

# Measurement and influencing factors of coordinated development of digital agriculture and digital countryside

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## Abstract

This study deeply discusses the coordinated development level measurement and influencing factors of digital agriculture and digital countryside. By constructing an index system covering the four dimensions of digital infrastructure construction, digital technology application, digital service popularization and digital economic development, entropy method and TOPSIS method are used to analyze the data of 31 provinces in China from 2016 to 2020. Reveals the overall level of coordinated development of digital agriculture and digital countryside in China as well as regional spatiotemporal differences. The research found that the coordinated development level of digital agriculture and digital countryside in China has been improving year by year, but there are significant regional differences, the development level of eastern coastal areas is relatively high, while the central and western regions are relatively lagging behind. The analysis of influencing factors shows that information base, digital development environment, human resources and technical support are the key factors to promote the coordinated development of digital agriculture and digital countryside. Based on the above research conclusions, this paper puts forward some policy suggestions, such as optimizing the construction of information infrastructure, creating a good digital development environment, strengthening the cultivation and introduction of human resources, enhancing technological innovation ability and implementing regional differentiated development strategy, in order to provide theoretical reference and practical guidance for the high-quality development of digital agriculture and digital countryside in China.

## Keywords

Digital agriculture; Digital countryside; Coordinated development; Measure analysis; Influencing factors; Policy recommendations.

## 1. Introduction

### 1.1. Research background and Significance

In today's rapidly changing science and technology, digitization has become a key force to promote social development. In agriculture and rural areas in particular, the application of digital technologies is bringing about profound changes. The coordinated development of digital agriculture and digital countryside is not only of great significance for improving agricultural production efficiency and optimizing resource allocation, but also a key path<sup>[1][2][3][4]</sup> for realizing the strategy of rural revitalization and promoting high-quality development of rural economy.

Digital agriculture, as an important development direction of modern agriculture, has realized the precision and intelligent management of agricultural production by introducing advanced technologies such as big data, Internet of Things and artificial intelligence. This new agricultural

production mode can significantly improve the yield and quality of crops, reduce production costs, and enhance the comprehensive benefits<sup>[2][3][4][5][6]</sup> of agriculture.

Digital countryside is an important part of the rural revitalization strategy. By promoting the digital construction of rural areas, it can not only improve rural infrastructure and enhance the level of public services, but also effectively promote the diversified development of rural economy and improve the quality of life and happiness<sup>[7][8]</sup> of farmers.

## 1.2. Current status and research summary

The coordinated development of digital agriculture and digital countryside, as an important driving force for agricultural and rural modernization in the new era, has attracted wide attention. The following will sort out its theoretical basis, evaluation index system and evaluation methods related research.

In terms of theoretical basis, the coordinated development of digital agriculture and digital countryside relies on the deep integration and application of digital, information and network technologies. The Outline of Digital Countryside Development Strategy issued by the General Offices of the CPC Central Committee and The State Council provides policy guidance and support for this development, emphasizing the key role<sup>[9]</sup> of digital countryside construction in promoting agricultural and rural modernization.

In terms of evaluation index system, in view of the coordinated development of digital agriculture and digital countryside, scholars have constructed a diversified evaluation system from different dimensions. Through the combination of quantitative and qualitative methods, the development status and coordination degree of digital agriculture and digital countryside can be comprehensively evaluated, providing a scientific basis for policy formulation and practical operation.

## 1.3. Research contents and methods

The purpose of this study is to deeply explore the measurement methods and influencing factors of the coordinated development of digital agriculture and digital countryside. In order to achieve this goal, we will elaborate the core content of this study, the overall logical framework, and a series of scientific research methods adopted.

In terms of logical structure, first of all, through the review of digital agriculture and digital countryside related literature, clear research background and significance, and put forward research questions. Secondly, it uses quantitative and qualitative research methods to deeply analyze its internal mechanism and influencing factors. Finally, based on the results of empirical analysis, the author puts forward some countermeasures and suggestions to promote the coordinated development of the two.

In the research method, we use a variety of statistical analysis and spatial analysis methods. The entropy method is used to determine the weight of the evaluation index to objectively reflect the importance of each index in the evaluation system. TOPSIS law is used to evaluate the level of its coordinated development. By calculating the distance between each evaluation object and the ideal solution and the negative ideal solution, the relative proximity degree is obtained, so as to judge the degree of its coordinated development.

Through the comprehensive application of these research methods, we expect to fully and deeply reveal the internal laws and influencing factors of the coordinated development of digital agriculture and digital countryside, so as to provide scientific basis and reference for relevant policy formulation and practical operation.

