Research on the Development Level of Agricultural Products Logistics in Hunan Province

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Abstract. The no. 1 document of the central government in 2023 clearly defines the important tasks of solving rural problems, promoting rural revitalization and accelerating agricultural and rural modernization. Therefore, this study aims to explore the logistics situation of agricultural products in Hunan Province and provide logistics and transportation direction support for agricultural development. First, 14 provincial cities in Hunan province were selected as study samples and adopted SPSS.25 The software conducts factor analysis to evaluate the difference in the development level of agricultural products logistics in each city. Subsequently, through cluster analysis, these cities and states were divided into four categories according to the comprehensive score, which laid a foundation for further suggestions to promote the efficient development of agricultural products logistics in Hunan Province.

Keywords: agricultural products logistics; factor analysis method; cluster analysis; Hunan Province

1 Introduction

Agriculture is an important pillar of China's national economy, and the logistics industry is crucial for economic and social development. The logistics of agricultural products marks the transformation of China's agriculture towards modernization. As a major agricultural province, Hunan is known for its rice, rapeseed, tea, and livestock industries. As of 2023, according to the National Bureau of Statistics, the added value of agriculture, forestry, animal husbandry, and fishery in Hunan will increase by 3.7% year-on-year; The total grain output was 61.36 billion kilograms, an increase of 1 billion kilograms from the previous year. The rice area and total output ranked first in the country[1]. At the same time, the Hunan Provincial Government will implement the strategy of "strengthening nodes, building chains, and optimizing networks" from 2021, improve the circulation network of agricultural products, strengthen production and sales docking, build a modern circulation system, focus on developing cross regional agricultural product wholesale markets and cold chain logistics, fill the gaps in circulation facilities, and ensure smooth circulation of agricultural products[2]. In this context, studying the development capacity of agricultural product logistics in various cities of Hunan Province is crucial for enhancing the vitality and level of agriculture in China.

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Such research can help promote the healthy development of agriculture and logistics industry, and provide more development opportunities for China's agriculture.

Many scholars have studied and discussed the agricultural products logistics, among which the earliest research on the agricultural products logistics is the American scholar J.E. Growell, In his book "Agricultural Products Circulation Industry Committee Report", he innovatively discusses the key factors affecting the distribution cost of agricultural products in multiple dimensions. The report not only highlights its profound industry insight, but also provides theoretical support for cost optimization in the field of agricultural products circulation[3]. Zhang Qian (2003) analyzed what agricultural products logistics is, explained the characteristics of agricultural products logistics and divided the types of agricultural products logistics, and subsidized the vacancy of this research in China[4]. Gao Ai and Man Guangfu (2014) analyzed the logistics development level of 17 cities in Shandong Province, and selected 17 evaluation indicators reflecting the 4 dimensions of their logistics development level[5]. Li Haoze (2023) also analyzed the logistics capacity of agricultural products in Jiangsu Province, and selected 11 indicators from four dimensions: economic basic conditions, agricultural products development conditions, logistics infrastructure level and logistics informatization level[6]. Li Xiaohong (2023) analyzed the development level of agricultural products logistics in 18 urban areas of Henan Province through 3 first-level indicators and 12 second-level indicators[7]. In view of the in-depth research of the existing literature in the field of agricultural products logistics evaluation provides a valuable reference for this study, however, the special discussion on the current situation of agricultural products logistics in Hunan province is still insufficient and lack of targeted insights. Therefore, on the basis of the essence of previous research, this study carefully constructed a set of agricultural products logistics development capacity evaluation system specific to the cities in Hunan Province, aiming to accurately analyze the differences of agricultural products logistics between different regions, and provide targeted development strategies and suggestions for the cities in Hunan Province. Such a system can not only help to optimize the allocation of regional agricultural products logistics resources, but also promote the healthy development of agricultural products logistics industry in Hunan Province.

2 Evaluation of Agricultural Products Logistics Development Level in Hunan Province

2.1 Construction of the Index System

In ensure that the index data is scientific, representative, regional, objectivity, comparability, on the basis of this study from past scholars to urban agricultural logistics level of evaluation index system, and combined with the current Hunan province bureau of statistics update 2023 and transportation and logistics in Hunan province logistics industry development research report, selected 16 can fully reflect the city logistics development level of evaluation index, established the corresponding evaluation index

system. The data of each indicator are from the Statistical Yearbook of Hunan Province in 2023.

The evaluation index system for logistics development level includes three levels of indicators. The first level objective layer evaluates the logistics development level of each city and prefecture. The second level indicator layer selects four relevant indicators reflecting the logistics development level of each city, including economic development level, agricultural product production level, rural logistics development level, and informatization level. Among them, the rural economic development level includes two third level indicators, namely the total production value of agriculture, forestry, animal husbandry and fishery, and the total value of export commodities. X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, X_{10}, X_{11}, X_{12}, X_{13}, are used to represent each data variable, as shown in Table 1.

