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A research on measure of regional agricultural economic development level based on Entropy-CRITIC method and K-Means

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Abstract: *The continuous promotion of China's rural revitalization strategy has not put forward higher requirements for the development of overall agriculture. However, it is difficult to regulate the status quo of unbalanced regional economic development. Based on this, this paper selects the provinces and cities in Sichuan Province from 2018-2020 as the research object and constructs a regional agricultural economic development level index system, and then uses the entropy value CRITIC method to assign weights and carry out linear weighting to obtain the regional agricultural economic development level index from the consideration of the volatility and conflict of data. Then, K-Mean clustering was used to analyze the level of agricultural economic development in Sichuan Province from two dimensions: geographical and temporal. The empirical results show that: from the time dimension, the comprehensive index of high-quality agricultural economic development in most regions shows a trend of increasing year by year since 2018-2020; from the geographical dimension, it shows the form of strong in the north and weak in the south, and strong in the center and weak in the fourth. Finally, this paper puts forward relevant suggestions for the development of regional agricultural economy in conjunction with the actual situation.*

Keywords: *Regional Agricultural Economy; Entropy CRITIC; K-Means Clustering; Coordinated Development*

1. Introduction

Since the 19th Party Congress put forward the strategy of revitalizing the countryside, promoting high-quality development of agriculture and rural areas has become the top priority for China to realize the modernization of agriculture and rural areas. This paper quantifies the level of high-quality agricultural development in 21 cities and municipalities in Sichuan Province in five dimensions and puts forward targeted policy recommendations based on the evaluation results.

High-quality development of agriculture is of great significance to promote comprehensive upgrading of agriculture. Leng Gongye, Yang Jianli et al. argue that high-quality development of agriculture in China is in an urgent situation of both crisis and opportunity to promote high-quality development of agriculture[2]; Zhang Faming and Ding Feng et al. used the entropy TOPSIS method to indicate that the level of agricultural high-quality development in China's main grain-producing areas is low[2]; Wang Xiaohong and Zhao Xiaofei measure the level of high-quality agricultural development and its spatial relationship through the weighted principal component analysis method and Moran's I [3].

It is not difficult to see from the existing literature that regional agricultural economy is influenced by various factors. Therefore, this paper selects 34 evaluation indicators from 2018 to 2020 in Sichuan Province. The comprehensive entropy value and CRITIC assignment method objectively weight the evaluation object, so that the CRITIC algorithm based on the original data can widely consider the possibility of the development and change of each evaluation index, in order to help Sichuan achieve high-quality agricultural development faster and better.

2. Methodology

By comparing the principles of entropy method and CRITIC method, we further find that there is a natural complementary relationship between the two methods. Specifically, in the process of objective weight assignment, this combination method can not only consider the particularity of each index, but also take into account the variability between data. The two weights that have been derived are re-

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weighted according to the following method:

$$W_j = \frac{W_j^1 * W_j^2}{\sum_{j=1}^{m} W_j^1 * W_j^2}, \quad (1)$$

where the $W_j^1$is the weight obtained by the entropy method. Similarly, the weights are calculated using the CRITIC method.W_j^2. Calculate the regional agricultural economic development level score.

$$S_j = \sum_{j=1}^{m} W_j * P_{ij} \quad (2)$$

Next, using the K-Means clustering algorithm, the data were analyzed by time and geography to derive the evaluation levels of each city (state) in different years and ranked by capital letters. The specific modeling process is shown below

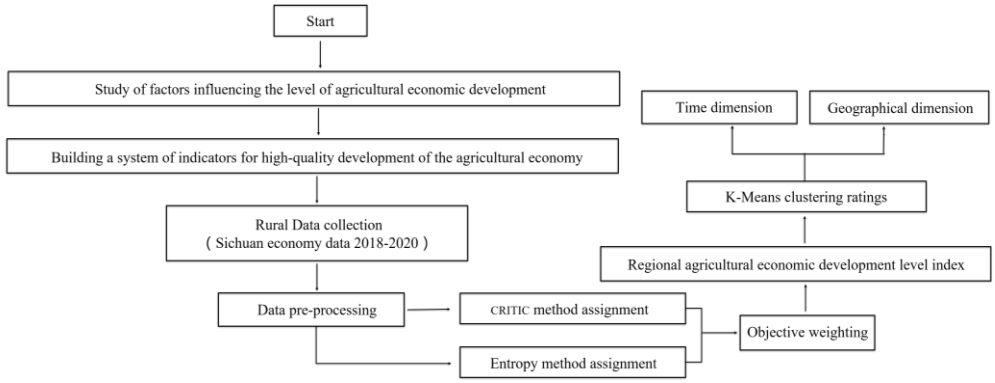

Figure 1: Modeling process

3. Empirical analysis

3.1. Index selection and data sources

Zhang et al. (2021) proposed to divide the evaluation index system of high-quality development of agricultural economy into five subsystems [5]. Based on this, this paper established the evaluation index system of agricultural economic development as the target layer, divided it into five dimensions, and constructed 34 specific indicators, see Table 1 below.

