# An Analysis of the Mechanism of Agricultural Digital New-Quality Productive Forces Empowering Farmers' Income Increase in Tianjin

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**Abstract: Against the backdrop of the deep integration of the digital economy and agricultural modernization, agricultural digital new-quality productive forces have emerged as a pivotal driver for addressing the issues related to agriculture, rural areas, and farmers, as well as boosting farmers' income. Based on the practices of agricultural digitalization in Tianjin, this paper clarifies the core connotation of agricultural digital new-quality productive forces. Drawing on seven practical theories including the theory of digital technology diffusion and the theory of network externality, it systematically analyzes the internal mechanism of such forces in empowering farmers' income increase from seven dimensions such as the improvement of production efficiency and the expansion of sales channels, with a focus on the direct integration of theory and practice. The research finds that, through the penetration of digital technologies into the entire agricultural industrial chain, agricultural digital new-quality productive forces optimize the allocation of production factors, drive the innovation of industrial forms, and extend the value chain, thus effectively breaking through the bottlenecks of traditional agriculture, such as low production efficiency, narrow sales channels and capital shortage. Combined with typical cases like the Digital Rice Industrial Park in Baodi District, the paper verifies the effectiveness of the theoretical application, providing a reference with both theoretical support and practical value for regions to promote farmers' income increase by virtue of agricultural digital new-quality productive forces.**

**Keywords: Tianjin; Agricultural Digital New-quality Productive Forces; Farmers' Income Increase; Digital Technology**

## 1. Introduction

### 1.1 Research Background and Significance

At present, the digital economy is deeply integrated with agricultural modernization. The 2023 Central Government Document No.1 explicitly states that it is necessary to "accelerate the development of the agricultural digital economy and promote the in-depth integration of digital technologies with agricultural production, operation, management and services", incorporating agricultural digitalization into the national strategy. As a new form of the in-depth integration of digital technologies and agricultural productive forces, agricultural digital new-quality productive forces integrates big data, artificial intelligence, the Internet of Things and other technologies to carry out systematic transformation of the entire agricultural industrial chain, which can precisely address the pain points of traditional agriculture such as "low efficiency, narrow channels and difficulty in increasing income".

As a forerunner of modern agriculture in northern China, Tianjin has built benchmark projects including the Digital Rice Industrial Park in Baodi District and the Smart Agriculture Demonstration Park in Xiqing District. In 2024, the online retail sales of agricultural products exceeded 10 billion yuan, and the effect of digital technologies in boosting farmers' income has initially emerged. However, existing academic studies on the relevant mechanisms suffer from the disconnection between theory and practice. There is an urgent need to strengthen the direct guidance of theory to practice based on actual cases.

Against this background, this study has both theoretical and practical values. Theoretically,

it clarifies the core connotation of agricultural digital new-quality productive forces to make up for the lack of clear conceptual definition, constructs a mechanism analysis framework of "seven major theories - seven major dimensions", directly connects classic theories with agricultural digitalization practices, and enriches the theoretical system of agricultural digital technologies empowering farmers' income increase[1]. Practically, it systematically sorts out the practical paths of agricultural digital new-quality productive forces empowering farmers' income increase in Tianjin, provides decision-making basis for local policy formulation, and refines replicable practical experience, thus offering a theory-practice integrated paradigm for other regions across the country.

## 1.2 Research Methods

Literature Research Method: By systematically reviewing the relevant literature on agricultural digital technologies and farmers' income increase, this study defines the core concepts and constructs an analysis framework that connects theory with practice.

Case Study Method: Taking typical cases such as the Digital Rice Industrial Park in Baodi District and the Smart Agriculture Demonstration Park in Xiqing District as the research objects, this study conducts an empirical analysis of the effectiveness of theoretical application in practice.

## 2. An Analysis of the Mechanism of Agricultural Digital New-quality Productive Forces Empowering Farmers' Income Increase in Tianjin

## 2.1 Mechanism of Production Efficiency Improvement Based on the Theory of Digital Technology Diffusion

Proposed by Everett Rogers, the Theory of Digital Technology Diffusion holds that technological innovation spreads gradually among members of a social system through specific channels over a given period of time, following the phased process of *knowledge-interest-evaluation-trial-adoption*.

