

# Analysis on the Difference of Agricultural Mechanization Level in Main Grain Producing Areas

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**Abstract:** Promoting agricultural mechanization is not only the practical requirement of developing China's agricultural economy, but also the only way of China's agricultural modernization. This paper makes an empirical study on the difference of agricultural mechanization level among 13 provinces in China's main grain producing areas by using the method of principal component analysis. The results show that among the main grain producing areas, Shandong Province has the highest level of agricultural mechanization, Henan Province and Anhui Province are close behind, and Jiangxi province lags behind slightly. On this basis, from the aspects of economic development efficiency, suitable operation level of agricultural machinery and the development of agricultural machinery service system, this paper analyzes the reasons restricting the development of agricultural mechanization level in main grain producing areas, and puts forward some policies to improve the level of Agricultural Mechanization in main grain producing areas, such as consolidating the economic foundation of agricultural machinery development, strengthening the research and development of characteristic agricultural machinery and perfecting the supporting service policies of agricultural machinery.

**Keywords:** Main grain producing areas, Agricultural mechanization, Differentiation, Principal component analysis.

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## 1. Introduction and Literature Review

Food security has always been an overall strategic issue related to China's stable economic development, social stability and national independence, and agricultural mechanization is an important strategy to improve agricultural production efficiency and ensure food security. After the reform and opening up, China has continued to increase its support for agricultural mechanization. It is not only pointed out in the guiding opinions on the implementation of agricultural machinery purchase subsidy policy from 2021 to 2023 that it is necessary to promote the development of modern agricultural industrialization with the support of modern agricultural technology and high-tech agricultural equipment, but also emphasized in the opinions of the CPC Central Committee and the State Council on doing a good job in the key work of comprehensively promoting rural revitalization in 2022, We should strengthen the basic support of modern agriculture and improve the R & D and application level of agricultural machinery and equipment, which provides greater policy support for promoting the development of agricultural mechanization.

At present, experts and scholars have conducted a lot of research on the development of agricultural mechanization from many aspects. Firstly, in order to improve the level of agricultural mechanization, some scholars analyzed the key factors affecting the development of agricultural mechanization. In addition to quantifying the relationship between labor transfer and agricultural mechanization, they found that there was a positive relationship between the level of agricultural mechanization and the degree of agricultural labor transfer [1-2]. Zhang Yongli et al. Analyzed the influencing factors of agricultural mechanization level by establishing GA-BP neural network model, and concluded that the proportion of corn sowing area and the per capita net income of rural households also affected the level of agricultural mechanization [3]. Secondly, with the rapid

improvement of China's overall agricultural mechanization level, the imbalance of regional development still exists. Some experts and scholars, such as Xu Ouyang and Wang Xianhua, believe that due to the influence of terrain, farming in mountainous areas has a series of problems such as difficult access to land, difficult operation and low efficiency of agricultural machinery. The level of agricultural mechanization in mountainous areas is lower than that in plain areas, and the appropriate operation level of agricultural machinery has become a major resistance in the process of comprehensive mechanization [4-6]. In addition, Li Bo and others believe that the reasons for restraining the development of agricultural mechanization may also be the differences in ecological conditions and socio-economic development [7]. Wang Haoyu and others analyzed that the factors restricting the improvement of agricultural mechanization level in Hilly and mountainous areas of Anhui Province are insufficient adaptability of agricultural machinery, poor economic environment and imperfect construction of agricultural mechanization service system, which provides a research basis for exploring the causes of differences in agricultural mechanization [8].

The main grain producing areas are the main export areas of China's grain. Improving the level of agricultural mechanization in the main grain producing areas is of great significance to ensure China's grain security. This paper analyzes and empirically studies the differences of agricultural mechanization level among provinces in China's main grain producing areas by using the method of principal component analysis, finds out the reasons restricting the improvement of agricultural mechanization level, and puts forward corresponding measures, in order to improve the agricultural production efficiency of main grain producing areas, liberate rural productivity, accelerate rural revitalization, and provide support for the realization of comprehensive mechanization in main grain producing areas.

## 2. Empirical Analysis

Principal component analysis is a method that can transform multiple indicators into a few comprehensive indicators. The purpose is to find out the principal components with more information and reduce the problem of high correlation caused by too many variables. Therefore, this paper uses the principal component analysis method in SPSS statistical software to analyze the differences of agricultural mechanization level among 13 provinces in China's main grain producing areas, and ranks the development effects of agricultural mechanization level in each province.

