness

The present lack of competitiveness in green and low-carbon agricultural value chains is primarily due to their relatively low levels of modernization, small economies of scale, and lack of standardization. The adoption of cutting-edge technology in the establishment of green and low-carbon agricultural value chains is thwarted by a lack of ingenuity (Sheng, 2022). Under the effect of innovation spillovers, various entities of green and low-carbon agricultural value chains may engage in free riding, extortion and other forms of market failure during the process of collaborative innovation<sup>6</sup>, leading to both an undersupply of innovation and unsustainable innovation. Significant upfront investment is necessary to develop and implement green and low-carbon agricultural technologies such as fertilizer and water integration, biogas fermentation, soil testing and formulation, and the use of farm wastes as fertilizer, feedstock, and energy. The challenges of diseconomies of scale and inadequate technological sophistication impede the widespread adoption of these technologies.

Financial support is essential for green and low-carbon agricultural value chains to achieve economies of scale. The lack of capital has stymied innovation and prevented supply chain growth by blocking the flow of feedstock, technology and talent. Green and low-carbon agriculture has the potential to transform traditional concepts and practices. However, it presents risks and unstable returns that discourage private investors. With increasing complexities in domestic and international situations, it has become less advantageous for local governments to rely on traditional policies such as using land and tax credits to attract investment. In the financial sector, most traditional agricultural financial institutions have yet to embrace the transformation of traditional agricultural practices into green ones. In the countryside, projects such as green loans remain in the pilot stage and there is a limited supply of agriculture-related financial products such as mortgage loans for agricultural produce, livestock, equipment, and land, forest and property rights. While green credit accounts for over 90% of green finance<sup>7</sup>, other green financial products such as green bonds and green insurance are in short supply, limiting the synergy between green agricultural financial products. A large stock of assets lays idle in the countryside and is unavailable for disposal and transaction.

China has been making great efforts to nurture superior species, improve quality, develop new products, and encourage standardized production. The current degree of standardization in green and low-carbon agricultural value chains is undesirable for a number of reasons. When viewed through the lens of the entire agricultural value chains, China's agricultural standardization appears to be fragmented rather than systematic. There are gaps in the standardization of seed tracing, production techniques, brand registration, and other processes of agricultural value chains. Selling high-quality goods for a premium price is challenging, and so is finding such goods for discerning consumers. For the majority of green and low-carbon agricultural products, tracing seeds is a challenging task due to the proliferation of

<sup>6</sup> Tian Ruiying: "Innovation Chain Can Catch the 'Chain Chief System' Express Train?" *Chinese Journal of Science*, September 22, 2021.

<sup>7</sup> Source: "China ranks first in the world for green credit issuance", <https://m.gmw.cn/baijia/2021-11/18/35318947.html>.



counterfeit seeds and the depletion of valuable seed resources. The absence of standardized procedures related to the application of chemical fertilizers and pesticides in eco-friendly agricultural products hinders efforts to enhance quality by increasing efficiency and reducing chemical residues. With regard to brand registration, the agricultural market in China is teeming with numerous small agribusinesses, some of which engage in the production and distribution of counterfeit goods.

### **3.2 Lack of Coordination**

Green and low-carbon agricultural value chains cannot function effectively without coordination between upstream and downstream supply chain entities. The problem is that those entities are fragmented and lack coordination. The absence of dominant enterprises has led to green and low-carbon agricultural value chains having poor organization. With asymmetric access to information, upstream and downstream entities have poor coordination with each other. Fragmented smallholders, in particular, have modest means and few social connections. Without market supervision and access to information, they have little bargaining power (Wang and Zhang, 2021). In the distorted relationship between agribusinesses and farmers, smallholders cannot take an active part in the creation of green and low-carbon agricultural value chains (Han et al., 2020). In addition, inadequate public communication creates barriers to the adoption of R&D, resulting in the poor reception of green and low-carbon technologies and products by farmers.

### **3.3 Poor Resilience of Green and Low-Carbon Agricultural Value Chains**

Resilience is a key aspect of the high-quality development of green and low-carbon agricultural value chains, whose current fragility stems from the high cost of eco-friendly products, cold-chain logistics issues, and lack of access to toll-free transportation. Rent-seeking and speculative behaviors have emerged in distribution channels and market competition as a result of exorbitant green cost, giving rise to instances of “bad money driving out good money”. Some consumers are reluctant to pay a premium for green food. Partnership between agribusinesses and farmers becomes distorted if the green cost is shared in an uneven and unreasonable manner. External logistical shocks disrupt the marketing and cold-chain transportation of green and low-carbon agricultural products. The resulting shortage of inventory has ramifications on product supply and price. Agricultural wastes are not eligible for toll-free transportation for harmless treatment and recycling. Only a small proportion of agricultural waste is recycled due to the absence of effective recycling mechanisms and regional coordination (Zhang et al., 2021).