Its characteristics, such as compatibility, complexity and relative advantage, exert an impact on the diffusion effect. This theory is applicable to agricultural production scenarios: it not only explains the transmission logic of

digital technologies moving from laboratories to farmlands, but also provides theoretical support for addressing the difficulties of traditional agricultural technology promotion and its slow implementation.

In traditional agricultural production, farmers in Tianjin relied on manual labor and experience-based decision-making, which gave rise to problems such as low efficiency, severe resource waste and unstable quality of agricultural products. Digital technologies address these challenges through full-process penetration: the Digital Rice Industrial Park in Baodi District has introduced an intelligent irrigation system that performs precision irrigation based on soil moisture and meteorological data, increasing water use efficiency by 50% and boosting the average rice yield per mu by approximately 3,000 yuan. egetable growers in Wuqing District adopt unmanned aerial vehicle (UAV) plant protection, which raises operational efficiency by about 5–6 times and cuts pesticide application by 30%[2].

The in-depth integration of theory and practice indicates that the core of digital technology diffusion lies in the precise alignment between the "phased law" and the "actual demands of agricultural production". Only when technological characteristics (compatibility, relative advantage, etc.) match the pain points of farmers' production, and the diffusion process (from knowledge to adoption) conforms to the reality of agricultural extension, can a positive cycle of technology coverage and efficiency improvement be achieved[3]. Tianjin's practice is exactly the successful implementation of this theoretical logic—the deeper the technology diffusion, the more thoroughly the production pain points are resolved, the more significant the effect of increasing farmers' income becomes, and eventually a sound closed-loop of technology promotion-efficiency improvement-income growth is formed.

## 2.2 Channel Expansion Mechanism in the Sales Link Based on the Theory of Network Externality

Proposed by Katz and Shapiro, the theory of network externality holds that the value of a product or service increases with the number of its users, forming a positive cycle of "more users - higher value - an influx of more users".

It is divided into direct externality derived from direct user interaction and indirect externality brought by the increased supply of complementary products.

Under the traditional sales model, farmers in Tianjin are plagued by such pain points as information asymmetry, excessive intermediate links and limited sales scope, with their profits squeezed layer by layer. The network externality of digital platforms has effectively addressed these problems: e-commerce platforms such as Pinduoduo and JD.com enable characteristic agricultural products like Shawo radishes to reach consumers across the country directly; live-stream e-commerce on Douyin and Kuaishou has seen single live-stream sales volume top 10 million yuan, boosting farmers' income; community group buying has reduced circulation losses through bulk purchasing, leading to a marked drop in the unsalable rate of vegetables in Wuqing District.

The in-depth integration of theory and practice shows that in the digital circulation of agricultural products, the scale expansion of users (consumers, growers and circulation entities) is strongly correlated with value improvement. The higher the user agglomeration degree, the more prominent the optimization effects on the efficiency of production and marketing connection, profit margin and market coverage. As the core carrier for the practical application of this theory, digital platforms generate direct externality by aggregating both supply and demand sides, and amplify indirect externality by virtue of complementary services such as data integration and logistics support, thus effectively solving the pain points of traditional agriculture including information asymmetry and redundant circulation links. This also reveals the key logic of the digital transformation of agriculture: it is imperative to take expanding the scale of user participation and improving supporting services as the starting point, drive the positive cycle of "user agglomeration - value upgrading - industrial efficiency improvement", and provide a sustainable path for upgrading the quality of agricultural production and marketing and increasing farmers' income.

## 2.3 Value-added Mechanism in the Industrial Integration Link Based on the

**Theory of Industrial Convergence**

Originating from the breakdown of the boundaries of traditional industries by digital technologies, the theory of industrial convergence holds that different industries or different sectors within the same industry integrate with each other through technological penetration, business interconnection and value chain restructuring, giving rise to new forms and models of business, which in turn elevates the overall industrial value and competitiveness[4].

Traditional agriculture in Tianjin is dominated by a single "production-sales" value chain, leaving farmers' income highly vulnerable to fluctuations in agricultural product prices. Digital technologies have driven the in-depth integration of agriculture with tourism, education, health and wellness industries: the Smart Agriculture Demonstration Park in Xinkou Town, Xiqing District, has created an "agriculture + tourism" model, allowing tourists to enjoy a "one-click park tour" via a mobile app and bringing a substantial increase in the per capita annual income of surrounding farmers; the Digital Rice Industrial Park in Baodi District has developed research and study courses on digital rice cultivation, with each mu of the research and study base generating an annual income of about 20,000 yuan; the "health and wellness agricultural parks" in Jizhou District monitor the ecological environment through the Internet of Things, driving up the prices of green agricultural products by 50% to 100%.