### 2.1. Index Selection and Data Source

#### 2.1.1. Index Selection

Using advanced agricultural machinery to improve agricultural production and management conditions and improve the level of agricultural equipment, so as to increase grain output is the fundamental purpose of agricultural mechanization. With the continuous advancement of agricultural modernization, agricultural production equipment has been gradually improved. Relying on tractors, planters, harvesters and other equipment for agricultural production has greatly promoted the development of agricultural mechanization.

Therefore, this paper selects seven representative indicators to construct the following evaluation index system of the development level of agricultural mechanization: (1) the number of small tractors. (2) Number of large and medium-sized tractors. (3) Number of agricultural tools

equipped with large and medium-sized machines. (4) Number of agricultural water pumps. (5) Number of water-saving irrigation machinery. (6) Number of combine harvesters. (7) Number of powered threshers

#### 2.1.2. Data Sources

The article data comes from the statistical yearbook of each province and the China Rural Statistical Yearbook.

### 2.2. Empirical Test

#### 2.2.1. Validity Test

Before principal component analysis, KMO test and Bartlett spherical test should be used to judge whether each index can be analyzed by principal component analysis. The KMO value is between 0 and 1. Generally, when the KMO value is greater than 0.6, principal component analysis is supported. In Bartlett spherical test, p value less than 0.05 is also suitable for principal component analysis. The test results show that the KMO value is 0.742, greater than 0.6, and the p value in Bartlett spherical test is 0.000, which meets the premise requirements of principal component analysis. Therefore, this data can be used for principal component analysis.

#### 2.2.2. Principal Component Analysis

##### (1) Principal component selection

SPSS software is used for principal component analysis of the data, and the eigenvalues are selected according to the principle that the cumulative variance contribution is greater than 85%. The selection results of eigenvalues are shown in Table 1.

**Table 1.** Interpretation rate of eigenvalue and variance

Number	Characteristics of the root			Principal component extraction		
	Characteristics of the root	Variance interpretation rate%	Cumulative variance interpretation rate%	Characteristics of the root	Variance interpretation rate %	Cumulative variance interpretation rate%
1	4.115	58.784	58.784	4.115	58.784	58.784
2	1.651	23.581	82.365	1.651	23.581	82.365
3	0.529	7.558	89.923	-	-	-
4	0.365	5.215	95.138	-	-	-
5	0.161	2.303	97.441	-	-	-
6	0.111	1.584	99.025	-	-	-
7	0.068	0.975	100.000	-	-	-

**Table 2.** Load factor

Variable	Load factor		Degree of commonness
	M1	M2	
Miniature tractor	0.905	-0.032	0.820
Large and medium-sized tractor	0.654	-0.536	0.715
Large and medium-sized machines with farm tools	0.934	-0.208	0.916
Number of agricultural pumps	0.648	0.714	0.930
Number of water-saving irrigation machinery	0.790	0.302	0.715
Number of combine harvesters	-0.272	0.840	0.780
Number of motor threshers	0.937	0.108	0.889

It can be seen from table 1 that two principal components are extracted from the principal component analysis. The variance interpretation rates of the two principal components are 58.78% and 23.58% respectively, and the total amount of information contained has reached 82.27%, indicating that the two principal components can fully reflect the seven

indicators of the level of grain and agricultural mechanization and basically represent the information of the original data. Therefore, the first two eigenvalues are selected as the main components, and named M1 and M2 respectively.

In order to determine the reflection degree of M1 and M2 to the original index, this paper uses the principal component

factor load for identification. See Table 2 for the principal component factor load table.

Table 2 shows that in the M1 principal component, the number of motorized threshers, the number of agricultural machines and tools equipped with large and medium-sized machines, the number of small tractors and the number of water-saving irrigation machinery are larger than other indicators, indicating that these four indicators have a strong correlation with M1, and M1 can effectively reflect the information covered by these variables. In the M2 principal component, the coefficients of the number of combine harvesters, agricultural water pumps and large and medium-sized tractors are large, indicating that M2 can basically cover these two indicators. Therefore, the extracted two principal

components M1 and M2 can contain the information of all indicators.

Combined with the results in Table 1 and table 2, the comprehensive evaluation model of agricultural mechanization weighted by the information contribution rate of M1 and M2 is  $Y = 0.5878Y_1 + 0.2358Y_2$ .

