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# Technological Innovation Characteristics and Capacity Enhancement Ways for the Agricultural Science and Technology Enterprises in Beijing City

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**Abstract** From the perspective of innovation mechanism, capital, personnel, achievements and conversion, this study analyzes the current situation of technological innovation in Beijing agricultural science and technology enterprises, and summarizes the characteristics including single financing channel of R&D funds, low conversion rate of innovative products, unbalanced distribution of technology and innovative talents, the underestimated position of enterprises as the main body of technological innovation, the large gap of innovation achievements between developed provinces and Beijing. At last, this study puts forward the ways to improve technological innovation ability in Beijing agricultural science and technology enterprises as follows: developing technological innovation strategies; improving the R&D expenditure and expanding the financing channels; perfecting the mechanism of professional personnel training in agricultural technology innovation; enhancing the level of innovation performance management; establishing and improving the corporate culture of innovation and cultivating technology innovation spirit.

**Key words** Agricultural science and technology enterprises, Technological innovation, Current situation, Characteristics, Ways

## 1 Introduction

As the object of study, the agricultural science and technology enterprises are the for-profit social and economic organizations of an independent legal personality, with some research and development resources as the basis, technological innovation as the driving force, some industries related to farming, forestry, animal husbandry and fishery as the leading industries, modern mode of business operation and management as means<sup>[1-2]</sup>. Some scholars have conducted studies on the agricultural science and technology enterprises. Based on the questionnaire data of 85 agricultural science and technology enterprises assessed by the risk investment institutions, Wang Bin and Wang Jianzhong (2014) use Logit regression model to analyze the factors that affect the risk investment in agricultural science and technology enterprises<sup>[3]</sup>. Zhang Yan and Wang Huan (2014) argue that the financing model is an important factor that affect the conversion of agricultural scientific and technological achievements, and propose some recommendations such as establishing credit evaluation system and credit guarantee system for agricultural science and technology enterprises, playing the service functions of policy banks, regulating agricultural technology property right trading markets and developing risk investment to contribute to the diversification of financing<sup>[4]</sup>. Using the survey data, provided by Rural Research Center of the Ministry of Science and Technology, on 173 agricultural science and technology micro-enterprises, Su Xiaosong and He Guangwen

(2014) employ orderly probit for regression analysis, and find that the technology elements have not significant effects on small and micro enterprises' bank financing and private financing, while the enterprises' credit and operating time have a significant impact on the small and micro enterprises' financing from any channel<sup>[5]</sup>. As for the study on the technological innovation of agricultural science and technology enterprises, Gao Qijie (2008) uses the first-hand information on 125 agricultural science and technology enterprises to analyze the current technological innovation of Chinese agricultural science and technology enterprises; uses mathematical statistics and Likert table to study the 26 indicators that reflect the technological innovation capacity of agricultural science and technology enterprises, and point out the main influencing factors; uses the 26 indicators to evaluate the technological innovation capacity of agricultural science and technology enterprises<sup>[6-7]</sup>. Xiao Gengsheng, Yao Qiong and Li Chongguang (2010) build the two-dimensional model (process dimension and risk dimension) for technological innovation risk factor identification of agricultural science and technology enterprises, and use the t statistical test for empirical test by surveying the agricultural science and technology enterprises in Guangdong Province. The results show that at four stages of technological innovation of agricultural science and technology enterprises, 10 categories of risk factors affect the technological innovation, and they can be summarized as general and periodic risk factors, thereby verifying "process dimension-risk dimension" in the two-dimensional model<sup>[8]</sup>. Chen Zhiming, Xu Bin, Jie Xiaowen (2012) employ management connotation and the symbiotic relationship between biological populations to study the coupling and interaction between enterprises' technological innovation cooperation and various elements of symbiotic system, and take agri-

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cultural science and technology enterprise as a case to discuss the symbiotic management model<sup>[9]</sup>. Yao Qiong, Xu Meisi and Zhang Yong (2015) use the first-hand data on 314 agricultural science and technology enterprises for empirical research, and explore the impact of technological innovation mode on resource integration and corporate performance in the context of agricultural science and technology enterprises. Compared with the cooperative innovation model, the resource integration under independent innovation model and imitative innovation model has a more significant impact on corporate performance<sup>[10]</sup>. With agricultural biotechnology, agricultural information technology, agricultural circular technology, agricultural deep processing technology and agricultural facility and equipment technology as the technological areas, the agricultural science and technology enterprises in Beijing City play an important role in developing the technological, green, cultural and processing added value, and these enterprises provide solid scientific and technological support for agricultural development. At the same time, it should be noted that there are still some deficiencies in the process of technological innovation of the agricultural science and technology enterprises in Beijing City, and there is a need to further study the operational mechanism, mode of operation and selection of path regarding enterprise's technological innovation. The enterprise's technological innovation capacity needs to be improved. Therefore, we analyze the current situation, characteristics and key problems concerning the technological innovation of agricultural science and technology enterprises in Beijing City, and explore how to enhance the technological innovation capacity of agricultural science and technology enterprises.