Lack of ingenuity makes green and low-carbon agricultural value chains susceptible to external shocks and technology constraints, making them fragile and less resilient.

### **3.4 Limited Value Addition**

The ultimate goal of value realization and the development of green and low-carbon agricultural value chains is value added. Value addition from eco-friendly agricultural products has been hampered, however, by limited revenue streams and inadequate consumer awareness. Further exploration of the recreational, ecological, and cultural benefits associated with green and low-carbon agriculture is necessary in order to extend agricultural chains and generate additional revenue. Possible explanations for the lack of consumer demand for green and low-carbon agricultural products include that consumer interest in purchasing ecological and low-carbon agricultural products is low and the promotion of green and low-carbon consumption is not adequately supported by the diverse stakeholders in the green and low-carbon agricultural value chains.

As can be seen from the above, value addition from green and low-carbon agricultural value chains is hampered by uncompetitiveness, the absence of coordination between stakeholders and insufficient chain resilience. These challenges have made achieving the ultimate goal of ecological circulation and value addition elusive.

#### 4. Pathways by Which the Chain Chief System Can Support Development of the Green and Low-Carbon Agricultural Value Chains

Self-regulation of the market is not enough to resolve the challenges confronting green and low-carbon agricultural value chains. In order to compensate for market failures and facilitate coordination among stakeholders, the government must employ the chain chief system. However, the government's visible hand can fall prey to the entrapment of an omnipotent government if it provides incentives to supply chain entities in excess of what is required by the laws of market development. In the upgrading and transformation of agricultural value chains, the chain chief system should prioritize challenges that are beyond the scope of market-based mechanisms. By following this approach, the limits of a capable government that can support the chain chief system in advancing green and low-carbon agricultural value chains can be clearly defined. Supply chain chiefs assume the responsibilities of arbitrators, facilitators, and coordinators. It is their duty to provide guidance and support for the advancement of green and low-carbon agricultural value chains, as well as to address any challenges that may arise in order to enhance competition, coordination, resilience, and value addition (refer to Figure 1).

