Advances in Social Science, Education and Humanities Research, volume 516
Proceedings of the 2020 3rd International Seminar on Education Research and Social Science (ISERSS 2020)

Research on Development Level of Agricultural Modernization in Yangtze River Economic Belt

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ABSTRACT
The transformation from traditional agriculture to modern agriculture is an inevitable trend in the development of national modernization. The increase in production efficiency brought about by agricultural modernization has provided a solid material foundation and life guarantee for our country. The purpose of this paper is to study the level of agricultural modernization, discover its influencing factors, and propose suggestions to promote the development of agricultural modernization. This paper takes 11 provinces (cities) in the Yangtze River Economic Belt as the research object, constructs agricultural modernization evaluation indicators to study the development of agricultural modernization, and uses SPSS17.0 software to perform factor analysis. It is concluded that the development level of agricultural modernization in the Yangtze River Economic Belt is significantly different. Hunan and Anhui have higher levels of modernization; comprehensive agricultural production conditions have a greater impact on agricultural modernization. Accordingly, it is proposed to promote agricultural modernization in accordance with local conditions, increase investment in science and technology, and cultivate agricultural talents.
Keywords*: Yangtze River Economic Belt, development level of agricultural modernization, factor analysis, suggestions*

1. INTRODUCTION

Agriculture is the foundation of the national economy and the cornerstone of national development. Rural revitalization is a decisive strategy for building a moderately prosperous society in an all-round way and building a modern socialist country in an all-round way. It is the overall starting point for doing the "agriculture, rural areas and farmers" work in the new era. Agricultural and rural modernization is both a process of implementing rural revitalization and a way to achieve rural revitalization. It is particularly important for accelerating the process of urbanization and promoting the development of urban-rural integration. Agricultural modernization refers to the use of modern science and technology, modern industry and scientific management methods to transform traditional agriculture into modern agriculture, to realize the coordinated development of agricultural mechanization, scientization, water conservancy, and electrification, and ultimately achieve the goal of high efficiency, high quality, low consumption, and environmental protection. Agricultural and rural modernization helps to improve the efficiency of agricultural production, transform agricultural development methods, adjust the agricultural industrial structure, and realize the sound and rapid development of agricultural economy. At the same time, it helps to improve the system and capacity of rural governance, and build a beautiful, harmonious, ecologically livable and civilized new countryside.

China's Yangtze River Basin is rich in water resources, and the coastal areas have superior agricultural production conditions. The plain areas in the middle and lower reaches also provide unique natural conditions for agricultural development. At the same time, the implementation of the Yangtze River Economic Belt strategy makes the relevant provinces closely linked in various aspects of construction, which is conducive to coordinated development and plays a certain role in promoting regional agricultural modernization. Therefore, this paper analyzes the development level of agricultural modernization in 11 provinces (cities) in the Yangtze River Economic Belt in order to draw useful conclusions.

2. LITERATURE REVIEW

The development of agricultural modernization has always been concerned by many scholars, and the scope of research is also very wide. This article combs the related literatures on the development level of agricultural modernization, and finds that scholars' research mainly focuses on the construction and evaluation of the index system.

Scholars have constructed an evaluation system based on the influencing factors of agricultural modernization, from the perspectives of agricultural input and output,

informatization, economic development level, social development level, sustainable development level, geographical factors, agricultural structure and development model, ecological environment, etc.[1-5]. It covers a wide range of contents and can comprehensively reflect the level of agricultural modernization. In terms of measurement methods, most scholars use factor analysis, cluster analysis[6-7], analytic hierarchy process, expert scoring method[8] to estimate the level of agricultural modernization. They find that China's agricultural modernization is in the transitional and leaping stage, the average level of agricultural modernization in China has not reached the level of basic realization of agricultural modernization, and the development of agricultural modernization is unbalanced and has obvious regional differences[9], and the overall distribution pattern is gradually decreasing from east to west: the western region is significantly lower than the eastern, northeastern, and central regions, and the central region's agricultural modernization is generally backward in the eastern region[10].