## 2 Current situation of technological innovation of the agricultural science and technology enterprises in Beijing City

Based on the statistics from *Beijing Statistical Yearbook* about some agricultural enterprises engaged in technological innovation activities on farming, forestry, animal husbandry and fishery, combined with the actual survey data on some typical enterprises, we carry out the specific analysis. These agricultural enterprises are engaged in the technological innovation-oriented research and development activities, and the business scope is also consistent with the definition of agricultural science and technology enterprises in this study, so we can use agricultural science and technology enterprises to represent these enterprises in the following analysis. The analysis is conducted from R&D institution establishment, R&D personnel, R&D funding, patent application and acquisition, new product performance and other R&D activities. These aspects are also the most basic point of view to analyze the current situation of enterprises' technological innovation. Therefore, the analysis on the research and development activities of these enterprises can reveal the basic status of technological innovation of the agricultural science and technology enterprises in Beijing City.

### 2.1 Structural establishment and R&D personnel investment

In 2011, there was a dramatic decline in the number of Beij-

ing's agricultural science and technology enterprises engaged in research and development activities compared with 2010; the number of agricultural science and technology enterprises was basically stable and rose slightly for the next three years. The number of enterprises that set up research institutions was basically stable from 2010 to 2013. Since 2011, there has been a significant decline in the number of agricultural science and technology enterprises, but the number of enterprises that set up research institutions has remained unchanged, and the number of agricultural science and technology enterprises that set up research institutions was even significantly increased in 2014. In 2010, the R&D personnel investment was small; in 2011, the R&D personnel were increased considerably compared to 2010; in other years, the R&D personnel investment underwent little change. However, the number of R&D personnel and FTE (Full Time Equivalent) of R&D personnel declined dramatically in 2013, which is worthy of attention. In 2014, the R&D personnel investment level and converted R&D personnel FTE rebounded, as shown in Fig. 1.

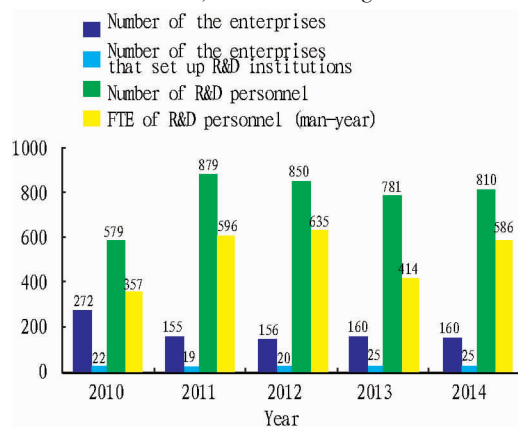


Fig.1 R&D structural establishment and personnel

**2.2 R&D funding** From 2010 to 2015, Beijing's agricultural science and technology enterprises engaged in research and development activities increased R&D expenditure year by year, and especially in 2011, it increased by nearly three times compared to 2010, and maintained steady growth thereafter. In terms of the funding source structure, it can be found that enterprises' R&D funding is from the enterprises' internal funds, government funds, foreign funds and other funds, and enterprises' internal funds have been the main source, more than 90% of the total investment. Government's funding investment accounts for 6.86% of total investment on average, while other funds account for less than 2% of total investment on average. Except 2013, there were no foreign sources of funding in other years (Table 1).

**2.3 Innovations and conversion** As can be seen from Table 1, in recent years, the number of patent applications and patent of invention has substantially increased year by year for Beijing's agricultural science and technology enterprises; in 2012, it increased to the highest level in nearly five years, an increase of nearly 2.5 times compared to 2011; in 2013, the number of patent applications and patent of invention declined dramatically, but

still larger than in 2011; except 2012, the new product output value and new product sales in other years increased over the previous year; in 2012, the export earnings started to decline and did not rebound until 2014.

## 2.4 Comparison of agricultural science and technology enterprises' R&D activity between Beijing and some other regions

The Second National R&D Resource Inventory Data in 2010 show that the agricultural science and technology enterprises in Beijing City have more advantages in terms of amount of R&D personnel, R&D expenditure, number of research institutions and research result quantity than in Tianjin, Chongqing and Shanghai.

