Analysis of the Coupling Coordination Effect of Agricultural Innovation and Agricultural Economic Development in Heilongjiang Province Under the SPSS Method

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Abstract: According to the data on agricultural innovation and agricultural economic development of 12 prefecture-level cities in Heilongjiang Province, SPSS software was used to conduct coupled and coordinated analysis of the two based on computer systems. The research results showed that the associated coordinated development level of agricultural innovation and agricultural economic development in Heilongjiang Province was low, which was related to the government's insufficient investment in agriculture and its creation, so it put forward basic suggestions for increasing agricultural investment and improving the innovation ability of talents.

1 INTRODUCTION

Since the Eighteenth National Congress of the Communist Party of China, with the popularity of the Internet, the coverage of big data, the "three rural areas" issue has attracted much attention. Promoting the modernization and development of rural agriculture is a critical way to ensure the stable development of the agricultural economy. Agricultural land in Heilongjiang Province is included in the scope of national black land protection, based on revitalizing rural revitalization and revitalizing old industrial bases in Northeast China. Heilongjiang Province's rational and scientific layout proposed to vigorously develop the agricultural economy based on ensuring agricultural innovation, optimizing the supply-side structure, using incentive policies to retain enterprises and talents, and using modern technology to provide guarantees for the development of the farm economy to achieve a highly coordinated result of agricultural economic development and agricultural innovation. After long-term ongoing efforts, the total agricultural capacity of Heilongjiang Province has been significantly improved, so it is necessary to increase support for agricultural innovation and consolidate the strategic position of the rural economy. As an important force in developing rural economy, the study of the coupling and coordination relationship between the two is of great practical significance to developing the agricultural economy in Heilongjiang Province.

According to previous scholars' research, most scholars only pay attention to one aspect of agricultural economic development and innovation. Few scholars combine the two elements to analyze the coupling and coordination effect. Therefore, based on the research on the former, this paper integrates the data on agricultural economic development and agricultural innovation of 12 prefecture-level cities in Heilongjiang Province. The coupling coordination degree model calculates the coupling coordination between the two, analyzes the relationship between the two, and on this basis, puts forward suggestions for the integration and development of the two.

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2 THE COUPLING AND COORDINATION EFFECT OF AGRICULTURAL ECONOMIC DEVELOPMENT AND AGRICULTURAL INNOVATION

The Eighteenth National Congress of the Communist Party of China proposed to implement the strategy of innovation-driven economic development and promote the scientific development of the economy and society. During the "13th Five-Year Plan" period, innovation was taken as the first of the five major development concepts of "innovation, coordination, green, openness and sharing", and it was proposed to put innovation at the core of the overall development of the country (Ge, Han, Wu 2020).

The agricultural economy is an essential part of social and economic development, and the degree of pastoral innovation determines the quality and efficiency of agricultural economic development. The story of the farm economy is related to land resources, land use efficiency, and how to improve land use efficiency in the case of limited land resources has become the key to agricultural economic development. Therefore, Heilongjiang Province needs agricultural innovation to improve land use efficiency and develop a farming economy based on low-carbon environmental protection.

At the same time, developing the agricultural economy can effectively promote the progress of rural innovation and lay the foundation for introducing agricultural scientific and technological talents and financial support in Heilongjiang Province. From a practical point of view, local governments at all levels in Heilongjiang Province have actively implemented the national rural revitalization strategy, increased investment in agricultural innovation, and maintained the sustained growth of the rural economy. Governments at all levels have formulated related policies to promote the implementation of rural strategies, such as the "14th Five-Year Plan for National Economic and Social Development of Heilongjiang Province and the Outline of Long-term Goals for 2035" adopted by the Fifth Session of the 13th National People's Congress of Heilongjiang Province, which put forward the policy requirement of "taking the lead in realizing agricultural and rural modernization."

To sum up, the high-quality agricultural development system and the agricultural scientific and technological innovation capacity system produce synergistic amplification effects through interaction and linkage: The agricultural high-quality development system provides high-quality development conditions and growth platforms for the agricultural scientific and technological innovation ability, and the agricultural scientific and technological innovation ability is the core driving force for the high-quality development of agriculture (Liu, Guo, Ma 2021).Therefore, we must correctly understand and grasp the mutually beneficial and win-win coupled and coordinated relationship between agricultural economic development and agricultural innovation and continuously improve agricultural economic benefits and innovation.

3 DATA SOURCES, RESEARCH METHODS AND MODEL CONSTRUCTION

3.1 Page Setup

In this paper, the relevant data on agricultural economic development and agricultural innovation level of 12 prefecture-level cities in the province (data from Heilongjiang Statistical Yearbook 2020, China Regional Statistical Yearbook 2020, and China Urban Statistical Yearbook 2020) are selected, and SPSS software is used to analyze the coupling, coordination, and coupling coordination effect between the two.

