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Research on the Mechanism and Path of New-Quality Productive Forces Driving the Improvement of Total Factor Productivity in the Agricultural Product Industrial Chain

Yanjiao Qiao, Tianzhen Qi

School of Economics and Management, Tianjin Agricultural University, Xiqing District, Tianjin 300380, China

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Abstract: New-quality productive forces serve as the core engine for promoting the high-quality development of agriculture and improving the total factor productivity of agricultural product industrial chains. Based on the theory of new-quality productive forces, this paper analyzes the practical bottlenecks restricting the development of current agricultural product industrial chains, and reveals that the three-dimensional synergistic mechanism consisting of revolutionary technological breakthroughs, innovative factor allocation, and in-depth industrial transformation and upgrading drives the improvement of total factor productivity in agricultural product industrial chains. At this stage, China's agricultural product industrial chains still face multiple dilemmas, including insufficient adaptation between technology supply and demand, blocked flow of high-end factors, loose interest linkage among market entities, and imperfect policy and institutional support, which restrict the full release of the empowering effect of new-quality productive forces. Accordingly, this paper proposes optimization paths from four aspects: strengthening key core technology research and achievement transformation, smoothing the flow channels of high-end factors, reshaping the structural resilience of industrial chains, and deepening institutional and mechanism reforms. This study aims to improve the theoretical system of agricultural industrial chains empowered by new-quality productive forces, and provide practical references for advancing the modernization of agricultural product industrial chains, enhancing agricultural total factor productivity, and facilitating the high-quality development of agriculture.

Keywords: New-quality productive forces; Agricultural product industrial chain; Total factor productivity; Factor allocation

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1. Introduction

In September 2023, General Secretary Xi Jinping first put forward the important concept of "new-quality

productive forces" during his inspection tour in Heilongjiang Province. In January 2024, he clearly defined its scientific connotation: new-quality productive forces represent an advanced form of productive forces where innovation plays a leading role, breaking away from traditional economic growth modes and development paths of productive forces. Characterized by high technology, high efficiency and high quality, they conform to the new development philosophy, with a substantial increase in total factor productivity as the core marker. The Central Economic Work Conference held at the end of 2025 identified new-quality productive forces as a strategic pillar for the 15th Five-Year Plan period. In the agricultural sector, the No.1 Central Document of 2025 proposed for the first time to develop new-quality productive forces in agriculture in light of local conditions. The No.1 Central Document of 2026 emphasized integrating artificial intelligence with agricultural development. The 15th Five-Year Plan places agricultural new-quality productive forces in a more prominent strategic position and proposes, for the first time, to foster and expand emerging and future industries in agriculture. This series of policy releases indicates that China's agricultural development has entered a new stage driven by scientific and technological innovation.

Agricultural new-quality productive forces are an advanced form of productive forces that apply modern production concepts and technologies to new objects of agricultural labor and improve agricultural total factor productivity through factor innovation and optimal allocation of resources. The core marker for the formation and development of new-quality productive forces lies in the substantial leap in total factor productivity (TFP). Agricultural new-quality productive forces particularly emphasize the combinatorial leap of factor allocation. As a new type of production factor equally important as land, capital and human resources, data drives other factors to achieve more efficient and flexible allocation.

Agriculture is the foundation of the national economy. The efficiency and resilience of agricultural product industrial chains are directly related to fundamental national issues including national food security, the supply of key agricultural products, and the increase of farmers' income and prosperity. In April 2025, the *Plan to Accelerate Building up Strength in Agriculture (2024–2035)* issued by the CPC Central Committee and the State Council takes upgrading the level of the whole agricultural industrial chain and improving agricultural quality, benefits and competitiveness as the core task of building an agricultural powerhouse; the Ministry of Agriculture and Rural Affairs has clearly proposed to "promote the digitalization of the whole agricultural industrial chain" and "build market-oriented, data-driven and efficiently coordinated intelligent supply chains". Policies and practical explorations introduced in recent years fully demonstrate that boosting the total factor productivity of agricultural product industrial chains via new-quality productive forces has become an important component and powerful driving force for advancing high-quality agricultural development and accelerating the construction of an agricultural powerhouse.