In previous studies, scholars have conducted studies with samples of provinces across the country as well as studies on the development of individual provinces. The Yangtze River Economic Belt spans the three major regions of China's east, middle and west, and has certain links in economics and policies. As a whole, the research can promote the coordinated development of its agriculture and promote the modernization of agriculture and rural areas in the Yangtze River Economic Belt. Through the establishment of an evaluation system, this paper comprehensively evaluates the level of agricultural modernization in the provinces of the Yangtze River Economic Belt, and proposes targeted countermeasures.

3. RESEARCH DESIGN

3.1. Index System Construction and Data Sources

3.1.1. Index system construction

Based on the research of related scholars on the development of modern agriculture and considering comprehensive factors such as the representativeness and availability of data, the following indicators were selected as table 1 shown.

The indicators include 10 secondary indicators in three aspects: economic environment, basic elements and technical elements. The total agricultural output value and the proportion of the primary industry in GDP measure the importance and status of agriculture in the province; per capita disposable income and grain production reflect the output level of agricultural activities. These four indicators are used to represent the environment for rural economic development. To some extent, the number of rural population reflects the rural labour force that can engage in agricultural activities, that is, human capital resources; the cultivated land area and the total sown area of crops reflect the amount of land used for agricultural production, that is, land resources, which are indispensable basic conditions for agricultural production. The total power of agricultural machinery, fertilizer application and plastic film application reflect the input of agricultural production technology and are called technical elements.

3.1.2. Sample selection and data sources

This paper studies the cross-sectional data of 11 provinces and cities in the Yangtze River Economic Belt in 2017. The data come from EPS China Agriculture, Countryside and Farmers Database, China Statistical Yearbook(2018), China Rural Statistical Yearbook(2018) and 2018 provincial statistical yearbooks.

3.2. Data Processing and Analysis

3.2.1. Factor analysis

The factor analysis method is a multivariate statistical method that uses the idea of dimensionality reduction and starts from the study of the dependency relationships in the correlation matrix of the original variables to attribute some variables with complex relationships to a few comprehensive factors. There are n samples, and p indicators are observed for each sample. Both the original variable and the normalized variable vector are represented by X, and F_1, F_2,...F_m (m<p) are used to represent the standardized common factors. The factor model is as follows:

$$\begin{cases} X_1=a_{11}F_1+a_{12}F_2+\ldots+a_{1m}F_m+\varepsilon_1 \\ X_2=a_{21}F_1+a_{22}F_2+\ldots+a_{2m}F_m+\varepsilon_2 \\ \ldots\ldots\ldots\ldots \\ X_p=a_{p1}F_1+a_{p2}F_2+\ldots+a_{pm}F_m+\varepsilon_p \end{cases} \quad (1)$$

The matrix form of the model is:

$$X=AF+\varepsilon \quad (2)$$

$$A=\begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1m} \\ a_{21} & a_{22} & \cdots & a_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ a_{p1} & a_{p2} & \cdots & a_{pm} \end{bmatrix}$$

3.2.2. KMO and Bartlett test

Before the empirical analysis, the sample data should be standardized. In this paper, the data of 11 provinces and cities were brought into SPSS17.0 for correlation coefficient test, and the correlation coefficient among variables were all greater than 0.3. The KMO value is 0.757 and Bartlett sphericity test shows that p value is 0, which indicates that there is a strong correlation between variables and the data is suitable for factor analysis.