3.2 Index System Construction

Based on the current situation of agricultural economic development and agricultural innovation development in Heilongjiang, this paper selects 11 secondary indicators to build an indicator system as follows:

Table 1: Evaluation index system of agricultural economic development and agricultural innovation in heilongjiang province.

Coupling system	Primary index	Secondary index
Agricultural economic development	Agricultural economic scale	Gross agricultural production
		Proportion of agriculture in GDP
		Per capita disposable income in rural areas
	Agricultural output	Grain output
	Agricultural development guarantees	Rural electricity consumption
		Number of agricultural industrial activities
Agricultural innovation	Agricultural funds	Agricultural financial expenditure
		Regional financial expenditure
	Agricultural personnel	Agricultural service personnel
	Agricultural innovation achievements	Total power of agricultural machinery
	Agricultural land resources	Grain sown area

3.3 Determine Indicator Weight

First, optimize the data of secondary indicators to homogenize heterogeneous indicators: ($0 \leq i \leq a, 0 \leq j \leq b$)

$$U_{ij}' = \frac{U_{ij} - minU_{ij}}{maxU_{ij} - minU_{ij}}$$

$$U_{ij}' = \frac{maxU_{ij} - U_{ij}}{maxU_{ij} - minU_{ij}}$$

U_{ij}: Index j of the ith year

Secondly, calculate the proportion P_{ij} of index j in different years:

$$P_{ij} = \frac{U_{ij}}{\sum_{i=1}^{a} U_{ij}} (i = 1, 2\ldots a; j = 1,2\ldots b)$$

Finally, calculate the entropy e_j of index j:

$$e_j = -\frac{1}{k}\sum_{i=1}^{a} p_{ij} \ln （p_{ij}）$$

$$g_j = 1 - e_j$$

$$W_j = \frac{g_j}{\sum_{j=1}^{b} g_j}$$

$$S_\lambda = \sum_{j=1}^{b} W_j \cdot U_{ij}$$

After the above calculation, the index weight results are as follows:

Table 2: Index weight.

Third level indicator	weight
Gross agricultural production	0.166
Proportion of agriculture in GDP	0.110
Per capita disposable income in rural areas	0.134
Grain output	0.171
Rural electricity consumption	0.217
Number of agricultural industrial activities	0.202
Agricultural financial expenditure	0.164
Regional financial expenditure	0.345
Agricultural service personnel	0.193
Total power of agricultural machinery	0.165
Grain sown area	0.133

3.4 Research Methods

3.4.1 Development Level Index

In this paper, the data of 12 prefecture-level cities are processed by the extreme difference method. Then the data is calculated by the entropy method by SPSS software, and the development level index is finally obtained.

3.4.2 Development Level Index

Coupling refers to the degree of dependence between agricultural innovation and economic development, and coordination refers to the degree of integration between the two. This paper uses SPSS software to build the model as follows:

$$D = \sqrt{C \cdot T}$$

$$C = \sqrt{\left(U_1 \cdot U_2\right) \Big/ \left(U_1 + U_2\right)^2}$$

$$T = a \cdot U_1 + b \cdot U_2$$

U_1 : The level of agricultural economic development

U_2 : The level of agricultural innovation and development

D: The degree of coupling coordination between the level of agricultural economic development and the level of agrarian innovation development

C: The coupling degree between the level of agricultural economic development and the level of agrarian innovation development

T: Harmonized index of the level of agricultural economic development and the level of agricultural innovation development

a: 0.5 (the two work equally)

b: 0.5 (the two work equally)

3.4.3 Grades and Classification Criteria for Coupled Coordinated Development

This paper divides the coupling coordination level based on the former study.

Table 3: Classification standard of coupling coordination degree.

Compatibility	Coordination level
$0 \leq D \leq 0.3$	Low coupling coordination
$0.3 < D \leq 0.5$	Moderate coupling coordination
$0.5 < D \leq 0.8$	High coupling coordination
$0.8 < D \leq 1$	Extreme coupling coordination

4 ANALYSIS OF THE COUPLING AND COORDINATION EFFECT OF AGRICULTURAL ECONOMIC DEVELOPMENT AND AGRICULTURAL INNOVATION IN HEILONGJIANG PROVINCE

The coupling and coordination analysis of agricultural economic development and agricultural innovation development level in Heilongjiang Province in 2019 was conducted with SPSS software, and Table 4 was obtained.