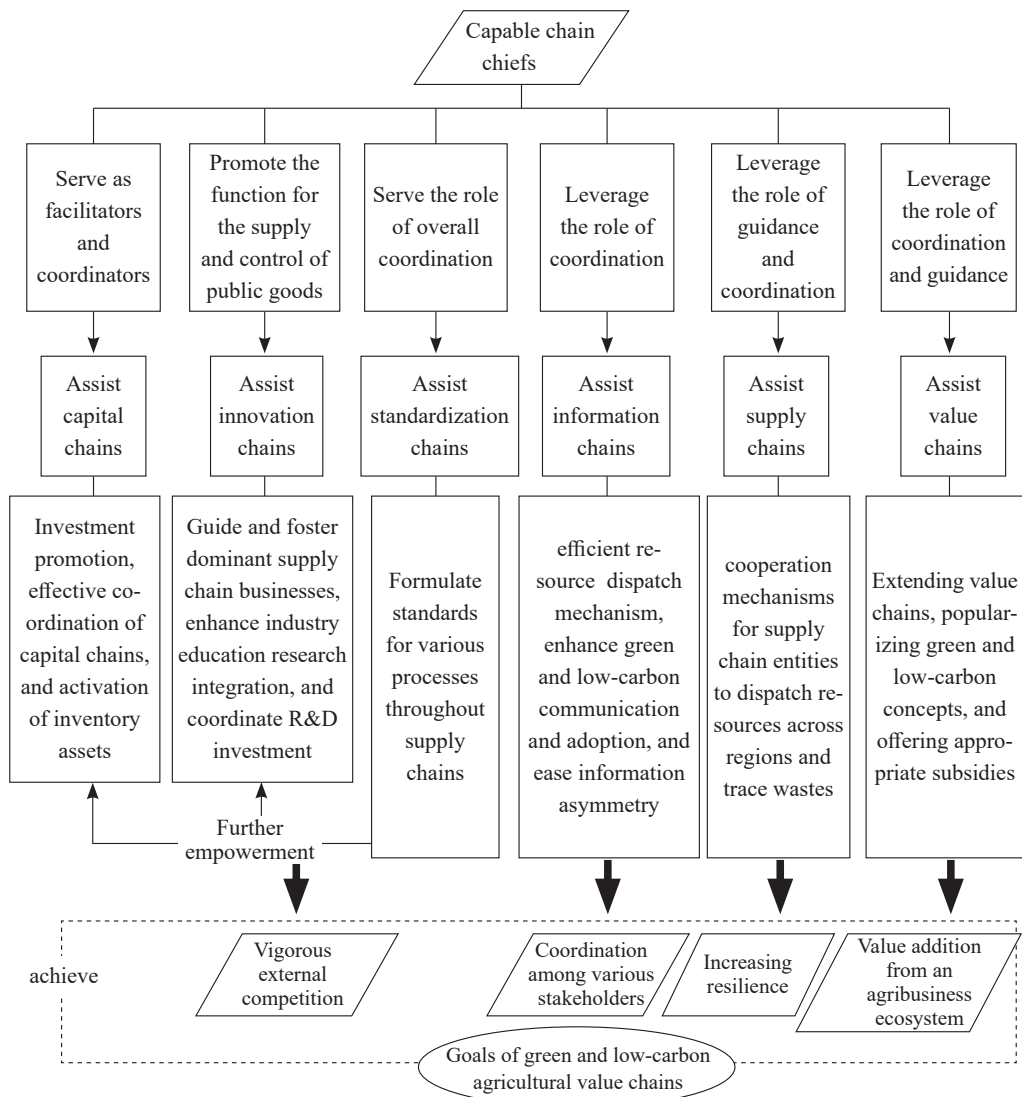


Figure 1: Paths by Which Capable Chain Chiefs Supporting Green and Low-Carbon Agricultural Value Chains

#### **4.1 Empowering Capital, Innovation and Standardization Chains to Realize Vigorous External Competition**

Capable chain chiefs are essential to realizing vigorous external competition by activating the capital chain, strengthening the innovation chain, and developing the standardization chain.

Capable chain chiefs function as intermediaries, facilitators, and coordinators who infuse vitality into eco-friendly agricultural value chains (Research Group of the Institute of Industrial Economics of CASS and Qu, 2022). Promotion of investment to mitigate the scarcity of funds is a critical function of chain chiefs. Chain chiefs are more familiar with local situations. In order to support green and low-carbon agricultural value chains, it is their duty to attract capital and talent in accordance with local agricultural conditions and supply chains. The collection of detailed information regarding local entrepreneurs and businesses is the responsibility of investment promotion work groups that are organized hierarchically and directed by chain chiefs. Capable chain chiefs have the ability to recognize crucial supply chain operations and allocate regional resources, including the promotion of cross-border investment, in order to facilitate the efficient flow of regional resources. Capable chain chiefs are able to efficiently integrate capital chains. Traditional agricultural financial service institutions are less equipped to oversee the provision of green financial services than chain chiefs, who have access to more comprehensive market information. Regional agricultural digital finance platforms are used to connect banks and agribusinesses, as well as to provide green financial products for low-carbon agricultural value chains. Optimal coordination among green financial products for agriculture enhances the smooth movement of capital across supply chains. Capable chain chiefs are able to coordinate the standardization of agricultural green finance. The integration of environmental standards into credit and review procedures strengthens market-oriented green financial services that support eco-friendly agriculture across supply chains. Creating a cycle between existing investments and new assets, capable chain chiefs are ultimately responsible for activating the stock of idle and inefficient assets, such as rural land parcels, for the development of green and low-carbon agriculture.

Capable chain chiefs are responsible for the provision of public goods to enhance the innovation chain and increase the competitiveness of the supply chain. They provide guidance and policy incentives for dominant supply chain businesses to grow and invest more in R&D to become more innovative. Businesses are encouraged to develop and implement green and low-carbon agricultural processes and waste recycling technologies. Chain chiefs can promote the interconnection of green and low-carbon agricultural value chains within the region, increase industry-education-research collaboration, and establish R&D and innovation platforms for the commercialization of generic technologies for green and low-carbon agriculture. The chain chief is responsible for coordinating investments by local financial institutions and government authorities in developing green and low-carbon technologies. Priority can be given to creating an R&D fund for generic technologies to achieve breakthroughs in critical areas of green and low-carbon agricultural technologies.

