

Research on the Construction Model of “Innovation-Network-Space” Industrial System of Agricultural Product Processing in Hebei Province

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Abstract: The agricultural product processing industry of Hebei Province is a significant component of the province's agricultural economy. It plays a vital role in increasing farmers' incomes, elevating the added value of agricultural products, and advancing agricultural modernization. This article examines the foundations and current status of technological innovation in Hebei's agricultural product processing industry and puts forth relevant policy recommendations. The research findings indicate that there's an uneven distribution of technological achievements in Hebei, a lack of foundational support for technological innovation in the agricultural product processing industry, and an imbalanced distribution of disciplines. Therefore, it's imperative to strengthen government guidance, establish technical cooperation mechanisms, build collaborative innovation networks, optimize the spatial layout of the industry, and promote the healthy development of the agricultural product processing industry.

Keywords: Complex network, Agricultural product processing, Industrial system, Construction model.

1. Introduction

Boasting abundant agricultural resources and strategically surrounding Beijing and Tianjin, Hebei Province has a sophisticated agricultural product consumption market. This advantage provides a strong foundation for the development of the agricultural product processing industry. As a bridge to the integration of primary, secondary, and tertiary industries, the systematic development of the agricultural product processing industry is indispensable. Despite the potential, Hebei's current level of industrial development in agricultural processing lags behind other provinces and lacks a comprehensive industry system.

In terms of distinguished industries, Hebei showcases wheat, corn, oil crops, peanuts, potatoes, sweet potatoes, grains, beans, cotton, vegetables, edible fungi, and more. Currently, there are 19 innovation teams formed around these (such as wheat, corn, cotton, soybeans, grains, beans, vegetables, and edible fungi). These teams focus on solving significant challenges and bottlenecks hindering high-quality development by pioneering research, conducting trials, and promoting the entire value chain's enhancement.

Innovations in agricultural science and technology primarily encompass precision agriculture, biotechnology, and smart robotics. Precision agriculture aims to leverage big data and remote sensing technologies to enhance production efficiency and minimize environmental impacts. As many studies have suggested, this approach allows farmers to manage resources like water, fertilizers, and pesticides more effectively [1]. Biotechnology, encompassing gene editing, genome sequencing, and synthetic biology, finds extensive application in agriculture [2]. Today, gene editing is being broadly used to improve disease resistance, nutritional value, and adaptability to adverse environments. Robotics, such as drones and autonomous robots, have been increasingly adopted in agriculture, performing tasks like precise spraying, autonomous harvesting, and planting. These robots significantly improve production efficiency [3].

Despite the benefits of agricultural tech innovations, there are challenges. New technology adoption requires substantial investment, which might be taxing for many small-scale farmers [4]. Ethical and environmental concerns, like the potential threat to biodiversity posed by gene editing, are also paramount [5].

Technology-driven innovation is a pivotal catalyst for the development of the agricultural product processing industry. Numerous studies attest to this. For instance, Li et al. (2020) explored the implications of technological innovation in agricultural product processing, indicating that it can boost efficiency, elevate product quality, and trim production costs [6]. Another study by Chen et al. (2021) analyzing China's agricultural product processing industry deduced that technological innovations amplify competitiveness [7].

While the fruits of technological innovation are evident, the rapid pace of innovation poses challenges for the agricultural product processing industry. As pointed out by Zhang et al. (2022), constant tech upgrades necessitate continuous investments and human resources [8]. Additionally, the environmental implications of these novel technologies and processes cannot be overlooked. As highlighted by Liu et al. (2023), there's a pressing need to consider these environmental impacts and pivot towards more sustainable methods [9].

2. Data and Methods

2.1. Data

This paper selects the data on scientific and technological achievements transformation from universities in Hebei Province as sample data. Moreover, patent data is sourced from the CNKI (China National Knowledge Infrastructure) patent database.

2.2. Methods

The transmission matrix T_u formed by the transformation relationships mutually conducted between different

institutions is as follows:

$$T_u = \begin{bmatrix} w_{1,1} & \cdots & w_{1,k} \\ \vdots & \ddots & \vdots \\ w_{k,1} & \cdots & w_{k,k} \end{bmatrix} \quad (1)$$

In the matrix T_u , the elements represent different institutions. Taking each institution involved in the transformation of scientific and technological achievements and the transformation destination as nodes, the technology transformation relationship between different institutions and the transformation destination is defined as the directed edge of the network, with the number of transformations as the weight, constructing the directed weighted network of scientific and technological achievements transformation in Hebei Province.