Table 1 Evaluation index of modern agricultural development level

Index system construction		
Index of level 1	Index of level 2	Variable
Economic environment	Total agricultural output value (100 million yuan)	X_1
	Proportion of primary industry to GDP (%)	X_2
	Per capita disposable income of rural residents (yuan)	X_3
	Grain production (10,000 tons)	X_4
Basic elements	Rural population (10,000 people)	X_5
	Cultivated land area (10,000 hectares)	X_6
	Total sown area of crops (1,000 hectares)	X_7
Technical elements	Total power of agricultural machinery (10,000 kilowatts)	X_8
	Application Amount of Agricultural Chemical Fertilizer (10,000 tons)	X_9
	Application Amount of Agricultural Plastic Film (10,000 tons)	X_{10}

Table 2 Explanation of total variance

Index	The initial eigenvalue			Square extraction and loading			Square rotation and loading		
	Total	Variance	Accumulation	Total	Variance	Accumulation	Total	Variance	Accumulation
1	7.616	76.166%	76.166%	7.616	60.103%	76.166%	6.117	61.167%	61.167%
2	1.402	14.016%	90.183%	1.402	14.016%	90.183%	2.902	29.015%	90.183%
3	0.407	4.070%	94.253%						
4	0.229	2.291%	96.544%						
5	0.136	1.362%	97.906%						
6	0.112	1.123%	99.029%						
7	0.069	0.685%	99.714%						
8	0.016	0.161%	99.875%						
9	0.011	0.106%	99.981%						
10	0.002	0.019%	100.000%						

3.2.3. Analysis results

The data was substituted into SPSS17.0 software for factor analysis. According to the principle that the characteristic root is greater than 1, two common factors were selected, and the cumulative variance contribution rate was 90.183%, which was sufficiently representative. The common factors were subjected to the maximum orthogonal rotation of variance, and the results are shown in Table 2.

To facilitate the conclusion, the columns of the output load matrix were arranged according to the size of the load coefficient, and the variables with higher loads on the same common factor were arranged together. The output results are shown in Table 3.

It can be seen from Table 3 that the common factor F_1 has a large load on X_4, X_8, X_9, X_1, X_7, X_5, X_{10}, X_6, that is, basic elements and technical elements of agricultural production, total agricultural output value, and grain output. These indicators include human capital, land capital and technological capital investment, which are necessary conditions for modern agricultural production, so they are named comprehensive agricultural production conditions. The common factor F_2 has a large load on X_2 and X_3, namely the proportion of primary production and the per capita disposable income. These two indicators measure the level of agricultural economic development, and F_2 is named the agricultural economic development condition.

Table 3 Rotation matrix

Index	1	2
X_4	0.944	0.211
X_8	0.912	0.201
X_9	0.909	0.219
X_1	0.902	0.210
X_7	0.845	0.509
X_5	0.845	0.417
X_{10}	0.839	0.259
X_6	0.722	0.639
X_2	0.219	0.962
X_3	-0.231	-0.944

3.2.4. Factor scores

In order to study the scores of the common factors of the provinces in the Yangtze River Economic Belt and to compare the scores of the provinces, the factor scores of the data were analyzed. The output is shown in Table 4.

Table 4 Components scoring coefficient matrix.

Index	1	2
X_1	0.193	-0.104
X_2	-0.180	0.497
X_3	0.172	-0.483
X_4	0.204	-0.114
X_5	0.126	0.028
X_6	0.037	0.186
X_7	0.103	0.081
X_8	0.198	-0.112
X_9	0.193	-0.101
X_{10}	0.164	-0.061

From the coefficients in Table 4, the expression of the common factor represented by the original variable is obtained as follows:

$$\begin{cases} F_1=0.193X_1-0.180X_2+\cdots+0.164X_{10} \\ F_2=-0.104X_1+0.497X_2+\cdots-0.061X_{10} \end{cases} \quad (3)$$

Finally, factor score was calculated, and the proportion of variance contribution rate of each factor in the total variance contribution rate of the two factors was used as the weight to make weighted summary, and the comprehensive score F of each province was obtained, that is:

$$F=(61.167\times F_1+29.015\times F_2)/90.183 \quad (4)$$

Table 5 Province factor score and comprehensive score

Provinces(cities)	F_1	F_2	F
Shanghai	4948.10	-13456.38	-973.31
Jiangsu	6910.89	-9873.31	1510.75
Zhejiang	5616.25	-12294.44	-146.30
Anhui	5952.34	-6638.83	1901.25
Jiangxi	4340.36	-6489.53	855.96
Hubei	5563.60	-6993.22	1523.57
Hunan	6042.24	-6825.09	1902.30
Chongqing	3419.94	-6173.77	333.27
Sichuan	6039.60	-6221.57	2094.69
Guizhou	3451.83	-4280.94	963.89
Yunnan	4271.39	-4870.73	1330.01