Table 1: Index system of agricultural economic development

F	X	Index meaning	F	X	Index meaning
F1	X1	Fertilizer application	F3	X18	per capita grain output
	X2	total sown area of crops		X19	added value of primary industry
	X3	fertilizer use intensity		X20	added-value of primary industry GDP
	X4	irrigated arable land area		X21	proportion of output value of non-agricultural industry
	X5	actual arable land area		X22	proportion of non-farm employment
	X6	energy consumption of gross product		X23	animal husbandry and fishery
	X7	replanting index		X24	proportion of agriculture
	X8	the area covered by greenery	F4	X25	proportion of forestry
	X9	effective mechanization level		X26	proportion of pastoralism
F2	X10	the proportion of effective irrigated area		X27	proportion of fishery
	X11	total power of agricultural machinery		X28	animal husbandry and fishery
	X12	increase of primary industry		X29	per capita disposable income of rural residents
	X13	power of agricultural tractors		X30	consumption of rural households
	X14	rural electricity consumption	F5	X31	number of medical personnel per capita
	X15	Labor productivity		X32	income gap the GDP of primary industry
F3	X16	land output rate		X33	income gap between urban and rural residents
	X17	output per unit area		X34	employees number of primary industry

Finally, the indicator data in this paper are mainly obtained from the Statistical Yearbook of Sichuan Province 2021, the Statistical Yearbook of Sichuan Province 2019, and the statistical development bulletins of each state and city. In this paper, for missing values, we use linear interpolation to fill in the missing values, and in addition, we normalize the data because our model requires positive indicators.

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3.2. Empowerment results

The weight size of each indicator of the agricultural economy high-quality development index system is calculated by the entropy critic method, as shown in Table 2, among them, the largest indicator is the effective mechanization level, with a weight of 0.28; the smallest indicator is the proportion of added value of primary industry to regional GDP and the proportion of output value of non-agricultural industry, with a weight of 0.06 and a difference of 0.22.

Table 2: Indicator system and weights of high-quality development of agricultural economy

F	X	Three-year average	F	X	Three-year average
F1	X1	19.11%	F3	X18	15.86%
	X2	10.17%		X19	20.65%
	X3	8.17%		X20	6.37%
	X4	8.50%		X21	6.37%
	X5	11.35%		X22	7.16%
	X6	6.82%		X23	22.79%
	X7	9.43%	F4	X24	11.82%
	X8	26.45%		X25	14.09%
	X9	8.51%		X26	14.66%
F2	X10	28.38%		X27	18.17%
	X11	9.16%		X28	11.31%
	X12	19.19%		X29	12.86%
	X13	8.74%	F5	X30	7.72%
	X14	26.03%		X31	22.51%
	X15	18.50%		X32	18.53%
F3	X16	23.33%		X33	22.30%
	X17	8.92%		X34	19.66%

3.3. Time dimension analysis

Firstly, this paper conducted correlation tests on the indicator values, and concluded that the level of agricultural green economy development is shown in Figure 2 below: the correlation between the values of each year is above 0.8, which proves that the correlation between the values of the level of agricultural green economy development is high and consistent. We use the acronym of the Chinese name of the region as the name, and from Table 3, among which the comprehensive rating levels of YB, YA, and LS show a decreasing trend year by year; the comprehensive rating levels of MY and LS show a rising and then decreasing trend; The comprehensive rating levels of MS and GZ remained unchanged for three consecutive years.

