Research on the Logic and Policy Optimization of the Impact of Biological Breeding Technology Progress on the Formation of New Quality Productivity

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ABSTRACT
Under the background of the deep integration of high-quality agricultural development and scientific and technological revolution, cultivating new agricultural productivity has become the core strategy to ensure food security and realize comprehensive rural revitalization. This article focuses on the progress of biological breeding technology and explains its internal mechanism and institutional path driving the formation of New Quality Productivity (NQP). This article studies and defines the attribute characteristics of biological breeding technology as a high-end element and its corresponding basis with agricultural modernization. At the same time, the system deconstructs the mechanism of reshaping the triple elements by this technology, and reveals the evolutionary logic of the whole chain value transmission; furthermore, the risk challenges such as mismatch between innovation cycle and capital return, ethical regulation and technological diffusion tension, and intellectual property barriers are analyzed. This article puts forward a policy optimization approach that combines the reconstruction of financial support, the improvement of property rights protection and inclusive prudential supervision. Biological breeding technology realizes the leap of production efficiency by empowering the stock of factors and reorganizing the industrial structure, but it is subject to the lag of the system. Straightening out the relationship between technology and policy adaptation through institutional innovation is the only way to accelerate the formation of new agricultural productivity and consolidate the cornerstone of agricultural and rural modernization.

Keywords: *Biological breeding technology, New quality productivity, Remodelling elements, Institutional response, Policy optimization.*

1. INTRODUCTION

Under the dual background of the profound adjustment of global economic structure and the accelerated evolution of scientific and technological revolution, high-quality development has become the primary task of Chinese modernization [1]. As the first driving force to lead development, the concept of “NQP” provides a new path to crack the bottleneck of development and reshape the competitive advantage [2]. As the basic industry of national economy, the modernization level of agriculture is directly related to national food security and social stability [3]. At the key node of the transformation from traditional agriculture to modern agriculture, biological breeding technology, as a “chip” in the field of agricultural science and technology, is the core engine to promote the upgrading of agricultural industrial chain and the key variable to cultivate new agricultural productivity [4]. Technology itself is not directly equivalent to productivity. How to transform the frontier breakthrough of biological breeding into realistic industrial efficiency and then form systematic NQP is still a theoretical proposition that needs to be clarified urgently.

Looking at the existing academic research, the discussion on biological breeding technology mostly focuses on specific germplasm resources

mining or economic benefit calculation per unit yield, and lacks systematic theoretical construction from the perspective of macro productivity change [5]. In particular, there is still a “black box” effect on the mechanism of how biotechnology can finally realize the transition of total factor productivity by reshaping the skills of workers, innovating the attributes of labor tools and optimizing the allocation of labor objects. The existing seed industry support policies are mostly based on the traditional industrial support logic, and they show certain lag and fragmentation characteristics in the face of new problems such as ethical regulation, property rights definition and market monopoly brought about by subversive technologies such as gene editing [6]. The lag of theoretical cognition and the shortage of institutional supply have restricted the full release of biological breeding technology dividends to a certain extent, and affected the accelerated formation of new agricultural productivity. Based on the cross vision of Marxist political economy and new growth theory, this article attempts to construct a theoretical analysis framework between the technological progress of biological breeding and the formation of NQP.

2. DYNAMIC MECHANISM AND EVOLUTIONARY LOGIC

Biological breeding technology, as the core engine of NQP, its driving mechanism is reflected in the structural reshaping and systematic upgrading of agricultural production factors. This technology promotes the iteration of workers' quality at the micro level. The traditional experience-dependent agricultural subject is gradually replaced by a new type of practitioner with the ability of bioinformatics analysis, and the digitalization and knowledge of labor skills have significantly enhanced the connotation of human capital, enabling producers to master the complex biotechnology system, thus completing the transformation from physical strength to intelligence [7]. In terms of labor materials, biological breeding has realized the “genetic” innovation of production tools. The deep integration of high-throughput sequencing, automatic cultivation and intelligent breeding equipment has extended production activities from macro-field management to micro-molecular control, greatly expanding the depth and accuracy of human transformation of nature and promoting a nonlinear leap in production efficiency.

The attributes of labor objects have been fundamentally optimized. Through the precise design and directional improvement of germplasm resources, crop characters get rid of the random limitation of natural variation. This has greatly improved the output efficiency of unit resources, promoted the optimal allocation of scarce elements such as land, water and fertilizer, and realized the essential transformation of agricultural growth mode from extensive investment to intensive and efficient. The above-mentioned factor changes are coupled through the whole chain value conduction path of “technology-industry-ecology” [8]. The breakthrough of biological breeding technology has effectively promoted the linkage between upstream and downstream industries, spawned new formats such as seed science and technology services and smart supply chain, and formed a modern industrial system with innovation as the core.

3. SYSTEM BLOCK AND RISK CHALLENGE

Although biological breeding technology has great potential to drive the formation of NQP in theory, in the process of actual transformation and application, multiple systematic blocking factors constitute practical constraints [9]. These factors do not exist in isolation, but are intertwined in many dimensions, such as technological innovation, social acceptance and market structure, forming a complex network of constraints, which directly affects the promotion path of agricultural total factor productivity.