3. Results

3.1. Regional Analysis of Technology Achievement Transformation in Hebei Province

As shown in Fig. 1, from the perspective of technology

achievement transformation regions, Shijiazhuang city in Hebei Province has the most technology achievement transformations, reaching 24 times. Beijing is next at 12 times, followed by Baoding city in Hebei Province at 9 times. Handan and Tangshan cities in Hebei Province each reached 8 times. Cities following them include Langfang, Cangzhou, Hengshui, and Qinhuangdao in Hebei Province. Meanwhile, Shanghai and Tianjin each undertook 5 times, surpassing Chengde, Xingtai, and Zhangjiakou within Hebei Province. The city with the highest amount of technology achievement transformation is Shijiazhuang in Hebei Province, followed by Tianjin, Zhangjiakou, and Baoding in Hebei Province. Overall, the spatial distribution of technology achievement transformation, which reflects the ability of technology innovation to serve regions in Hebei Province, is relatively decentralized and has not formed a combined force. Especially in areas with insufficient agricultural technology development, there has been no targeted technology achievement transformation.

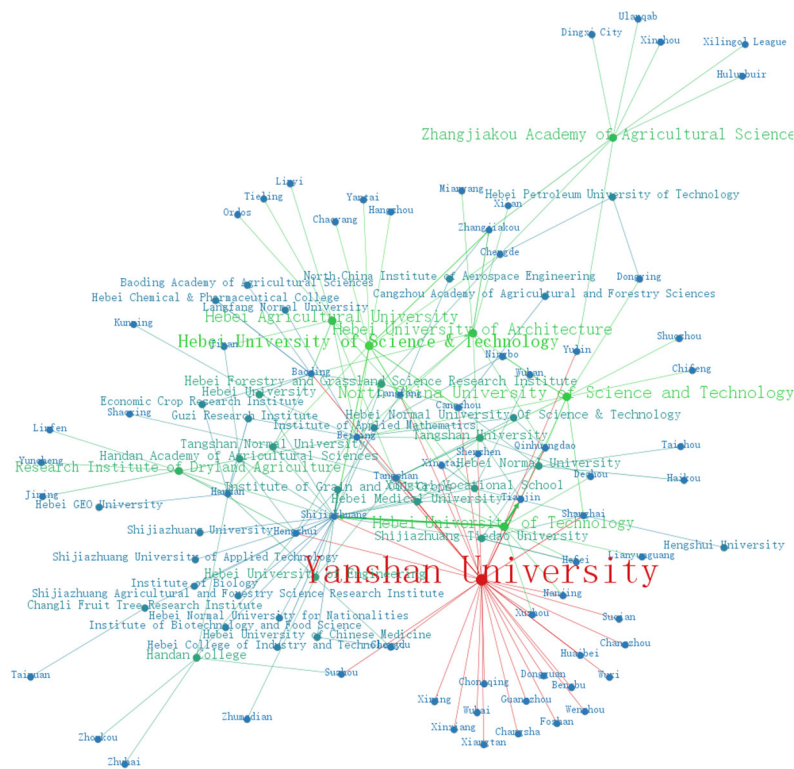


Figure 1. Network Distribution of Technology Achievement Transformation Destination in Hebei Province

3.2. Distribution of Agricultural-Related Patents in Hebei Province

Hebei Province has a total of 17,993 agricultural-related patents. The three disciplines with higher proportions are agricultural and forestry engineering, horticulture, and plant

protection. Light industry and handicrafts are integrated disciplines of agriculture and industry, with 60 cases, accounting for 0.33%. Overall, the proportion of agricultural-related patents related to production and processing in Hebei Province is relatively low.