Table 1. Index evaluation system of agricultural products logistics development level in Hunan Province

	Level 1 indicators	Secondary indicators
Agricultural products logistics development evaluation index system	Level of rural economic development	The total GDP of agriculture, forestry, animal husbandry and fisheryX1
		Total value of exports X2
		rural permanent resident population at the end of the yearX3
	Development level of agricultural products	the number of employees in the primary industryX4
		effective irrigation area X5
		The amount of fertilizer applied X6
		Main agricultural machinery ownership X7
	Logistics development level	highway mileage X8
		Number of trucks, X9
		Total business volume of posts and telecommunicationsX10
	Information level	The number of fixed telephone users X11
		Total telecom business volumeX12
		the number of mobile phone usersX13

2.2 Empirical Analysis

2.2.1 KMO and Bartlett Test.

In the data preprocessing phase, we strive to eliminate the raw data and standardize it by a standardized method. To verify the applicability of the factor analysis of the normalized data, we performed KMO and Bartlett spherical tests. Examination results showed that Bartlett significance was well below the threshold of 0.001, thus demonstrating that these data are highly suitable for factor analysis. Table 2 details the results of the analysis of this study, with the KMO value is 0.617, significantly exceeding the

standard of 0.6, and the significance of Bartlett sphere test is 0.000, both within the ideal range. Therefore, we can be sure that the factor analysis method adopted in this study is highly scientific and rigorous.

Table 2. KMO and Bartlett test values

Number of KMO sampling suitability quantities		.617
Bartlett sphericity test	Approximate chi square	308.088
	free degree	78
	conspicuousness	.000

2.2.2 Extraction of the Common Factor.

After an in-depth factor analysis of the normalized processed data, we obtained a table of total variance interpretation, and the specific results are detailed in Table 3. Based on the criterion of eigenvalues greater than 1, we successfully extracted 2 main common factors, namely F1, F2. The analysis results showed that the percentage of the first factor (F1) reached 60.642% after rotation, while the percentage of the second factor (F2) was 89.152% after rotation. This interpretation rate significantly exceeded the threshold of 85%. Therefore, we can be sure that the selection of these two public factors is enough to fully reflect the development of agricultural products logistics in 14 urban areas in Hunan Province.

Table 3. Interpretation of the total variance

ingredient	Initial eigenvalue			The sum of the load squares was extracted		
	amount to	variance percentage	accumulate%	amount to	variance percentage	accumulate%
1	7.883	60.642	60.642	7.883	60.642	60.642
2	3.706	28.510	89.152	3.706	28.510	89.152
3	.599	4.606	93.758			
4	.426	3.275	97.034			
5	.175	1.345	98.379			
6	.098	.751	99.130			
7	.060	.463	99.593			
8	.024	.183	99.776			
9	.016	.126	99.902			
10	.008	.062	99.964			
11	.004	.029	99.993			
12	.001	.006	99.999			
13	.000	.001	100.00			

2.2.3 Rotation Factor of the Load Matrix.

After the study methodology and data determination, data analysis was performed using SPSS25.0 statistical software. First, PCA was applied to extract the factor load matrix and then rotate the factor by Caesar normal maximization variance method to obtain the rotation component matrix, and the detailed results are shown in Table 4.

After the rotation, the total amount of post and telecommunications business, total telecommunications business, total export commodities, permanent rural population at the end of the year, the number of mobile phone users, the number of trucks and fixed telephone users are mainly explained by the first component, which are roughly defined as logistics input factors; the amount of chemical fertilizer application, the number of primary industry employees, highway mileage, gross production of agriculture, forestry, animal husbandry and fishery, effective irrigation area and main agricultural machinery ownership are mainly explained by the second component, and the factors of agricultural products development as its definition indicators.

Table 4. The component matrix after the rotationa

	ingredient 1	ingredient 2
Total postal and telecommunications business	.994	
Total telecom business	.986	
Gross exported goods	.983	
Rural permanent resident population at the end of the year	.964	
Number of mobile phone users	.957	
Number of trucks	.902	
Number of fixed-line telephone users	.900	
The amount of fertilizer applied		.945
Number of people working in the primary industry		.921
highway mileage		.921
The GDP of agriculture, forestry, animal husbandry and fishery		.918
effective irrigation area		.861
Main agricultural machinery ownership		.715

2.2.4 Construct the Evaluation Model of Logistics Development Level.

After the maximum variance rotation treatment, we obtained the coefficient matrix of the component scores, and the specific values are detailed in Table 5. Add the normalized value to multiply and add the coefficient in the three common factor score matrix, from which the standardized principal component score can be obtained. The formula is as follows:

$$F_1 = -0.002X1 + 0.167X2 + 0.149X3 - 0.049X4 - 0.0.038X5 - 0.039X6 - 0.012X7 - 0.050X8 + 0.132X9 + 0.170X10 + 0.140X11 + 0.160X12 + 0.145X13 \quad (1)$$

$$F_2 = 0.185X1 - 0.062X2 - 0.009X3 + 0.203X4 + 0.187X5 + 0.204X6 + 0.148X7 + 0.204X8 + 0.017X9 - 0.065X10 - 0.013X11 - 0.037X12 + 0.001X13 \quad (2)$$

$$F_{overall} = 60.642\%F1 + 28.510\%F2 \quad (3)$$

Table 5. The component score coefficient matrix

	ingredient			ingredient	
	1	2		1	2
X1	-0.002	0.185	X8	-0.05	0.204
X2	0.167	-0.062	X9	0.132	0.017
X3	0.149	-0.009	X10	0.17	-0.065
X4	-0.049	0.203	X11	0.14	-0.013
X5	-0.038	0.187	X12	0.16	-0.037
X6	-0.039	0.204	X13	0.145	-0.001
X7	-0.012	0.148			