Industrial convergence restructures the agricultural value ecosystem and drives the transformation of farmers from single sellers of agricultural products into diversified service providers[5]. The diverse "agriculture +" business formats broaden the channels for increasing farmers' income, shifting their income structure from a price-dependent one to a stable and diversified one, which leads to a simultaneous improvement in their risk resistance capacity and income level[6].

## 2.4 Fund Guarantee Mechanism in the Financial Support Link Based on the Theory of Digital Finance

The theory of digital finance is an integration of traditional financial theories and digital technologies. Its core connotation lies in optimizing the supply mode, risk control

mechanism and operational efficiency of financial services through digital technologies such as big data, artificial intelligence and blockchain, and it mainly addresses the problems faced by traditional finance including information asymmetry, high transaction costs and narrow service coverage.

In traditional rural finance, the approval rate of loans for farmers in Tianjin is only about 50% to 60%, with the approval process taking as long as 15 to 30 days. Digital financial technologies have effectively solved these problems: the "Bank-Farmer Direct Connection" product launched by Tianjin Rural Commercial Bank evaluates farmers' credit through agricultural big data, with loan applications submitted via a mobile app approved within 1 to 3 days and a maximum loan limit of 300,000 yuan; digital agricultural insurance adopts satellite remote sensing and UAVs for loss assessment, cutting the claim settlement time from 15 to 20 days to 3 to 5 days, with a coverage rate of over 90% and a 30% to 40% reduction in farmers' losses; blockchain-based payment enables real-time fund settlement for agricultural product transactions, driving the capital turnover efficiency of the vegetable wholesale market in Wuqing District up by more than 50%.

Digital finance has injected strong impetus into rural finance. Its efficient and convenient financial support not only breaks the supply bottlenecks of traditional rural finance, but also directly drives farmers to expand the scale of production and operation, upgrade the level of technical equipment and optimize the agricultural production structure[7]. It lays a solid foundation for farmers to broaden income-increasing channels and improve income quality from the supply side, transforming the sense of gain from rural financial services into tangible results for agricultural development and farmers' income growth.

## 2.5 Risk Reduction Mechanism in the Decision Optimization Link Based on the Theory of Data-Driven Decision-Making

The core proposition of the theory of data-driven decision-making is that decisions should be based on the collection, analysis and mining of objective data, rather than relying on empirical judgments or subjective intuition. Its core logic is to integrate multi-dimensional data and apply methods such as statistical analysis and machine learning to reveal the laws and trends behind the data, thereby providing accurate and scientific evidence for decision-making and reducing the blindness and risks of decision-making.

In traditional agricultural decision-making, the phenomena of "blindly following the trend in planting" and "input based on experience" are prominent among farmers in Tianjin, which are likely to lead to oversupply or resource waste. Agricultural big data platforms integrate data on meteorology, soil, market, plant diseases and insect pests, etc., to provide precise support for decision-making: rice growers in Baodi District predicted typhoons in advance through meteorological data, reducing losses by about 1.21 million yuan; in 2024, the platform predicted a 50% growth in demand for green and organic vegetables and guided farmers to adjust the planting structure; through the early warning system, the disposal rate of plant disease and insect pest prevention and control has reached more than 90%, the overall prevention and control effect has hit 85%, and the hazard loss rate has been controlled within 10%.

Data-driven approach has propelled a qualitative leap in agricultural decision-making: farmers have completely bid farewell to the traditional model of "relying on experience and intuition" and shifted to scientific production based on "data and laws". Empowered by the precise support of agricultural big data platforms[8], production risks have been systematically reduced, and the stability and sustainability of farmers' income growth have been significantly improved, injecting strong impetus into the high-quality development of modern agriculture.

## 2.6 Model Upgrading Mechanism in the Innovation-Driven Link Based on the Theory of Digital Innovation

The core of the theory of digital innovation lies in creating new value and competitive advantages through the innovation of products, services, processes and business models supported by digital technologies. Its core characteristics are the in-depth integration of technology and business, rapid iteration and user participation. The core logic is that digital technologies lower the threshold and cost of innovation, transforming innovation from an

exclusive activity of a small number of subjects into a common practice accessible to multiple stakeholders.