3.1 The Structural Dislocation Between the Innovation Cycle and the Return on Capital

The research and development of biological breeding technology has obvious long-term characteristics, and it usually takes years or even more than ten years from the breakthrough of basic theory to the landing of commercial varieties. Modern capital markets generally tend to pursue short-term return on investment, and this asymmetry in time dimension leads to a structural mismatch between capital supply and innovation demand. It is difficult for venture capital to patiently cultivate cutting-edge technology, which makes many subversive genes editing schemes stay in the laboratory stage. “Table 1” shows the risk assessment framework based on industry consensus and reveals the potential resistance points of each link.

Table 1. Multidimensional risk assessment matrix in the commercialization process of biological breeding

Risk Dimension	Specific Manifestation	Estimated Probability of Occurrence	Impact on Productivity
R&D Funding Gap	Financing difficulties in mid-stage trials	High	Severely hinders technological iteration
Lengthy Approval Process	Delays in obtaining biosafety certificates	Medium	Extends market access time
Market Perception Bias	Consumer resistance to genetically modified foods	Medium	Suppresses the release of market demand
Patent Licensing Disputes	Disputes over ownership of core gene sequences	Low	Increases legal compliance costs
Ecological Adaptability Variation	Trait drift after long-term cultivation	Low	Reduces production stability

3.2 Internal Tension Between Ethical Regulation and Technology Diffusion

The application of biological breeding technology, especially gene editing technology, has aroused deep concern from all walks of life about biosafety and ecological ethics. The existing regulatory system lags behind the iterative speed of technology itself, which leads to the compliance obstacle of technology diffusion [10]. When new technologies appear, policy makers lack enough scientific data to evaluate their long-term environmental risks, so they have to adopt a cautious and conservative attitude. Although this caution is necessary, it may also objectively delay the popularization of advanced breeding tools to the fields. The lack of social trust mechanism further aggravates the public's rejection of biotechnology products, making it difficult for technology dividends to be fed back to the production end through the consumption end, forming a closed loop of the industrial chain.

3.3 The Potential Game Between Intellectual Property Barriers and Market Monopoly

Seed industry is a high intelligence-intensive industry, and the protection of intellectual property rights has become a moat for the master of core technology, but it may also evolve into a market barrier that restricts competition. A few international giants have mastered a large number of core patents of keystone species' quality resources. This highly centralized intellectual property pattern may lead to the passive position of small and medium-sized scientific research institutions and traditional breeding enterprises. Market monopoly limits the diversity of provenance acquisition, and may also push up the price level of agricultural means of production, and ultimately weaken the actual income of farmers. Without the intervention of an effective anti-monopoly mechanism, technological advantages will solidify into economic privileges, which will distort the efficiency of resource allocation and hinder the inclusive generation of NQP in the agricultural field. The increasing dependence on technology may also threaten the autonomy and controllability of national food security.

4. SYSTEM RESPONSE AND POLICY APPROACH

In order to effectively resolve the systemic risks faced by biological breeding technology in the process of transforming into NQP, policy makers must build a set of institutional supply system that adapts to the technical characteristics. In order to ensure the dynamic balance between technological innovation, capital allocation and social governance, as the leading force of resource allocation, the government should re-examine the role of public finance in agricultural basic research and development, change the single back-end subsidy model in the past, and instead strengthen the investment in front-end basic research and common technology platforms. This transformation aims to reduce the innovation cost of micro-subjects, and at the same time share the market risk of early technology through the establishment of industrial guidance funds, thus solving the mismatch between the capital return cycle and the long-term technology research and development cycle. Policy subjects need to establish a diversified financial support network to encourage social capital to enter the field of seed science and technology.

4.1 Strengthening the Reconstruction of Financial Support Mode for Basic Research Investment

In the optimization of capital investment structure, policy enforcement agencies should

clearly distinguish the boundary between public welfare research and competitive development. For the underlying technologies involved in the protection of national germplasm resources, the financial department should implement a full guarantee mechanism to avoid the distortion of scientific research direction by short-term profit assessment. For commercial projects in the pilot stage, the tax authorities can encourage enterprises to bear more trial and error costs by adding deductions and tax credits. This strategy of classified support can significantly improve the efficiency of the use of financial funds and promote more laboratory results to the fields. The financial supervision department needs to guide commercial banks to develop credit products according to the characteristics of seed industry, so as to get through the financing blockage of scientific and technological achievements transformation.

4.2 Improving the Legal System of Biotechnology Property Rights Protection and Trading

Facing the market monopoly risk that may be caused by intellectual property barriers, the judicial administrative department should improve the confirmation and circulation mechanism of intellectual property rights in seed industry. The legislature needs to explore the establishment of an open licensing system, which can protect the rights and interests of core inventors and allow third parties to use keystone species quality resources under certain circumstances on the premise of paying reasonable fees. This mechanism design can effectively prevent a few giants from monopolizing upstream resources and promote the differentiated competition of small and medium-sized enterprises. The legal system also needs to strengthen the supervision of the performance of technology contracts to prevent the deadlock of cooperation caused by unclear ownership. By establishing a unified seed trading platform, policy makers can standardize the trading process, reduce the friction cost caused by information asymmetry, and form a unified and open seed market.