Chain chiefs serve as coordinators who assist local governments in setting green and low-carbon agricultural value chain standards to meet the need for different types of green and low-carbon agricultural products. Standardization throughout the supply chains will strengthen the capital and innovation chains and increase the competitiveness of the external agricultural chain. General chain chiefs work together with regional chain chiefs to create and improve the seed tracing system, share seed information, and protect superior seed resources. Capable chain chiefs assist local agricultural authorities in conducting public communication and training programs for the standardized use of chemical fertilizers and pesticides. They oversee dominant supply chain enterprises in managing business reputation and brand image.

#### **4.2 Assist the Information Chain in Increasing Synergy between Agribusinesses**


Capable chain chiefs serve as coordinators in establishing an efficient resource dispatch mechanism

on the basis of progression between general and regional supply chains. New-generation information technologies can be employed to increase coordination between agribusinesses, bridging the disconnects of green and low-carbon agricultural value chains. Using online platforms featuring the Internet of things (IoT), big data, cloud computing and block chain technologies, capable chain chiefs may fully leverage the digital economy's empowerment effect to expedite the creation of a green and low-carbon agricultural market, precisely and efficiently match supply with demand, and increase coordination and cohesiveness between upstream and downstream production and marketing businesses of all sizes. Not only may chain chiefs assist smallholders in accessing market information through digital applications, their role is also pivotal in the public communication and promotion of green and low-carbon technologies. Capable chain chiefs are supposed to train farmer households to use online platforms to access more information and mitigate information asymmetry.

### 4.3 Assist Supply Chains for Resilient and Continuous Enhancement

Capable chain chiefs provide guidance, coordination and overall planning to ensure the resilience of green and low-carbon agricultural value chains. They assist dominant supply chain businesses in addressing the contradictions between green and low-carbon agricultural value chain entities and establish cooperation mechanisms to share green cost and distribute profit under the repurchase contract. In this manner, market failures can be mitigated through collaboration between agribusinesses and farmers. It is the responsibility of capable chain chiefs to allocate resources across regions and adopt digital solutions for cold-chain logistics across regions. Cold-chain logistical channels should be created by sea, air and land routes to facilitate transportation and ensure timely delivery in case of contingencies during cold-chain transportation. Capable chain chiefs are expected to track agricultural waste by means of block chain technology and monitor and ensure proper waste treatment and recycling, contributing to supply chain resilience.

### 4.4 Assist Value Chains for Value Addition from Ecological Circulation

Capable chain chiefs ensure the permeation of green and low-carbon concepts for value added from an agribusiness ecosystem by enacting a series of incentives, penalties and development strategies. They are responsible for extending and broadening supply chains to explore the digital, cultural and ecological functions of green and low-carbon agriculture for the integrated development of primary, secondary and tertiary rural industries. In addition to raising awareness of green consumption, chain chiefs may also incentivize consumers to purchase green and low-carbon agricultural products, creating demand to boost the development of the eco-friendly agricultural value chains. 

## References:

- [1] Cheng, Hua, Fengjun Lu, and Lijiao Xie. 2019. "Connotation, Evolution and Development Direction of Agricultural Industry Chain Organization in China." *Issues in Agricultural Economy*, 12: 118-128.
- [2] Fan, Aijun, Zhiqiang Zheng, and Yongjian Ma. 2021. "Trade Policy, Global Value Chain Location and China's Carbon Dioxide Emissions." *Journal of Shandong University (Philosophy and Social Sciences)*, 6: 138-149.
- [3] Fu, Guohua. 1996. "Operation of Agricultural Products Industrial Chain to Improve the Efficiency of Agricultural System." *China's Agricultural Reclamation Economy*, 11: 24-25.
- [4] Gao, Yang, Xue Yao, Yongxiu Bai, and Zhenlei Wu. 2022. "Active 'Chain Chief' Empowers Green and Low-carbon Agriculture Industry Chain: Internal Mechanism and Realization Path." *Economist*, 12: 116-124.
- [5] Han, Xiyan, Wei Liu, and Zhifeng Gao. 2020. "Selection Preference and Preference Heterogeneity of Smallholders' Participation in Agricultural Industrial Chain: An Analysis Based on the Choice Experiment Method." *China Rural Survey*, 2: 81-99.