**Table 1 R&D funding sources and technological innovations**

Year	R&D funding	Funding sources				Number of patent applications	Number of patent of invention	New product output value 10 <sup>4</sup> yuan	New product sales 10 <sup>4</sup> yuan	Exports 10 <sup>4</sup> yuan
		Government funds	Enterprises' funds	Foreign funds	Other funds					
2010	4 794	355	4 314	0	125	71	46	200 874	198 979	6 184
2011	18 988	1 434	15 182	0	2 372	81	70	274 916	268 280	7 605
2012	19 294	923	18 371	0	0	203	140	261 233	260 397	4 810
2013	25 845	1 562	23 547	312	424	131	96	290 809	286 110	3 223
2014	26 288	815	25 389	0	84	139	106	308 732	303 459	5 804

Data source: *Beijing Statistical Yearbook* (2011–2015).

**Table 2 Agricultural science and technology enterprises' R&D activity in Beijing and some other regions**

Regions	Internal R&D expenditure 10 <sup>4</sup> yuan	Number of units having R&D activities	Number of R&D personnel	FTE of R&D personnel man-year	Number of R&D institutions	Number of patent applications	Number of patent of invention	Number of valid patent of invention
Total	134523	611	3116	2220	119	271	4040	78
Beijing	5299	18	420	130	9	4	4	13
Tianjin	1209	5	75	60	5	50	30	0
Chongqing	331	3	32	23	1	1	0	0
Shanghai	2067	18	253	205	18	32	15	11
Jiangsu	13144	108	1388	1076	51	137	49	40
Zhejiang	13311	97	948	726	35	47	29	14
Guangdong	26225	56	1984	1457	61	70	43	68
Shandong	4770	25	386	331	16	24	16	12
Hunan	7629	32	684	560	14	48	18	4
Yunnan	4463	83	1222	837	29	86	33	19

Data source: *The Second National R&D Resource Inventory Data Compilation*, China Statistics Press, Beijing: 2011.

## 3 Technological innovation characteristics of the agricultural science and technology enterprises in Beijing City

**3.1 Single R&D financing channel and insufficient external financing capacity** More than 90% of R&D funding of agricultural science and technology enterprises is from enterprises' internal funds, while the funds from government financial support, risk investment and other financing modes account for less than 10%, and foreign capital investment is more difficult to obtain. Continued funding for innovation is a reliable guarantee of effective implementation of innovative activities. Raising funds for innovation using different ways and different channels can not only help improve enterprises' technological innovation capacity, but also help effectively disperse and control the risks of innovation.

### 3.2 Low conversion rate of technological innovations

However, there is a big gap in technological innovation investment and results of agricultural science and technology enterprises between Beijing and some economically developed provinces such as Zhejiang, Jiangsu and Guangdong. Internal R&D expenditure in Guangdong, Zhejiang and Jiangsu accounts for about 50% of total national expenditure, and these provinces have obvious advantages in R&D activities, R&D expenditure, personnel investment and R&D achievements. In recent years, Beijing enterprises' technological innovation resource input has gradually increased, but still lags behind compared with Guangdong, Zhejiang, Jiangsu and other developed provinces.

Beijing's agricultural science and technology enterprises have rich technological innovations, but the conversion rate of innovations is low. From the foregoing analysis, it can be found that there were most patents of invention in 2012, but the enterprise's output value and sales did not increase over the previous year. Since 2012, the number of patent of innovation has increased by 63% on average, while the new product output value sales have increased by 4.37% and 5.61%, respectively, far lower than the growth rate of inventions. Conspicuously, the conversion rate of most patents of innovation is low and the technological innovations fail to be effectively commercialized.

**3.3 Uneven distribution of innovative technologies and innovative talents** Most agricultural technological innovative talents who master new innovative technologies are concentrated in large-scale leading agricultural enterprises or agricultural high-tech en-

terprises, making the technological innovative talents unevenly distributed in agricultural science and technology enterprises. For some leading agricultural enterprises and high-tech enterprises, the proportion of scientific and technological personnel has reached one-third, while most small and medium agricultural science and technology enterprises lack technological innovative talents. As shown in Fig. 1, the R&D personnel investment showed a downward trend in 2012 and 2013. The main reason for the brain drain is that the technological innovation of the agricultural science and technology enterprises in Beijing City is slower than in some developed areas where the agricultural science and technology enterprises have a huge demand for agricultural professional and technical personnel, and are capable of providing the research conditions and treatment for innovative talents, so the flow of talent is also an important reason for uneven distribution of professionals in agricultural science and technology enterprises.