Taking the theory of new-quality productive forces as the analytical framework and adopting a holistic perspective of agricultural product industrial chains, this paper systematically discusses the mechanism and realization path through which new-quality productive forces drive the improvement of total factor productivity of agricultural product industrial chains. The structure of this paper is organized as follows. The first part is the introduction, which mainly elaborates on the research background; the second part sorts out the practical dilemmas faced when new-quality productive forces drive the improvement of TFP in agricultural product industrial chains; the third part clarifies the mechanisms through which new-quality productive forces promote the coordinated improvement of TFP in all links of the industrial chain; the fourth part puts forward path suggestions for promoting the TFP growth of agricultural industrial chains; the fifth

part summarizes the whole paper.

2. Practical dilemmas for new-quality productive forces to drive the improvement of TFP in agricultural product industrial chains

2.1. Dilemma of matching between technology supply and industrial chain demand

Relying on innovation carriers such as digital technology, biological breeding, intelligent equipment, big data and the Internet of Things, new-quality productive forces reshape agricultural product industrial chains and raise total factor productivity through the high coupling between technology supply and the demand of each link in the industrial chain. At present, there is a prominent structural mismatch between technology supply and actual industrial demand in China's agricultural product industrial chains. Insufficient integration of innovation chains and industrial chains restricts the implementation of new-quality productive forces and the sustained growth of total factor productivity [1].

The agricultural research system has long adopted an evaluation orientation of "valuing papers over commercialization". Research projects mostly focus on laboratory technological breakthroughs, while insufficient investigations are conducted into the differentiated demands of business entities in agricultural product industrial chains. Many R&D achievements pursue technological advancement yet ignore practical constraints including fragmented farmland, capital shortage, operators' skill levels and regional natural conditions, making it difficult for numerous achievements to be implemented on a large scale. Technical products feature high procurement and operation-maintenance costs as well as complicated operations, which fail to meet the practical low-cost and easy-to-operate demands of small and medium-sized business entities and thus hinder technology popularization.

Entities in agricultural product industrial chains have distinctly different demands for technologies. Small-scale farmers prefer low-cost, simple planting and breeding technologies; processing enterprises require intensive processing and by-product utilization technologies; the circulation segment needs low-cost cold-chain equipment and digital solutions for product traceability. The current technology supply system is mostly concentrated on the upstream planting and breeding links, and practical technologies for production, circulation and other segments are insufficient. The adoption level of technologies is affected by multiple factors: smallholders' technology adoption behavior is positively influenced by income, education and social identity; large-scale operation negatively inhibits their adoption probability; behavioral attitude and capability exert a chained mediating effect. This indicates that if the supply of new technologies fails to match farmers' actual operating conditions and risk-bearing capacity, it will be difficult to convert technologies into real productive forces even if the technologies themselves have efficiency advantages [2].

2.2. Barrier dilemmas in the flow of high-end production factors into agricultural product industrial chains

The core of fostering new-quality productive forces lies in promoting the agglomeration and restructuring of high-end production factors such as technology, human capital, digital data and innovation capital within agricultural product industrial chains. Relying on the innovative allocation of factors, the industrial production function can be reshaped further to raise the total factor productivity of industrial chains. Nevertheless, institutional barriers to factor flow between urban and rural areas hinder the effective sinking of high-end factors, and agricultural industrial chains are consequently trapped in the path dependence of

low-end lock-in [3].

The reverse flow of talent factors constitutes the primary dilemma. Fields including digital agriculture, biological breeding and agricultural product supply chain management require a large number of interdisciplinary talents proficient in technology, industry and market. Nevertheless, gaps between urban and rural areas in public services, employment opportunities and income expectations lead to the continuous outflow of high-end agriculture-related talents; agricultural practitioners feature a high aging level and weak capacity to learn and adopt new technologies; the incentive and guarantee mechanism for rural talents remains imperfect, resulting in the difficulty of attracting, retaining and effectively utilizing high-end agricultural talents.