- [6] Hirschman, Albert O. 1958. *The Strategy of Economic Development*. New Haven: Yale University Press.
- [7] Huang, Xianhai, and Xueyin Song. 2021. "Enabling Government: A New Theory of Government-Market Relation." *Journal of Management World*, 37(11):41-55+4.
- [8] Huang, Yan, Ruirui Zuo, and Shufen Chen. 2018. "Influencing Factors, Mechanism and Growth Path of China's Agricultural Industry Chain." *Journal of Commercial Economics*, 6: 142-144.
- [9] Jin, Minghua, and Qing Liu. 2019. "Research on the Profit Distribution of the Main Body of the Agricultural Industry Chain under the Background of 'New Retail'." *Academic Exchange*, 5: 104-113.
- [10] Liang, Xiaojun, and Duo Hu. 2022. "Institutional Logic of Relative Poverty Governance under the Goal of Common Prosperity." *Study and Practice*, 7: 87-95.
- [11] Lin, Shujun, and Hongfu Ni. 2022. "The Chinese-style Industrial Chain 'Chain Chief System': Theoretical Connotation and Practical Significance." *Social Sciences in Yunnan*, 248(04): 90-101.
- [12] Liu, Xiuyan. 2009. "Agglomeration Economies and Labor Productivity: Evidence from Chinese Urban Panel Data." *Journal of Quantitative & Technological Economics*, 26(07): 109-119.
- [13] Liu, Yiqiao, Xiaohong Xiao. 2022. "Leading Rural Revitalization with Green Development: Formation Mechanism and Evolution Path of Green Agricultural Industry Chain in Ethnic Mountainous Areas." *Journal of South-Central Minzu University (Humanities and Social Sciences)*, 42(01): 148-156+187.
- [14] Liu, Zhibiao, and Lingchi Kong. 2021. "The Chain Chief System under a 'Dual Circulation' Pattern – An Exploration on the New Form and Function of Local Leading Industrial Policies." *Journal of Shandong University (Philosophy and Social Sciences)*, 1: 110-118.
- [15] Liu, Zhibiao, and Yonghui Ling. 2021. "On Reshaping a New Industrial Chain under the New Development Pattern." *Economic Review Journal*, 5: 40-47+2.
- [16] Mighell, Ronald L., and Lawrence A. Jones. 1963. *Vertical Coordination in Agriculture*. U. S. Government Printing Office.
- [17] Porter, M. E. 1990. *The Competitive Advantage of Nations*. New York: Free Press.
- [18] Qi, Zhenhong, and Peicheng Wang. 2010. "Coupling Mechanism of Low-carbon Agricultural Ecological Industry under Game and Interaction Theory." *Forum on Science and Technology in China*, 11: 136-141.
- [19] Research Group of the Institute of Industrial Economics of CASS, and Yongyi Qu. 2022. "The Theoretical Connotation of the Central Enterprise as the Chain Leader of Industry Chain and the Function Realization." *China Industrial Economics*, 7: 5-24.
- [20] Sheng, Zhaoxun. 2022. "From Industrial Policy to Industrial Chain Policy: Strategic Choice of Industrial Development in 'Chain Era'." *Reform*, 2: 22-35.
- [21] Tu, Niansong, and Kaixiang Gong. 2022. "'Bringing in' and 'Going out' Technology Spillovers and Manufacturing Value Chain - A Study of the Threshold Effect Based on R&D Capabilities and Industrial Agglomeration." *Jinan Journal (Philosophy & Social Sciences)*, 44(07): 64-79.
- [22] Wang, Banban, Qionghui Mo, and Haoqi Qian. 2020. "The Diffusion Models and Effects of the Local Environmental Policy Innovation - A Micro-econometric Evidence from the Diffusion of River Chief Policy." *China Industrial Economics*, 8: 99-117.
- [23] Wang, Kai, and Jinqin Han. 2002. "Preliminary Study on Agricultural Industry Chain Management." *Chinese Rural Economy*, 5: 9-12.
- [24] Wang, Weiwei, and Yingliang Zhang. 2021. "Regional Brand Empowerment: An Effective Way for Small Farmers to Connect with Modern Agriculture." *Academic Journal of Zhongzhou*, 5: 36-43.
- [25] Wen, Tiejun, Zhenghua Tang, and Yahui Liu. 2021. *From Agriculture 1.0 to Agriculture 4.0*. Beijing: Oriental Press.
- [26] Yang, Qizhi. 2012. "Research on Low-Carbon Agricultural Development from the Perspective of Industrial Chain." *Academic Tribune*, 35(06): 119-122.
- [27] Zhang, Gui. 2021. "To Seek the Focus of Building a New Development Pattern with the 'Chain Chief System'." *People's Tribune*, 2: 41-43.
- [28] Zhang, Linxiu, Yunli Bai, Mingxing Sun, Xiangbo Xu, and Lin Jia. 2021. "Views on Agricultural Green Production from the Perspective of System Science." *Issues in Agricultural Economy*, 10: 42-50.