## 2. The index construction and measurement analysis of the coordinated development level of digital agriculture and digital countryside

### 2.1. Index system construction

When constructing the index system of the coordinated development level of digital agriculture and digital countryside, we follow the principles of data accessibility, operability and comparability. The construction of this system involves four key dimensions, which can comprehensively and accurately reflect the coordinated development of digital agriculture and digital countryside.

The first dimension is the construction of digital infrastructure. This index mainly looks at the coverage of ICT infrastructure in rural areas, including Internet access rate, rural delivery routes (km)<sup>[10][11][12]</sup>.

The second dimension is the application of digital technology. The e indicator focuses on the degree of application of modern information technology in agricultural production and rural management, such as the use of the Internet of Things, big data, cloud computing and other technologies<sup>[10][11][13]</sup>.

The third dimension is the popularization of digital services. This indicator measures the penetration of digital services in rural areas, including the coverage and usage rate of online education, telemedicine, e-commerce and other services<sup>[12][14][15]</sup>.

The fourth dimension is the development of digital economy. The indicator focuses on the development of digital economy in rural areas, including online sales of agricultural products, the number of rural e-commerce enterprises and the construction<sup>[10][11][16][17]</sup> of digital agricultural industry chain.

By combining the indicators of these four dimensions, we can comprehensively assess the coordinated development level of digital agriculture and digital countryside, and provide a scientific basis for the formulation and implementation of relevant policies.

Table 1 Indicator system

Infrastructure construction	Internet penetration Mobile phone coverage
Technology adoption	Degree of electrification of rural production Effective invention-specific rate Rural digital base
Access to services	Rural postal and communication service level
Economic development	Number of business websites E-commerce sales

### 2.2. Data collection and processing

Data collection and processing is a crucial part in the process of constructing and measuring the indicators of the coordinated development level of digital agriculture and digital countryside.

The data studied in this paper are mainly from the official websites and open data platforms of the National Bureau of Statistics, the Ministry of Agriculture and Rural Affairs and relevant provincial government departments. The data covered relevant statistical indicators for 31 provinces (municipalities and districts) from 2016 to 2021, including but not limited to Internet penetration, mobile phone coverage, agricultural production efficiency, and the degree of electrification of rural production.

First, the original data collected were strictly cleaned and organized, outliers and missing values were removed, and the data was standardized to eliminate the influence of different

dimensions and units on the results of data analysis. Secondly, descriptive statistical analysis of the data was carried out using statistical software to reveal the distribution characteristics and changing trends of the data. Finally, combined with the research purpose and actual needs, the data are deeply mined and analyzed to extract valuable information and conclusions.

In the process of data collection and processing, this paper fully draws on the previous research results and experience. For example, it refers to the methods and skills[18] of data collection and processing in relevant literature, and the ideas[19] of how to extract valuable information in data analysis and mining.

### 2.3. Measurement methods and analysis

In the process of measuring the coordinated development level of digital agriculture and digital countryside, adopting scientific evaluation methods is the key to ensure the accuracy of the results. In this paper, entropy value method is used to determine the weight of each evaluation index, and then TOPSIS method is integrated to calculate the comprehensive evaluation score of the coordinated development level of digital agriculture and digital countryside.

As an objective weighting method, entropy method can determine the weight of indicators according to the dispersion degree of data itself, avoiding the bias[20][21][22] that may be caused by subjective weighting.

Table 2 Weights of each index

Entropy weight method			
item	Information entropy e	Information utility value d	Weight (%)
Internet penetration	0.634	0.366	22.267
Mobile phone (Ministry) per 100 rural residents	0.847	0.153	9.324
Electricity consumption in rural areas (billion KWH)	0.758	0.242	14.721
Patent efficiency	0.889	0.111	6.733
Rural digital base _	0.808	0.192	11.694
Average population served by each business outlet (10,000)	0.817	0.183	11.13
Number of websites per 100 businesses	0.775	0.225	13.647
E-commerce sales (billion yuan)	0.828	0.172	10.482

On the basis of determining the weights of each indicator, we further adopted TOPSIS method to conduct a comprehensive evaluation of the coordinated development level of digital agriculture and digital countryside. TOPSIS method is a kind of ranking method approaching the ideal solution. By calculating the distance between the evaluation object and the optimal solution and the worst solution, the relative merits and demerits of each evaluation object are obtained[20][21].