### (2) Comprehensive evaluation and analysis

According to the above comprehensive evaluation model of agricultural mechanization, the agricultural mechanization level of China's main grain producing areas is evaluated, and the agricultural mechanization level of each province is ranked according to the agricultural mechanization level components and comprehensive scores of each province, as shown in Table 3 below.

**Table 3.** Principal component score and comprehensive score of agricultural mechanization level

Region	Component scores		Composite scores	Comprehensive ranking
	M1 component score	M2 component score		
Liaoning	-0.26	-0.65	-0.54	10
Hebei	-0.38	0.23	0.06	4
Shandong	0.89	2.09	1.75	1
Jilin	-0.91	-0.46	-0.59	11
Inner Mongolia	-1.11	-0.50	-0.68	12
Jiangxi	-0.08	-0.95	-0.70	13
Hunan	1.70	-0.64	0.03	5
Sichuan	1.70	-1.29	-0.44	9
Henan	0.28	1.66	1.27	2
Hubei	0.14	-0.31	-0.19	6
Jiangsu	-0.59	-0.29	-0.37	8
Anhui	0.25	0.81	0.65	3
Heilongjiang	-1.63	0.32	-0.24	7

The results in Table 3 show that the top three provinces in the comprehensive score of Agricultural Mechanization in the main grain producing areas are Shandong Province, Henan Province and Anhui Province, and the level of agricultural mechanization ranks among the top three provinces in the main grain producing areas. According to the level of agricultural mechanization, the other provinces are Hebei Province, Hunan Province, Hubei Province, Heilongjiang Province, Jiangsu Province, Sichuan Province, Liaoning Province, Jilin Province and Inner Mongolia Province from high to low. The comprehensive score of Jiangxi Province is only -0.70, indicating that the level of agricultural mechanization is the lowest.

## 2.3. Result Analysis

On the whole, there is little difference in the score ranking among the provinces, mainly because the main grain producing areas are the main source of China's grain. In 2019, the grain output of China's main grain producing areas reached 489.0126 million tons, accounting for 73.66% of the country's total grain output. The agriculture of each province is more developed than that of other provinces, and the demand for agricultural mechanization is higher. Therefore, the gap of Agricultural Mechanization in these provinces is mainly reflected in the unbalanced level of economic development and inappropriate farming conditions of agricultural machinery.

### 2.3.1. Unbalanced Level of Economic Development

According to the scores and ranking in Table 3, Shandong Province has the strongest level of agricultural mechanization among the 13 main grain producing areas, mainly because Shandong Province is not only the city with the highest cultivated land rate, but also the main grain crop supply province of wheat, corn and sweet potato, but also the province with fairly developed secondary industry. According to preliminary accounting, the added value of the secondary industry in Shandong Province was 2861.219 billion yuan in 2020, with a growth rate of 1.06%. Heavy industrial enterprises such as Qilu Petrochemical, Shandong electric power and Chinalco Shandong Aluminum Plant in Shandong Province developed rapidly. The relatively strong industrial entity industry provided a solid economic foundation for the development of agricultural mechanization. Compared with Shandong Province, the second industry in the lower ranking provinces, such as Jilin Province and Heilongjiang Province, is slightly weak. In 2020, the added value of the second industry in Jilin Province and Heilongjiang Province was only 432.622 billion yuan and 348.351 billion yuan, which makes the promotion ability of the development of agricultural mechanization relatively weak. In addition, as a large resource-based Province, Anhui Province has large coal reserves in Huainan and Huaibei. Under the situation of coal economic decline, the economic development level of Anhui Province is also different from that of other provinces.

### **2.3.2. The Farming Conditions of Agricultural Machinery Are Not Suitable**

The operation of agricultural machinery needs good topographic conditions. According to the results in Table 3, Henan Province ranks second, which is largely related to the superior topographic conditions of Henan Province. Henan Province is located in the south of the Huang HuaiHai Plain. Not only the terrain is flat and the soil is fertile, but also the Yellow River and Huai River and their many tributaries play a great role in agricultural production in this area, which provides sufficient guarantee for agricultural irrigation in this area and makes the operation conditions of agricultural machinery suitable. In addition, the superior strip conditions make Henan Province the main output place of many crops such as wheat, corn, rice and soybean, improve the demand for agricultural machinery and promote the all-round development of agricultural mechanization. Compared with Henan Province, Jiangxi Province has a poor geographical location. Jiangxi Province is not only surrounded by mountains on three sides, but only Jiujiang River drives into the Yangtze River. Moreover, 60% of the land area of Jiangxi Province is mountainous and hilly. The topographic conditions limit the development of agricultural mechanization to a certain extent. Limited by the terrain conditions, Jiangxi Province focuses on the mountainous agricultural economy, the fruit and vegetable industry is relatively developed, there is a category demand for agricultural machinery, and the overall development level of agricultural mechanization is low.