4.3 Establishing an Inclusive and Prudent Regulatory Sandbox and Standard System

Considering the complexity of biosafety ethics, regulators should not adopt a “one-size-fits-all” ban, but should establish a hierarchical and classified regulatory sandbox mechanism. Industry authorities can pilot the commercial application of new technologies in specific areas or varieties, and collect data under monitoring conditions to assess the long-term ecological impact. The National Standards Committee needs to update the labeling management methods of molecular breeding products in time to ensure consumers' right to know and eliminate unnecessary panic.

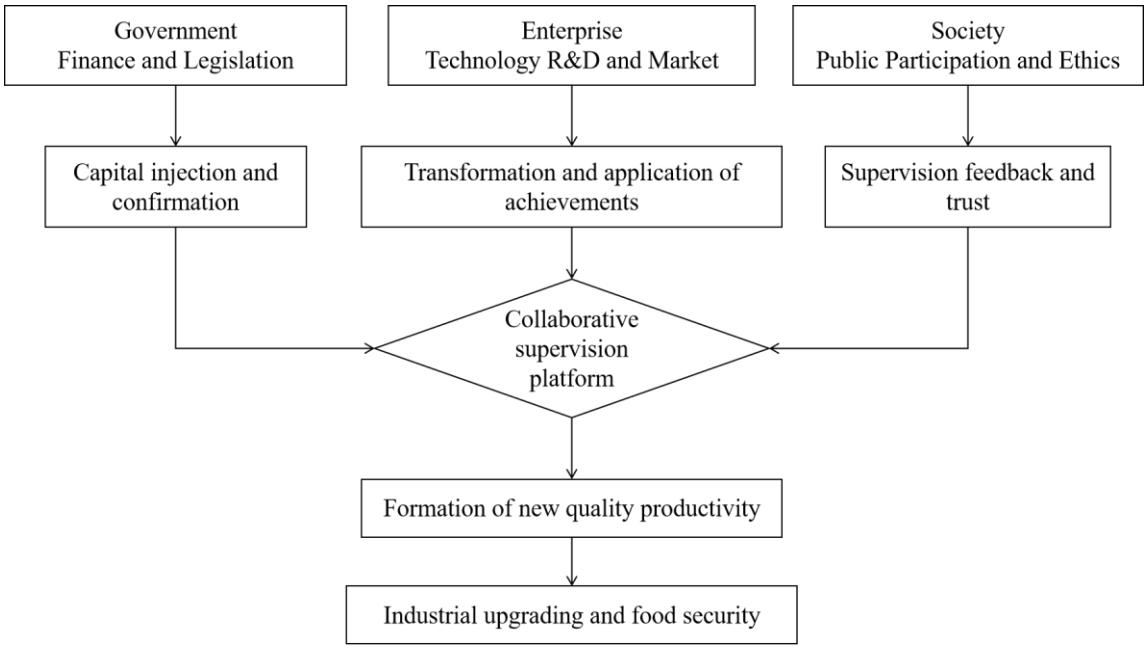


Figure 1 Policy synergy mechanism model for cultivating NQP in biological breeding.

The above model in “Figure 1” clearly defines the functional boundaries and interaction paths of government, enterprises and society in the institutional framework. As the central system, the supervision platform is responsible for integrating multi-party information and dynamically adjusting policy parameters to ensure the safety and economy of technological development.

5. CONCLUSION

The value of this study lies in breaking through the limitations of microeconomic analysis and constructing a theoretical framework from the perspective of macro-productivity evolution. Biological breeding technology is not a simple update of production tools, but a fundamental driving force to trigger systematic changes in agricultural production factors. By upgrading human capital, innovating production tools and optimizing resource allocation, it has effectively promoted agriculture to leap from traditional experience to modern science and technology, and laid a solid material foundation for NQP. There are multiple systematic obstacles in the process of transforming technology into real productive forces. The mismatch of capital return, ethical uncertainty and intellectual property monopoly all constitute external constraints that restrict the release of NQP. This shows that spontaneous market regulation has limitations in dealing with emerging technological risks, and we need to be alert to negative effects. Institutional supply must be moderately ahead of technological innovation. Relying solely on the market mechanism cannot solve the above-mentioned deep-seated problems, and the government needs to play a guiding role. By reconstructing financial support, perfecting property rights protection laws and establishing an inclusive and prudent supervision sandbox, transaction costs can be effectively reduced, social concerns can be resolved, and the transformation and commercial application of achievements can be promoted. Policy optimization should focus on overall coordination. The formation of agricultural NQP needs technological breakthrough, and depends more on Industry-University-Research’s innovative ecological support with deep integration.

Accelerating the progress of biological breeding is not only a strategic demand to ensure food security, but also a key engine to cultivate new agricultural productivity and realize Chinese-style agricultural and rural modernization. Only by adhering to the dual-wheel drive of innovation and system guarantee and transforming technological advantages into industrial advantages can we contribute to the sustainable development of global agriculture.

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