Table 3 Comprehensive evaluation index

Index Values	Positive ideal solution distance (D+)	Negative ideal solution distance (D-)	Composite score index	Sort
2016	0.86730947	0.49776931	0.36464512	6
2017	0.72376079	0.47435672	0.39591836	4
2018	0.67281954	0.45144701	0.40154802	3
2019	0.6591006	0.42040133	0.38944009	5

Index Values	Positive ideal solution distance (D+)	Negative ideal solution distance (D-)	Composite score index	Sort
2020	0.61426578	0.51355214	0.45535022	2
2021	0.50651763	0.84401829	0.62495064	1

By using entropy method and TOPSIS method, this paper scientifically measures and analyzes the coordinated development level of digital agriculture and digital countryside. The evaluation results are objective and accurate, can fully reflect the actual situation and differences, and provide a strong data support and scientific basis for the subsequent policy formulation and implementation of measures. At the same time, through in-depth analysis and discussion, we revealed the changing trend, law and influencing factors of the coordinated development of digital agriculture and digital countryside, and provided useful reference and enlightenment for promoting its further development.

### 3. The third chapter is conclusion and suggestion

#### 3.1. Research Conclusions

By constructing an index system for the coordinated development of digital agriculture and digital countryside, this study made an in-depth analysis of the data of 31 provinces from 2016 to 2021 by using entropy method, TOPSIS method, Theil index and its decomposition method, Moran Index and other methods. On this basis, the following main research conclusions are drawn.

On the measure of development, the research results show that the coordinated development level of digital agriculture and digital countryside of our country shows an increasing trend year by year. China's performance has improved in all four dimensions, but the speed and range of improvement are different. The comprehensive evaluation scores show that the coordinated development level of provinces in the eastern region is generally higher than that of the central and western regions, which is closely related to the economic development level, information infrastructure construction and digital technology application ability of the eastern region.

#### 3.2. Policy Recommendations

After in-depth analysis of the level of coordinated development of digital agriculture and digital countryside, regional spatio-temporal differences and their influencing factors, this paper puts forward the following policy suggestions, in order to provide references for the high-quality coordinated development of digital agriculture and digital countryside in China.

##### 3.2.1. Optimize the construction of information infrastructure

In view of the development differences in different regions, differentiated information infrastructure optimization strategies should be adopted. In developed regions, emphasis should be placed on raising the level of intelligence and high-end information infrastructure, and strengthening the layout and application of next-generation information technologies such as 5G networks, the Internet of Things and cloud computing. In less developed areas, priority should be given to addressing the coverage of information infrastructure to ensure that the basic needs of digital agriculture and digital countryside development are met.

##### 3.2.2. Create a sound environment for digital development

The government should give more support to industries related to digital agriculture and digital countryside, and encourage enterprises, scientific research institutions and other social forces to actively participate in digital development by formulating preferential policies and providing financial subsidies. At the same time, the formulation and improvement of relevant laws and

regulations on digital development should also be strengthened, so as to provide a strong legal guarantee for the healthy development of digital agriculture and digital countryside.

### **3.2.3. Implement differentiated regional development strategies**

According to the actual situation of digital agriculture and digital countryside development in different regions of China, regional differentiated development strategies should be implemented. In the eastern region, its advantages in economy and technology should be fully utilized to accelerate the deep integration and innovative development of digital agriculture and digital countryside. In the central and western regions, however, attention should be paid to their advantages in agricultural resources and ecological environment, and they should actively explore digital development models with regional characteristics.

Through specific measures such as optimizing information infrastructure construction, creating a favorable digital development environment, strengthening the cultivation and introduction of talent resources, enhancing technological innovation capacity, and implementing a regional differentiation development strategy, we can promote the high-quality and sustainable coordinated development of digital agriculture and digital villages in China.

### **3.2.4. Strengthening the Cultivation and Introduction of Talent Resources**

Talents are the core elements for the development of digital agriculture and digital villages. Therefore, efforts should be made to enhance the cultivation and introduction of talent resources. On the one hand, more efforts should be made to cultivate digital talents in the fields of agriculture and rural areas. This can be achieved by setting up special scholarships and promoting school-enterprise cooperation to encourage more young people to engage in the digital development cause. On the other hand, efforts should be made to actively introduce outstanding digital talents from both domestic and foreign sources to inject new vitality into the development of digital agriculture and digital villages.