The blocked flow of data factors represents the most prominent dilemma. Data serves as a major production factor for fostering new-quality productive forces. However, numerous data silos exist in the development of agriculture-related industrial chains, and the openness of public agriculture-related data is limited; rules for data rights confirmation and data trading are still incomplete; market entities have concerns such as data leakage and unbalanced benefit distribution, lacking incentives to share industrial chain data, which hinders the establishment of a full-chain data sharing mechanism; data can hardly be traded or mortgaged for financing as an asset, which weakens the empowering effect of data factors on breeding optimization, production and sales forecasting, and quality traceability.

The inflow of capital factors faces dual institutional and market constraints. Practical constraints such as non-standard land transfer, imperfect interest linkage mechanisms and poor channels for investment exit reduce the willingness of industrial and commercial capital to enter agricultural industrial chains; agricultural business entities are confronted with difficulties in loan application and financing; the ambiguous property rights of rural resources make it hard to convert such resources into tangible capital, restricting capital inflow and circulation. In addition, without effective interest linkage and risk-sharing mechanisms, capital going to rural areas tends to result in “capital crowding out farmers” rather than “capital driving farmers”, which further aggravates interest imbalance among entities in the industrial chain.

2.3. Structural dilemma of loose interest linkages among industrial chain entities

The interest linkage mechanism serves as the core bond connecting entities at all links of agricultural product industrial chains. Its tightness directly determines the fairness of value distribution within the industrial chain and the stability of collaborative innovation among all entities. Many industrial chain entities still maintain loose market relations based on one-off spot transactions, lacking close linkages featuring risk sharing and benefit sharing. This creates a structural dilemma of “superficial connection and shallow cooperation”, which seriously hinders the transmission of the efficacy of new-quality productive forces to the whole industrial chain. Most industrial chain cooperation modes rely mainly on simple order procurement. Leading enterprises control high-value-added links, including processing, branding and sales and enjoy advantages in information and premium gains; small-scale farmers only supply raw primary agricultural products and have weak bargaining power. Therefore, they can hardly share the value-added benefits generated from processing and brand marketing links, leading to an imbalanced pattern of benefit distribution.

The application of new-quality productive forces to industrial chains requires entities at all links to jointly invest capital, data and technology for digital transformation and quality upgrading. Nevertheless, under loose interest linkages, enterprises worry that they cannot obtain raw materials steadily after technology investment, while farmers fear that standardized production investment may fail to bring premium returns. All

entities tend to engage in short-term games and are reluctant to make long-term specific asset investments, which impedes the popularization and application of new factors such as digital technology and biological breeding across the whole industrial chain. Information among entities remains relatively isolated, and there is a lack of unified mechanisms for value distribution and risk sharing. Hence, enterprises, cooperatives and farmers can hardly form joint forces to cope with market fluctuations in a coordinated manner. Such loose interest relations weaken the incentives for entities to invest in high-end production factors jointly, and technological innovation in a single link can hardly be translated into productivity improvement of the entire industrial chain.

2.4. Institutional dilemma of the inadequate policy support system

The upgrading of the whole agricultural product industrial chain driven by new-quality productive forces cannot be achieved without systematic policy and institutional guarantees. Current policies are characterized by the bias of "valuing production over the entire industrial chain". Most policies focus on upstream production links, while special policies for value-added segments such as intensive processing of agricultural products, cold-chain warehousing and brand operation are insufficient; policies issued by multiple departments including agriculture, finance and market supervision are fragmented with inconsistent standards and discrete policy instruments, failing to form joint forces for cross-departmental collaborative governance; the institutional construction adapted to new-quality productive forces lags behind, rules for agricultural data right confirmation and data trading remain imperfect, making it difficult for data assets to circulate in the market, and the protection of agricultural intellectual property rights is inadequate; fiscal and financial support mainly takes the form of short-term project subsidies, lacking a long-term and stable investment mechanism, and agricultural business entities face difficulties in low-cost financing; the risk-sharing mechanism is incomplete, resulting in low willingness of capital to participate in industrial transformation. In addition, mechanisms for dynamic policy adjustment and localized detailed implementation are inadequate, and the policies have limited inclusiveness. Small and medium-sized business entities can hardly benefit from the policies, and the overall institutional supply falls behind the demands of agricultural industrial transformation.