As shown in Table 5, the provinces with the highest scores on the common factor agricultural comprehensive production conditions (F_1) are Jiangsu, Hunan, Sichuan and Anhui. Jiangsu is one of China's major grain producing areas. In 2017, the grain output ranked first among the provinces in Yangtze River Economic Belt. The Southern Song Dynasty has a proverb of "When the grain in Suzhou and Changzhou is mature, it is enough to feed the whole nation", which shows the significance of Jiangsu province's agricultural output in ensuring China's grain supply. Hunan is a large agricultural province. Dongting Lake plain has good terrain conditions and is an important commodity grain producing area in China. Therefore, it scores higher in comprehensive agricultural production conditions. Sichuan is the province with the highest total agricultural output value and the largest cultivated land area in the Yangtze River Economic Belt. Sichuan Basin has sufficient water resources and fertile soil and has inherent advantages in developing agriculture. It is known as the "Land of Abundance" and has good comprehensive agricultural production conditions. Anhui province has the largest absolute values on the total power of agricultural machinery (X_8) and the amount of chemical fertilizer applied (X_9), and these two variables have a greater impact on F_1, so Anhui scores higher on the comprehensive agricultural production conditions.

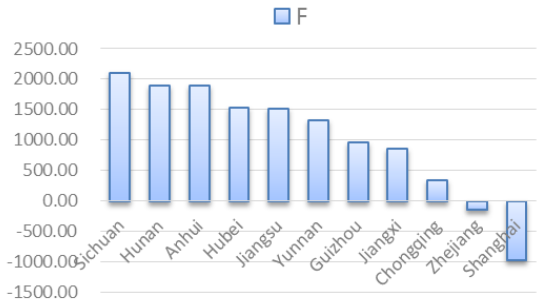

Figure 1. Comprehensive score of each province

The scores of the provinces in the Yangtze River Economic Belt in terms of agricultural economic development (F_2) are all negative, which is caused by the fact that most of the variable coefficients are negative in Table 5. F_2 is mainly affected by X_2 (proportion of primary industry in GDP) and X_3 (the disposable income of rural residents). The unit of X_2 is a percentage and the absolute number is small, which has little effect on the score of F_2. The X_3 coefficient is negative, the absolute value of disposable income is large and the difference between provinces is obvious, which has a greater impact on the F_2 score. From this, Shanghai, Zhejiang and Jiangsu, which scored the lowest on F_2, have higher levels of agricultural economic development. Shanghai has strong economic strength, small geographical area, limited agricultural land and less agricultural investment. Therefore, the comprehensive agricultural production conditions are general, while the agricultural economic development conditions are good.

As shown in figure 1, Sichuan, Hunan, and Anhui rank the top in comprehensive score and the last are Shanghai and Zhejiang. In the comprehensive score, F_1 has a higher weight than F_2, so F_1 has a greater impact on the comprehensive score. Therefore, Sichuan, Hunan, and Anhui provinces have the highest comprehensive scores, which are more consistent with F_1 rankings. As Shanghai and Zhejiang ranked last in F_2 and were negative, their overall rankings were greatly affected. From the perspective of comprehensive scores, the level of agricultural development of the provinces and cities in the Yangtze River Economic Belt is quite different, and the regional trend is not obvious. The agricultural provinces have a high comprehensive level, while the provinces and cities with high economic development level and small

geographical area, such as Shanghai, Zhejiang and Chongqing, have a low comprehensive score.