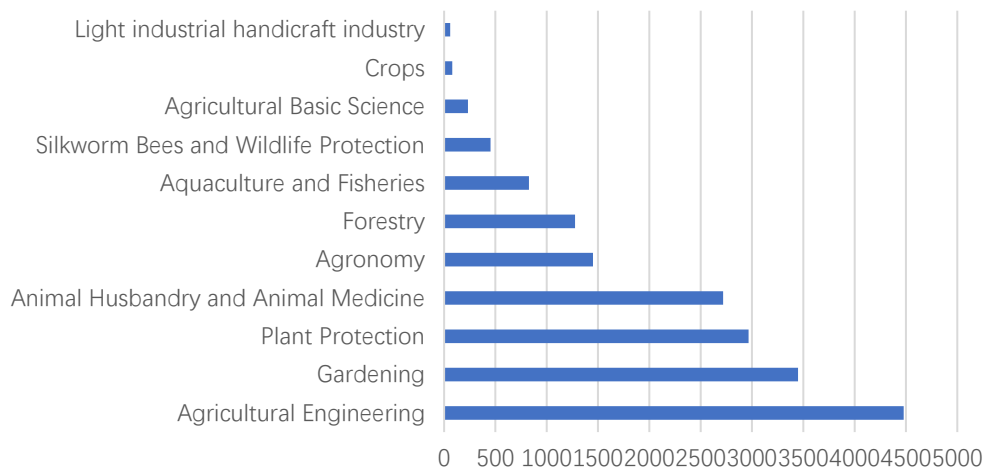


Figure 2. Distribution of Agricultural-Related Patents in Hebei Province

In the past decade, Hebei Province has had 84 patents related to aquatic product transportation, preservation, processing, and packaging, and 4 patents related to agricultural product processing, storage, and comprehensive utilization. Overall, there are too few patents directly related to the agricultural processing industry. Therefore, there is a significant deficiency in technological innovation.

In recent years, the agricultural processing industry in Hebei Province has developed rapidly, with an increasingly diverse range of products and an expanding market coverage. However, compared with advanced regions, there is a certain gap in output, quality, and brand image in the agricultural processing industry of Hebei Province. These problems are largely related to the lack of technological innovation. Some positive results have been achieved in technological innovation in the agricultural processing industry in Hebei Province. Breakthroughs have been made in areas such as deep processing technology of agricultural products, research and development of new agricultural products, and equipment automation. However, overall, the level of technological innovation in the agricultural processing industry of Hebei Province is still relatively low, with insufficient investment in technology research and development, and the speed and quality of new product development cannot meet market demand.

4. Conclusion

Based on the preceding analysis, there's a significant shortfall in the level of technological innovation for agricultural product processing in Hebei Province, making it inadequate to sufficiently support the industry. Considering the insufficiencies and imbalances in the development and distribution of technological innovation within the Hebei agricultural product processing industry, we suggest the following policy recommendations:

Firstly, establish a comprehensive and intertwined collaborative innovation network across the entire value chain. This requires breaking away from the previously isolated regional layout of the agricultural product processing industry. By leveraging the strengths of research in different regions, collaborative research, industry, and technological innovation bases should be set up. Multiple such bases can constitute Hebei's Internet collaborative innovation platform for agricultural product processing, supporting the technological

growth of this industry in all regions of Hebei. On this platform, the government acts as the administrator and supporter. Each technological innovation cooperation base is a hub of academia, research, and industry, integrating market, production, and research. By merging major corporate labs, industry research institutes, universities, and research institutions, it facilitates close collaboration on technological innovations in agricultural product processing, creating an efficient technological system. This can lead to a strategic alliance for technological innovation in the agricultural product processing industry based on the collaborative innovation platform.

Secondly, optimize the industry's spatial layout based on the collaborative innovation platform. The province-wide industry network encompasses numerous agricultural product processing enterprises. Given the current geographical layout of Hebei's agricultural product processing industry, it is vital to analyze the efficiency of innovation resource allocation and spatially optimize the "connecting points" or collaborative innovation platform. By effectively concentrating technological innovation resources, it guides agricultural resources towards high-tech processing areas. This will form an efficient, systematic "Collaborative Innovation Platform-Technological Innovation Base-Agricultural Product Processing Production" spatial structure, leading to a modern agricultural product processing industry system that encompasses grains, cotton, oils, tubers, meat, poultry, dairy, fruits, vegetables, teas, fungi, aquatic products, forestry products, and unique agricultural product technological innovation highlands.

Lastly, new policies should be introduced to encourage leading enterprises to establish close technological collaboration mechanisms with universities and research institutes. These enterprises should bolster their technological innovation and talent recruitment, relying on these mechanisms to enhance product quality and market competitiveness. At the same time, their market departments should strengthen market supervision and establish close collaboration with universities in the field of market management to improve brand-building.

In summary, although Hebei's agricultural product processing industry has achieved certain accomplishments in terms of scale expansion and technological innovation, it still faces challenges like insufficient technological innovation capabilities and unbalanced spatial distribution. Therefore, to

promote the healthy development of the agricultural product processing industry, there's a need to establish a collaborative innovation network, optimize industrial spatial layout, and establish technological collaboration mechanisms.

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