Table 4 shows that, from the perspective of coupling degree, the average coupling degree of 12 prefecture-level cities in Heilongjiang Province is 0.716, which is a medium-high state. Among them, the coupling degree of 5 cities, such as Qiqihar, is higher than 0.9, which is a high-level state; the coupling degree of 5 cities, such as Daqing, is higher than 0.5, which is a running in the state; the coupling degree of 2 cities such as Hegang is lower than 0.5, which is nonrunning in the state; From the perspective of coordination degree, the average coordination degree of 12 prefecture-level cities in Heilongjiang Province is 0.488, which is a medium-high coordination state. Among them, only one city in Harbin has a coordination degree of more than 0.9, a very high coordination state. The coordination degree of four cities, including Suihua, is 0.5-0.8, which is a high coordination state. The coordination degree of four cities, including Daqing, is 0.3-0.5, which is a medium coordination state. The coordination degree of three cities, including Hegang, is 0-0.3, a low coordination state. The above data shows that the coupling degree between agricultural economic development and agricultural innovation in Heilongjiang Province is at a medium-high level, indicating that they are interdependent and mutually beneficial; that is, agricultural economic development depends on the level of agricultural innovation, and agricultural innovation also needs the support of agricultural economic development; However, the coordination degree between the two is at a low level, which indicates that Heilongjiang Province generally has a low investment in agricultural innovation and less support for agricultural economic development, leading to a low level of coordinated development of the two. This requires the government to increase the introduction of high-quality talents and innovation investment to ensure the two highly coupled and coordinated development.

Table 4: Coupling degree and coupling coordination degree in Heilongjiang Province.

Urban	Coupling condition		Coordinated development		coordinated level
	C	ranking	D	ranking	
Qiqihar	0.998	1	0.771	3	Extreme coupling coordination
Harbin	0.994	2	0.948	1	High coupling coordination
Suihua	0.979	3	0.799	2	Moderate coupling coordination
Jiamusi	0.907	4	0.676	4	Low coupling coordination
Heihe	0.904	5	0.534	5	Moderate coupling coordination
Daqing	0.773	6	0.484	6	Moderate coupling coordination
Mudanjiang	0.755	7	0.437	7	Low coupling coordination
Shuangyashan	0.596	8	0.368	9	High coupling coordination
Jixi	0.566	9	0.390	8	Low coupling coordination
Qitaihe	0.512	10	0.110	12	Moderate coupling coordination
Hegang	0.417	11	0.210	10	High coupling coordination
Yichun	0.195	12	0.130	11	High coupling coordination
Average value	0.998	-	0.488	-	Moderate coupling coordination

5 RESEARCH CONCLUSIONS AND COUNTERMEASURES

5.1 Research Conclusions

According to the coupling degree of agricultural economic development and agricultural innovation in those mentioned above 12 prefecture-level cities in Heilongjiang Province and the level of coupled coordinated action between the two, based on computer systems, it can be seen that the level of connected coordinated development of agricultural economic development and agricultural innovation in Heilongjiang Province is low, which is related to the government's efforts to invest in agriculture and innovation.

5.2 Development Recommendations

First, increase agricultural input. Government input into agriculture affects the level of agricultural innovation. Heilongjiang Province should actively implement the national policy requirements and accelerate the completion of the transformation from the old industrial base to the agricultural base, which requires the provincial governments at all levels to increase the investment in supporting agriculture and create a good business environment through incentive policies to attract enterprises to settle in, improve the ability of agricultural innovation through agricultural economic development, and ultimately realize the modernization of agriculture.

Second, enhance the ability of talents to innovate. Agricultural scientific research talents have a favorable driving role in developing the farm economy, and the introduction of skills should be strengthened. Such as the construction of a talent incentive system, maintaining the cooperative relationship with universities and enterprises in talent training, improving the innovation, research, and practice ability of talents, providing a higher platform and broader development space for agricultural scientific and technological skills, drive agricultural economic development through agricultural innovation, and achieve the goal of highly coordinated development of the two.

REFERENCES

Ge Pengfei, Han Yongnan, Wu Xiaoxu. Measurement and Evaluation of the Coupling and Coordination of China's

Innovation and Economic Development [J]. Research on Quantitative Economy and Technology Economy, 2020,37 (10): 101-117. DOI: 10.13653/j.cnki.jqte.2020.10.006

Liu Chang, Guo Yidi, Ma Guowei. The level of coordinated development of high-quality agricultural development and agricultural scientific and technological innovation in Heilongjiang Province [J]. Science and Technology Management Research, 2021,41 (14): 81-88

Pang Jinbo, Tian Xinhui. Research on the Coordinated Development of Agricultural Economy in Heilongjiang Province [J]. Heilongjiang Animal Husbandry Medicine, 2015 (04): 7-9. DOI: 10.13881/j.cnki.hljxmsy.2015.0240

Su Weizhen. Comparative Analysis of Agricultural Economic Development Level in Heilongjiang Province [J]. China Collective Economy, 2012 (24): 16-17

Yu Zhigang, Huang Feng, Li Cuixia. Analysis of the Supply and Demand of Agricultural Economic Management Talents in Heilongjiang Province under the New Situation [J]. Higher Agricultural Education, 2014 (03): 63-66. DOI: 10.13839/j.cnki.hae.2014.03.011

Zhang Qingfang. Analysis on the Current Situation of Agricultural Economic Development in Heilongjiang Province [J]. Food Science and Technology and Economy, 2018, 43 (04): 101-105. DOI: 10.16465/j.gste.cn431252ts.20180424