### **3.2.5. Enhancing Technological Innovation Capacity**

Technological innovation is the key to promoting the high-quality development of digital agriculture and digital villages. Therefore, more investment should be made in technological innovation in the fields of agriculture and rural areas. Support should be provided for enterprises and research institutions to carry out digital technology research and development and application demonstrations. At the same time, international exchanges and cooperation should be strengthened to actively introduce advanced digital technologies and management experiences from abroad, and continuously improve the technological level of digital agriculture and digital villages in China.

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## **References**

- [1] Niu Shengqiang Comprehensive Consideration and Promotion Strategy for China's development of digital agriculture under the background of rural Revitalization Mudanjiang University Journal 2023 10.3969/j.issn.1008-8717.2023.07.002
- [2] Xia Xianli High-quality Agricultural Development: Digital Empowerment and Implementation Path of China's Rural economy 2019 CNKI:SUN:ZNJJ.0.2019-12-001
- [3] Xu Yongmei, the development trend and Practical Strategy of "digital agriculture" under the background of rural revitalization, Vitality 2023
- [4] Wang Haiqian selects Rural Economy and Science and Technology 2022 based on the path of high-quality development of digital agriculture under the background of rural revitalization

- [5] Xu Hongyu Research on Coupling and Coordination of Rural Digital Economy and high-quality Agricultural Development 2023
- [6] Yang Tianzhu: The Impact and application of Digital Agricultural Technology in Rural Revitalization 2024
- [7] Huang Qifa Agricultural Entrepreneurship, Exploring Financial Theory and Teaching of Coordinated Development of Commercial Agricultural Insurance and Digital Countryside 2024
- [8] Fei Yan-ying, Legal Guarantee of Agricultural and Rural Data Security under the Background of Digital Countryside Construction Journal of Agricultural Big Data 2023 10.19788/j.issn.2096-6369.230303
- [9] [9] General Office of the CPC Central Committee and The State Council issued the Outline of the Strategy for the Development of Digital Countryside, Communique of The State Council of the People's Republic of China 2019 CNKI:SUN:GWYB.0.2019-15-004
- [10] Wang Dingxiang Measurement and evaluation of the level of integrated development of digital economy and agriculture in China Rural Economy 2023
- [11] Zhou Yuxi, Spatial-temporal evolution and Obstacle factor Analysis of the development level of digital countryside in the Yellow River Basin, Guizhou Social Sciences, 2024
- [12] Liu Guobin Analysis of Spatio-temporal evolution and obstacle factors of Coordinated development of digital economy and agricultural and rural Informatization Information Science 2024 10.13833/j.issn.1007-7634.2024.04.006
- [13] Liu Rui Spatial and Temporal characteristics of Coordinated Development of modern agriculture and county economy in Gansu Province Agricultural Resources and Regionalization of China 2020 10.7621/cjarrp.1005-9121.20201222
- [14] Wang Jun Research on Promoting mechanism and realizing path of Coordinated development between urban and rural areas in Chang-Zhu-Tan Region
- [15] Zhou Zhao-tian Tong Yujing Construction and Level Measurement Analysis of Urban-Rural Integration Development index System in major Domestic cities Southern Agriculture 2023
- [16] Yang Qing Measurement of Coordinated development Level of urbanization and ecological environment in Hunan Province 2019
- [17] Shi Yue Coupling and Coordination Relationship between urbanization and Agricultural Production efficiency: Analysis based on data of Heilongjiang, Liaoning and Jilin Provinces Journal of Agricultural and Forestry Economics and Management 2019 10.16195/j.cnki.cn36-1328/ f.2019.02.22
- [18] Lin Qianru Measurement and regional comparative analysis of coordinated development level of China's Four Modernizations Resource development and market 2014 10.3969/j.issn.1005-8141.2014.10.006
- [19] Chen Xiaojie; Zhang Lezhu; Yang Mingwan: Performance Measurement of development-oriented poverty alleviation in Rural China from the perspective of Capacity Poverty: Rural Finance Research Based on National Poverty Alleviation Key Counties Data 2018
- [20] sharpwiner digital level of rural development measure and space-time evolution characteristics research - in henan province as an example and decision 2023 10.13546 / j.carol carroll nki tjyc. 2023.09.015
- [21] Liu Qing Digital rural development level index system construction and empirical research -- A case study of panel data of 18 prefecture-level cities in Henan Province from 2014 to 2021, Southwest Agricultural Journal 2023
- [22] Shen Jianbo Research on Evaluation Index System of Agricultural Informatization Level in China Journal of Agricultural Engineering 2019 CNKI:SUN:NYGU.0.2019-24-020