3. Mechanisms through which new-quality productive forces drive the improvement of TFP in agricultural product industrial chains

3.1. Revolutionary technological breakthroughs: Driving technological progress of industrial chains

Revolutionary technological breakthroughs serve as the primary mechanism for boosting total factor productivity in agricultural product industrial chains [4]. Cutting-edge technologies such as biotechnology, intelligent equipment and digital perception penetrate the whole industrial chain covering agricultural production, processing, warehousing and logistics, realizing the innovation of the production technological paradigm in industrial chains [5]. The innovation of breeding technology improves the quality and yield per unit area of agricultural products, consolidating the supply capacity of industrial chains from the source. The Internet of Things, remote sensing and intelligent agricultural machinery transform field production links, relying on precision variable-rate operations, they reduce agricultural input consumption and alleviate the high-consumption and low-efficiency dilemma of traditional agriculture. Cold-chain preservation and non-

destructive testing technologies reduce post-harvest losses and raise the commercialization rate of agricultural products. Digital traceability technologies reshape circulation and marketing links, enabling traceable product quality and real-time matching between supply and demand information, and cutting transaction costs caused by information asymmetry. Disruptive technological innovation improves the efficiency of each link in the industrial chain and acts as the direct driving force for the growth of total factor productivity.

Different from traditional incremental technological improvement, technological breakthroughs under new-quality productive forces generate cross-link spillover effects. Technological innovation in a single link can spread along the industrial chain, drive technological upgrading of upstream and downstream industries, and break the long-standing low-end technological lock-in of agricultural product industrial chains [6]. For instance, variety improvement in the breeding link forces processing enterprises to adjust processing technologies and sets higher standards for temperature control and preservation technologies in warehousing and logistics, promoting technological iteration across the whole industrial chain.

For a long time, China's agricultural product industrial chains have been constrained by insufficient R&D investment and poor technology transformation. A large number of business entities remain at the stage of primary raw material production, trapped in low-end technological lock-in with limited room for added value growth. The diffusion of cutting-edge disruptive technologies throughout the industrial chain can break the original low-level technological equilibrium, push the industrial chain to extend from primary raw material supply to high-value-added links such as intensive processing and brand marketing, and continuously release efficiency dividends of the whole industrial chain.

3.2. Innovative factor allocation: Optimizing the resource structure of industrial chains

Innovative factor allocation serves as the core mechanism for driving the improvement of total factor productivity in agricultural product industrial chains. Under the traditional agricultural production system, the fundamental reason for sluggish growth of total factor productivity lies in factor solidification and misallocation. Traditional production factors, including land, labor, and capital, have long been invested in a decentralized and extensive manner with rigid factor combination modes and low utilization efficiency, which can hardly support quality improvement, efficiency gains, transformation, and upgrading of industrial chains. The core transformative logic of new-quality productive forces is to break the traditional forms of factor allocation, foster new high-end production factors such as data, knowledge and technology, and promote the recombination of traditional production factors relying on technological innovation, so as to realize innovative factor allocation within agricultural product industrial chains [8].

Under such innovative allocation, all types of production factors achieve quality improvement and efficiency enhancement. As the core basic factor in agriculture, land is completely freed from the traditional empirical and extensive utilization mode. With remote sensing, the Internet of Things, big data and other tools, precise identification and dynamic monitoring can be realized to build a modern land use system of "managing farmland with data". Digital tools enable accurate assessment of cultivated land quality, soil moisture and planting suitability. They can effectively address problems such as farmland fragmentation, idle land waste and imbalanced planting-breeding structure, promote the agglomeration of land resources to large-scale, standardized and intensive business entities, and greatly improve land output efficiency and resource utilization rate [7].