4. CONCLUSIONS AND SUGGESTIONS

4.1. Conclusions

1. Judging from the comprehensive factors, the weight of the two common factors extracted in this paper is quite different in the comprehensive score, and the weight of the agricultural comprehensive production conditions is as much as twice that of the agricultural economic development conditions, which shows the development level of agricultural modernization is more affected by the agricultural comprehensive production conditions. Therefore, when advancing the development of agricultural modernization, it is necessary to fully consider the regional agricultural production conditions such as land capital, human capital, and technological input.
2. The higher the score of comprehensive factor F, the higher the development level of modern agriculture. Sichuan, Hunan and Anhui, as big agricultural provinces, have better comprehensive conditions for agricultural production, higher scores in F_1 and finally higher in the level of agricultural modernization. Although Shanghai and Zhejiang have greater advantages in economic development conditions, the result obtained according to F_2 calculation formula is negative, and the final comprehensive score of agricultural modernization is the lowest. The reason is that there is a certain competitive relationship between regional economic development and agricultural development, under the condition of unchanged provincial area, the increase of economic development land will reduce agricultural development land, resulting in the basic conditions of agricultural production not being met, which is not conducive to improving the level of agricultural modernization.

4.2. Suggestions

4.2.1. Promoting the development of modern agriculture according to local conditions

Due to the uniqueness of agricultural development among the provinces, agricultural modernization must be promoted according to their own circumstances. Sichuan, Hunan, Anhui, Hubei, Jiangsu and Jiangxi have a long history of agricultural development and good agricultural production conditions. They are the main grain producing areas in China. In the process of modernization development, we should maintain a certain amount of agricultural land and arable land, focus on modernization, large-scale, specialized and mechanized production, improve agricultural production efficiency and quality of agricultural products, improve the agricultural industry chain, and develop agricultural and sideline product processing industries to increase agricultural product prices.

For Shanghai and Zhejiang, which have good economic conditions but insufficient arable land, they should give full play to the role of economic advantages in the development of modern agriculture. The government and relevant departments should attach importance to input in agricultural science and technology, innovate traditional agricultural production models, and develop suburban sightseeing agriculture, leisure agriculture, characteristic agriculture, and urban agriculture. Make full use of the limited agricultural land, with the help of a perfect transportation system, sell agricultural and sideline products to cities, increase the income level of farmers, and promote the development of agricultural modernization. Chongqing has a limited geographical area, and the absolute value of agricultural basic factors and technical factors is relatively low, so the score of F1 is the lowest and the comprehensive score is also low. The agricultural development model of Chongqing can refer to Shanghai to develop suburban modern characteristic agriculture.

Yunnan and Guizhou are the two provinces with the highest proportion of primary production in GDP but the lowest disposable income of rural residents among the provinces and cities in the Yangtze River Economic Belt, which shows that agriculture accounts for a large proportion in their economic structure and the level of economic development is not high. Yunnan and Guizhou can increase their support for the development of agricultural modernization, use scientific production methods to increase agricultural output value, increase economic benefits, increase farmers' income, give full play to the role of agricultural industry in promoting economic development, and realize the development of agricultural and rural modernization.

4.2.2. Strengthening the application of modern science and technology in agriculture and cultivating high-level agricultural talents

Compared with traditional agriculture, modern agriculture pays more attention to scientific production, modern management and moderate scale management. The application of science and technology in agricultural production activities requires not only government capital investment but also high-quality human capital. Scientific production and management in modern agriculture requires technical agricultural talents to implement it, but there are only a few capable rural labourers. Therefore, it is necessary to carry out vocational training for them, strengthen their scientific and technological application ability, management ability and management level, so as to adapt to the scientific and technological development mode of modern agriculture and give full play to the value of modern agriculture.

ACKNOWLEDGMENT

Fund Projects: Projects funded by the National Social Science Fund (15BJY092)

I would like to thank my tutor, Mr. Xu, for his guidance in writing this paper. Although he is busy with his work, he carefully reviews my paper every time and puts forward detailed amendments, which is of great help to the improvement of my writing level. In addition, he also guides me a lot in paper submission, which makes my postgraduate study and life convenient.

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