**3.4 Unobvious innovation subject position** Beijing's agricultural science and technology enterprises have weak awareness of innovation, and the innovation subject position is not prominent. Through analysis, it is found that most agricultural science and technology enterprises do not attach importance to technological innovation, and innovation activities lack organizational security as well as market-oriented innovation system. According to previous analysis, the five-year average proportion of agricultural science and technology enterprises having independent R&D institutions is 11%, there are no formal organizations for enterprises' technological innovation activities, and the performance of innovation activities is difficult to guarantee. Since 2012, the agricultural science and technology enterprises have significantly decreased, but the number of R&D institutions remains unchanged, and the enterprises with stable R&D institutions have strong market competitiveness. Thus, as important subject of agricultural technological innovation, the agricultural science and technology enterprises should pay attention to the creation of innovative institutions.

**3.5 Large gap in innovation investment and innovations of agricultural science and technology enterprises** The technological innovation level of the agricultural science and technology enterprises in Beijing City is far lower than in some provinces with developed technological innovation such as Zhejiang, Jiangsu and Guangdong. The Second National R&D Resource Inventory Data in 2010 show that in terms of R&D funding, R&D personnel investment, research institutions, number of patent applications and number of valid patent of invention, the agricultural science and technology enterprises in Beijing City lags far behind the agricultural science and technology enterprises in Jiangsu, Zhejiang, Guangdong and other provinces. The regional advantages, technological advantages and human resource advantages of Beijing as the capital are not well reflected and applied, the technological innovation investment and performance of agricultural science and technology enterprises needs to be further improved, and enterprises' technological innovation management needs to be strengthened.

## 4 Recommendations

### 4.1 Developing the enterprises' technological innovation strategy

Technological innovation strategy is the major plan on enterprise's technological innovation activities, and the fundamental guiding ideology for building technological innovation system, throughout the whole process of technological innovation, which determines the investment direction and strength of innovative elements. Therefore, when the agricultural science and technology enterprises conduct technological innovation activities, it is necessary to make a comprehensive analysis of enterprise's internal and external environment and conditions according to the business development goals and direction, develop long-term innovative strategic plan<sup>[8]</sup>, integrate various innovation resources, and select the appropriate mode of technological innovation.

### 4.2 Increasing R&D expenditure and establishing diversified funding system

Capital is the most basic element of investment for agricultural science and technology enterprises to carry out technological innovation. In general, R&D funding input is proportional to total sales of enterprises. Therefore, it is necessary to accelerate the development of agricultural science and technology enterprises, and make business sales continue to increase, to help stably increase enterprises' R&D expenditure. At the same time, there is a need to build a business-investment-based and government-investment-oriented diversified funding system supported by financial loans, venture capital and foreign investment<sup>[9]</sup>, so as to provide funding for enterprises' technological innovation.

### 4.3 Improving the training mechanism for agricultural technological innovation professionals

The agricultural science and technology enterprises should speed up the training of agricultural science and technology professionals with innovative spirit and capacity, establish and improve the mechanism of incentives for the innovative talents to come to the fore. The agricultural science and technology enterprises should also take full advantage of Beijing's scientific and technological talents, and establish partnership with Beijing's universities and research institutes, in order to seek the advanced agricultural science and technology innovative talents needed for enterprise's technological innovation activities, and help to absorb technological innovation talents for agricultural science and technology enterprises and carry out technological innovation activities<sup>[10]</sup>.

### 4.4 Improving the level of innovation performance management

The agricultural science and technology enterprises should strengthen technological innovation performance management, strive to improve the efficiency of innovation activities, give full play to the role of market in the allocation of resources, put market mechanisms into enterprise's technological innovation activities, and improve the conversion rate of innovations. It is necessary to accelerate the conversion of patents and proprietary technology while increasing the number of patents and proprietary technology; successfully develop and apply innovative products, and expand production scale; improve market share of innovative products, and enhance the market competitiveness of agricultural science

and technology enterprises.

**4.5 Establishing and improving enterprise's culture of innovation and creative spirit** The agricultural science and technology enterprises should pay attention to innovation culture and creative spirit. Innovation culture refers to the cultural practice results precipitated in the innovation process, including the transition or upgrade in ideas, understanding methods, values, behavior and system mode. Enterprises provide many opportunities to learn innovation culture to stimulate the innovation spirit and beliefs of employees and form a good atmosphere of innovation culture within the enterprise. This will not only help to improve staff quality, create a favorable cultural environment for enterprises to carry out technological innovation, and greatly enhance the technological innovation capacity.

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