The innovative reconstruction of labor factors also profoundly transforms the production mode of industrial chains. Traditional agriculture relies mainly on manual labor and experience-based farming, where

labor features low added value and high substitutability. Against the backdrop of the development of new-quality productive forces, the digital and intelligent transformation of the agricultural industry forces labor factors to undergo a fundamental shift from manual labor to mental and skilled labor. Agricultural workers are no longer confined to basic planting and breeding operations and urgently need to master new skills such as intelligent agricultural machinery operation, agricultural data analysis, industrial chain operation and quality control. The quality upgrading of labor factors promotes the transformation of traditional farmers into new professional farmers, agricultural technical talents and industrial operation talents. It effectively adapts to the implementation and application of high-end technologies and new factors and removes the constraints caused by insufficient human capital in traditional agriculture.

As the core new-type factor of new-quality productive forces, data factors reshape the logic of agricultural production and industrial chain operation through "penetrative coupling". Different from the independent input mode of traditional factors, data factors are characterized by replicability, shareability, non-consumption and strong penetration, and can be deeply embedded in the whole chain of agricultural product breeding, production, processing, warehousing and circulation [4]. By integrating production and sales data, meteorological data, agricultural input data and quality data, precise production decision-making, accurate matching between supply and demand, and targeted risk early warning can be realized. It can effectively avoid industrial pain points such as blind production, inventory backlog and circulation loss, and correct problems including factor misallocation and resource waste in traditional industrial chains. The in-depth integration and innovative recombination of new and traditional factors establish an efficient and coordinated modern factor allocation system, continuously optimize the resource structure of industrial chains, and serve as the core driving force for the steady improvement of total factor productivity in agricultural product industrial chains.

3.3. In-depth industrial transformation and upgrading: Reshaping the organizational form of industrial chains

Relying on technological and factor changes, new-quality productive forces drive the in-depth transformation of agricultural product industrial chains and reshape their organizational models and division of labor systems. Digital platforms and socialized service organizations promote the vertical integration of industrial chains, giving rise to new organizational forms such as contract farming, industrial consortia and agricultural industrialization platforms. They connect production, processing, branding and sales links and extend the value chain of industrial chains.

Taking agricultural industrial consortia as an example, they are usually led by leading enterprises and united with cooperatives, family farms, small-scale farmers and socialized service organizations. Leading enterprises are responsible for order arrangement, processing and brand marketing; socialized service organizations provide farmers with advanced agricultural technologies such as improved seeds, intelligent field management technologies and mechanization technologies, and formulate unified production standards; farmers carry out planting and the consortium purchases production in accordance with orders and standards, and their products at a guaranteed base price. Agricultural industrial consortia can not only improve farmers' production technologies and the quality of agricultural products, but also enable leading enterprises to adjust farmers' production plans according to market demand, realize production based on sales, ease the mismatch between production and sales, and stabilize farmers' income.

Industrial transformation promotes the refinement of division of labor in industrial chains, achieves specialized production and large-scale operation, reduces transaction costs and improves the organizational efficiency of industrial chains, thus supporting TFP growth from the organizational dimension.

3.4. Synergistic interaction and nonlinear evolution among mechanisms

Technological breakthroughs, optimized factor allocation and industrial organization reshaping do not function independently. Instead, they form a systematic mechanism featuring synergistic interaction and nonlinear evolution. Technological revolution serves as the fundamental condition and provides instrumental support for factor recombination and industrial transformation; innovative factor allocation supplies factor carriers for technology implementation. Without matching data, talent and capital, cutting-edge technologies can hardly be converted into real productive forces; industrial organizational transformation establishes production relations adapted to new technologies and new factors. Only the synergistic linkage of the three can continuously unleash the efficacy of new-quality productive forces and systematically raise the total factor productivity of agricultural product industrial chains.

4. Path selection for promoting new-quality productive forces to drive the improvement of TFP in agricultural product industrial chains

4.1. Strengthening key technology research and achievement commercialization

Based on the pain points of agricultural product industrial chains, this section focuses on key core technologies such as biological breeding, intelligent agricultural machinery, cold-chain preservation of agricultural products and digital traceability. A collaborative innovation system consisting of universities, research institutes and leading agricultural enterprises should be established to tackle “bottleneck” technical problems in agriculture. Improve the commercialization mechanism of agricultural scientific and technological achievements, build regional agricultural technology test platforms, remove the bottlenecks restricting the industrial application of laboratory technologies in farmland, and reduce the implementation cost of new technologies. Improve the grassroots agricultural technology extension service network, carry out digital and intelligent technology training for new-type business entities, enhance their capacity to adopt and apply cutting-edge technologies, and drive the overall production efficiency improvement of industrial chains through sustained technological progress.