2.2.5 Score Evaluation.

We use the above formula (1-3) to substitute the relevant data of 14 cities and states in Hunan Province into it, in order to calculate the specific scores of each city and state in the development of agricultural products logistics. From these scores, we ranked the and states and details are shown in Table 6. This ranking provides us with an objective assessment of the level of development of the cities and states in this field.

Table 6. Public factor scores, comprehensive scores and ranking of various cities

city	F_1		F_2		$F_{overall}$	
	score	rank	score	rank	score	rank
Changsha	3.386	1	-0.391	9	1.941	1
Hengyang	0.084	2	1.025	2	0.343	2
Changde	-0.339	11	1.623	1	0.257	3
Shaoyang	-0.086	6	1.003	4	0.233	4
Yueyang	0.039	3	0.723	5	0.230	5
Yongzhou	-0.317	9	1.016	3	0.097	6
Chenzhou	-0.057	4	-0.037	8	-0.045	7
Yiyang	-0.439	12	0.444	6	-0.139	8
Huaihua	-0.316	8	0.018	7	-0.186	9
Zhuzhou	-0.069	5	-0.910	11	-0.301	10
Loudi	-0.271	7	-0.6665	10	-0.354	11
Xiangtan	-0.338	10	-1.134	13	-0.529	12
XiangXi	-0.612	13	-1.086	12	-0.681	13
Zhangjiajie	-0.661	14	-1.628	14	-0.865	14

2.2.6 Cluster Analysis.

In this paper, we adopted the Q-type cluster analysis method to deeply study the logistics development level in various cities. This method effectively brings together areas with similar logistics development characteristics, and highlights the differences in logistics development among different categories of regions, providing strong data support for subsequent in-depth analysis and strategy formulation. Using SPSS 25.0 statistical analysis software, cluster analysis was conducted on the factor scores of 14

cities and states. Through comparison, the classification results were good, and through the results of pedigree map, the 14 cities were divided into four categories, and the clustering results are shown in Table 7.

In the depth discussion of the development status of agricultural products logistics in Hunan Province, we clearly divided different categories of cities through cluster analysis. Through an in-depth analysis of the characteristics and needs of various cities, we can formulate targeted policies and measures to promote the overall improvement of the logistics level of agricultural products in Hunan Province.

The first type of city, namely the city with a higher level of economic development, Changsha city not only has excellent conditions for agricultural products development, but also has established a mature agricultural products logistics system, and is equipped with a high standard of modern agricultural facilities.

The second type of cities, namely the cities with considerable economy, still have the potential for further development, although their agricultural products logistics infrastructure is well constructed.

The third and fourth types of cities, namely those with relatively backward economic development, are faced with challenges such as imperfect agricultural products logistics infrastructure and limited market competitiveness.

Table 7. shows the cluster members

class	city	num
first category	Changsha	1
second category	Hengyang, Changde, Shaoyang, Yueyang, Yongzhou	5
third category	Chenzhou, Yiyang, Huaihua, Zhuzhou ,Loudi	5
fourth category	Xiangtan, Xiangxi, Zhangjiajie	3

3 Conclusion

This article uses factor analysis to evaluate the logistics development level of 14 cities in Hunan Province, and uses cluster analysis based on factor scores to cluster analyze the logistics development level of the 14 cities. Therefore, the following suggestions are proposed for the development of logistics industry in Hunan Province:

1. We will increase input in the rural economy. When discussing the development of logistics industry in Hunan Province, the investment and development strategy of agricultural products logistics is particularly critical. According to the data in Table 2, the significant contribution rate of social survival factors is as high as 60.642%, highlighting the far-reaching impact of agricultural products logistics investment on the development level. Therefore, it is an important way to promote the development of logistics industry to strengthen the guiding role of government policies, eliminate the institutional obstacles of the development of logistics industry caused by capital investment, and increase the related investment of agricultural products logistics through multiple channels to raise the funds of logistics industry.

2. Develop logistics-related industries. Want to enhance the level of agricultural products logistics in Hunan province, the emphasis on logistics related industries also nots allow to ignore, this can not only stimulate the potential demand of the logistics industry, can also by speed up the transportation, postal warehousing, wholesale and retail industry of the coordinated development, optimize the industrial structure, especially to strengthen the development of agricultural products logistics, in order to realize the comprehensive upgrade of the logistics industry.
3. To create conditions for the coordinated development of all regions. In order to promote the coordinated progress of the logistics industry in various cities of Hunan Province, Changsha city, as the leader in the development of the logistics industry, should maintain its rapid and healthy development trend, and drive the development of the logistics industry in other cities.

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