### **2.3.3. Imperfect Agricultural Machinery Service System**

The grass-roots agricultural machinery service system in mountainous areas is not perfect, and the introduction, demonstration, promotion, training and publicity of new technologies and machinery such as the production and primary processing of characteristic agricultural products lags behind, so the expansion effect is not obvious. Farmers are limited to their own education level, which leads to the inability to understand the excellent agricultural machinery products and technology in time, or they will not use them without professional training, which restricts the improvement of the level of agricultural mechanization to a certain extent. Affected by the geographical location of Jiangxi Province, farmers are imprisoned by the sense of small-scale prosperity and small-scale farmers, which reduces the popularization and use of agricultural machinery, makes the service system of agricultural machinery imperfect, and inhibits the development level of agricultural mechanization.

## **3. Suggestions**

According to the above analysis results, this paper puts forward countermeasures and suggestions on how to improve the level of Agricultural Mechanization in the main grain producing areas from the following aspects.

### **3.1. Reflect the Advantages of Economic System and Consolidate the Foundation for the Development of Agricultural Mechanization**

Continue to maintain the development trend in the provinces with rapid economic development, so as to ensure that agricultural mechanization can have a solid economic foundation. Cities with more developed industries have certain resource advantages in the process of developing

agricultural mechanization. In provinces with weak real industries such as industry, we should change the situation under the efficiency of economic development and find leading industries suitable for the development of the province. Some resource-based provinces can vigorously develop new industries, promote the diversification of economic structure, get rid of the economic development mode of relying on expendable resources as the leading industry, and promote sustainable and green economic development. On this basis, the provincial government departments can give more subsidy funds to farmers' purchase of agricultural machinery, give priority to the new agricultural machinery that plays a great role in the cultivation of local characteristic cash crops and the development and improvement of agricultural products into the pilot of new product subsidy, and optimize the grade of subsidized machinery according to the actual situation to improve farmers' demand for agricultural machinery, Promote the steady development of agricultural mechanization.

### **3.2. Accelerate the Development of Innovative Agricultural Machinery and Improve the Adaptability of Agricultural Machinery**

On the one hand, accelerate the research and development of agricultural machinery and equipment, and increase the research on agricultural production suitable for different provinces, especially high-efficiency, intelligent and green agricultural machinery according to the needs of special cash crops and other agricultural product production and processing machinery and equipment in different provinces, Provide sufficient supply of agricultural machinery suitable for the production of different types of cash crops, and develop innovative agricultural machinery needed by farmers. On the other hand, make good use of the advantages of local science and education resources, connect with local colleges and universities, strengthen the cooperation between government, industry, University and research, constantly carry out agricultural technology innovation, establish a complete system of R & D, production, promotion and training, and form a new mode of R & D and production gradually promoted and expanded from point to surface. In addition, according to different terrain differences, combine the operation characteristics of agricultural machinery with the growth characteristics of crops, and vigorously promote the agricultural machinery suitability operation level of characteristic cash crops in the province, so that farmers can "adjust measures to local conditions" in the use of agricultural machinery.

### **3.3. Improve the Supporting Services for the Popularization of Agricultural Mechanization and Improve the Utilization Probability of Agricultural Machinery**

Limited by the level of farmers' education, farmers' understanding and ability to use agricultural machinery are relatively low, especially in the current environment of deepening the transfer of agricultural labor force, the role of agricultural labor force is mostly assumed by women and the elderly, which makes it more difficult to popularize agricultural machinery. Therefore, it is not only necessary to increase farmers' understanding of agricultural mechanization and publicity of the methods of using agricultural machinery,

but also to improve farmers' understanding of advanced agricultural machinery and promote corresponding agricultural mechanization equipment through experimental demonstration, organizing demonstration meetings and holding training courses; We should also improve the supporting services of agricultural mechanization, establish good pre-sales and after-sales services, solve doubts and answer questions for farmers on the use of agricultural machinery, avoid farmers' insufficient understanding of agricultural machinery and low operation level, increase the market share of agricultural machinery, improve farmers' probability of using agricultural machinery, and promote the steady increase of the level of agricultural mechanization.

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