4.2. Smoothing the flow channels of high-end production factors

Remove institutional barriers hindering the flow of high-end factors such as land, capital, talent and data into agricultural product industrial chains, and guide innovative talents and science and innovation capital to the agricultural sector [8]. Improve the rural property rights trading market, revitalize rural land resources, and provide spatial carriers for large-scale and modernized operation of agricultural product industries. Innovate agricultural financial products and develop long-term credit suitable for digital agriculture and smart agriculture projects to ease the financing difficulties of innovative entities in industrial chains. Accelerate the establishment of rules for agricultural data rights confirmation and data circulation, build a public data platform for agricultural product industrial chains, promote data sharing in production, warehousing, marketing and other links, and guide the precise allocation of various resources through data factors to mitigate factor misallocation in industrial chains and unleash efficiency dividends from factor allocation.

4.3. Reshaping industrial structure and enhancing industrial chain resilience

Relying on new-quality productive forces, we can promote the vertical extension and horizontal integration of agricultural product industrial chains, optimize the industrial division of labor system, build industrial consortia with close cooperation among leading enterprises, cooperatives and small-scale farmers, and reshape the organizational structure of agricultural product industrial chains. Support the development of high-value-added segments such as intensive processing of agricultural products, brand operation and cold-chain logistics. Cultivate entities of digital agricultural platforms, develop new models including contract farming and direct production-marketing connection, stabilize the supply-demand relationship between upstream and downstream, and improve the interest linkage mechanism featuring risk sharing and benefit sharing. These measures can enhance the stability and value creation capacity of industrial chains and consolidate the industrial foundation for the sustained growth of total factor productivity.

4.4. Deepening institutional and mechanism reform

The dual-wheel drive of institutional innovation and technological innovation serves as an important guarantee for unleashing the efficacy of new-quality productive forces. Improve the standard system of agricultural product industrial chains, unify quality standards for agricultural production, processing and traceability, and reduce transaction costs within industrial chains. Optimize the incentive system for agricultural innovation, strengthen intellectual property protection, and safeguard the innovation benefits of agricultural researchers and industrial entities. Continue to deepen rural reform, clarify the rights and obligations of all entities in industrial chains, and build production relations compatible with new technologies, new factors and new industrial organizations, so as to provide institutional support for the improvement of total factor productivity in agricultural product industrial chains driven by new-quality productive forces.

5. Conclusion

At present, the transformation and upgrading of China's agricultural product industrial chains still faces multiple practical dilemmas, including the mismatch between technology supply and industrial demand, blocked inflow of high-end production factors into rural areas, loose interest linkages among industrial chain entities, and an inadequate policy and institutional support system. From the perspective of the development of new-quality productive forces, this paper explores the internal mechanisms through which new-quality productive forces promote the improvement of total factor productivity in agricultural product industrial chains. New-quality productive forces mainly work through three-dimensional mechanisms: revolutionary technological breakthroughs, innovative allocation of high-end factors, and in-depth industrial transformation. The three mechanisms form a coupled system with synergistic interaction and nonlinear evolution to drive efficiency upgrading of agricultural product industrial chains. In response to the above problems, this paper puts forward optimization paths: tackling the problem of technology adaptation through key technology research and achievement commercialization, smoothing the circulation channels of high-end factors such as talent, capital and data, reshaping industrial structure and strengthening industrial chain resilience, and improving institutional guarantees via institutional and mechanism reform to meet the modernization demands of agricultural product industrial chains fully. This paper clarifies the logic of how new-quality productive forces empower the upgrading of agricultural industrialization, and provides

theoretical references and practical suggestions for addressing the low-efficiency development dilemma of agricultural product industrial chains and promoting high-quality agricultural development.

Disclosure statement

The authors declare no conflict of interest.

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