Under the traditional model, agricultural production among farmers in Tianjin is highly homogeneous, resulting in a lack of market competitiveness. Digital technologies have driven model innovation: the integration of "digital agriculture + contract farming" has enabled rice growers in Baodi District to sign green standard contracts with processing enterprises, with the purchase price being more than 15% higher than the average market price; intelligent greenhouse vertical strawberry cultivation in Xiqing District has increased output by 15% and doubled the selling price, bringing an additional annual income of about 3,000 yuan per mu; personalized customization and adoption models for agricultural products have emerged, with the selling price of customized rice rising by 40% and the per capita income of cooperatives increasing accordingly[9].

Digital innovation has driven a leap in agricultural value: digital technologies have broken the predicament of homogeneous traditional production. Through the innovation of diverse models such as "digital agriculture + contract farming", "intelligent vertical cultivation" and "personalized customization and adoption", agricultural products have been transformed from "ordinary commodities" into "characteristic high-value-added products", which has significantly improved farmers' income and market competitiveness[10], blazing a new trail for the quality improvement and efficiency enhancement of the agricultural industry.

**2.7 Quality Improvement Mechanism in the Green Development Link Based on the Theory of Green Development**

The core of the theory of green development is to balance ecological environmental protection and efficient resource utilization in the process of economic development, so as to achieve a win-win synergy between economic development and ecological benefits. Its core logic is to drive the transformation of production modes from a pattern of "high input, high consumption and high pollution" to one of "low input, low consumption and low pollution" through technological innovation, institutional improvement and conceptual

guidance, with the core goal of realizing the harmonious coexistence of humans and nature. Under the traditional model, the certification rate of green agricultural products in Tianjin was less than 20% with a market premium of only 10% to 20%, while some single products such as Shawo radishes boasted a premium rate of as high as 100%. Digital technologies have boosted green production and quality traceability: intelligent fertilization and irrigation systems have raised the utilization rate of chemical fertilizers by 60% to 80% and that of water resources by more than 85% to 90%; green prevention and control technologies for plant diseases and insect pests have reduced the usage of chemical pesticides by 20% to 30%, with the qualification rate of pesticide residue detection exceeding 97.8%[11].

The traceability system for the quality and safety of agricultural products has laid a solid foundation for consumer trust. Upgraded green quality has brought stable premium income to farmers, and the development of green agriculture has simultaneously safeguarded the basic agricultural ecological foundation, ultimately achieving a two-way win-win result of both economic and ecological benefits.

**3. Conclusions**

This paper takes the agricultural development practice of Tianjin as the research object, and systematically analyzes the mechanism of agricultural digital new productive forces empowering farmers' income growth based on seven core theories combined with Tianjin's practical cases. The theory of digital technology diffusion facilitates precision farming and drives the improvement of production efficiency; the theory of network externality broadens sales channels and boosts farmers' income growth; the theory of industrial convergence extends the value chain and integrates agriculture with tourism; the theory of digital finance provides financial guarantee and solves capital-related problems; the theory of data-driven decision-making reduces production risks and cuts production and consumption costs; the theory of digital innovation upgrades business models and opens up income-increasing space in an all-round way; the theory of green development improves product quality and directly elevates production efficiency and

product value.

Through cases such as the Digital Rice Industrial Park in Baodi and the Smart Agriculture Demonstration Park in Xiqing of Tianjin, these theories directly address the core pain points of agricultural production and operation via specific technological applications, platform construction and model innovation, transforming theories into concrete paths of "technological implementation - pain point resolution - income improvement" and forming a closed loop of "theories anchoring the direction and practice verifying the effects". Tianjin's practice shows that through the digital transformation of the entire agricultural chain and the in-depth integration of digital technologies with all links of agriculture, agricultural digital new productive forces not only solve the pain points of traditional agriculture such as "low efficiency, narrow channels and high risks" and effectively break many limitations of traditional agriculture, but also build a pattern of "diversified, stable and long-term income growth" for farmers and create diversified channels for them to increase income.

In the future, it is necessary to further deepen the integration of digital technologies with agricultural scenarios and strengthen the connection between theories and practices, promote the more extensive penetration of digital technologies into all links of agricultural production and operation, continuously unlock the income-increasing potential of agricultural digital new productive forces, and advance the sustainable development of agriculture.

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