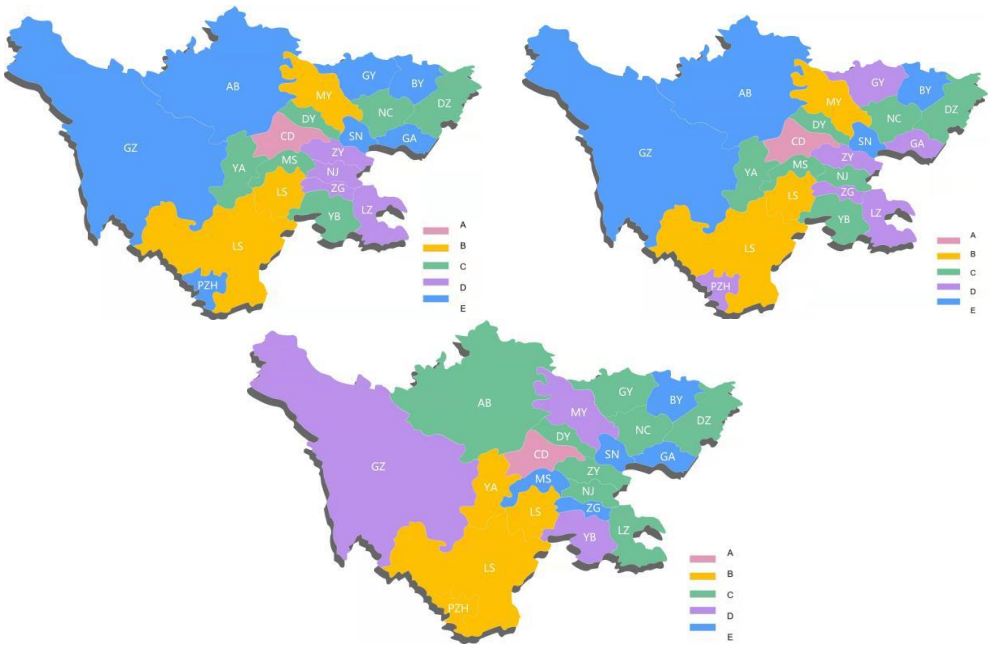

Figure 2: Numerical correlation analysis by year

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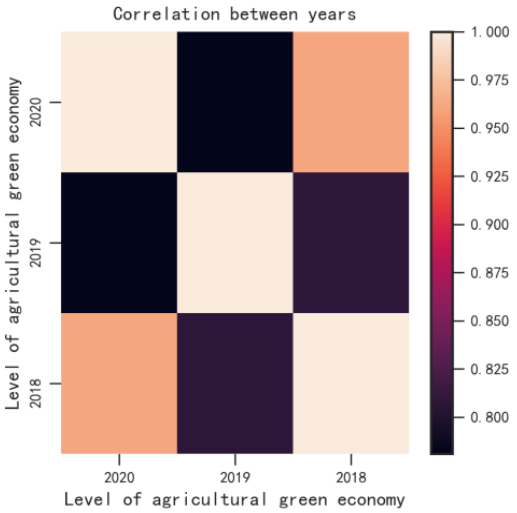

Figure 3: Regional distribution of comprehensive ratings in Sichuan Province, 2018-2020

Table 3: Evaluation results of the level of high-quality development of agricultural economy

Region	2018	2019	2020	Region	2018	2019	2020
CD	A	A	A	MS	C	C	E
ZG	D	D	E	YB	C	C	D
PZH	E	D	B	GA	E	D	E
LZ	D	D	C	DZ	C	C	C
DY	C	C	C	YA	C	C	B
MY	B	B	D	BZ	E	E	E
GY	E	D	C	ZY	D	D	C
SN	E	E	E	AB	E	E	C
NJ	D	C	C	GZ	E	E	D
LS	B	B	B	LS	B	B	B
NC	C	C	C				

3.4. Regional dimensional analysis

Figure 2 shows the comprehensive regional rating levels for 2018-2019. In 2018. the comprehensive rating level shows a large imbalance within the region in terms of the high quality internal structure of the agricultural economy. In 2018. The southern region and MY have a higher level of grade of B; the regions with a grade of C are more scattered; most of the cities in the southeastern region have a grade of D; and most of the cities in the northern and western regions have a grade of E. In 2019, LS located in the south, and MY in the north have a comprehensive rating of B. Most of the regions with ratings of C and D are concentrated in the central and eastern regions, while cities in the western region have a rating of E. In 2020. As can be seen from the figure, the area rated A is Chengdu, the area rated B is the southern region, the area rated C is mostly concentrated in the northern and southeastern regions, and the areas rated D and E are also more scattered.

4. Conclusions and Recommendations

In terms of time dimension, the comprehensive index of high-quality agricultural economic development in most regions shows a trend of increasing year by year. From the geographical dimension, regional differences are obvious, with the northern and central regions having a high level of agricultural economic development, the other have the low level of development. The following recommendations are made based on the conclusions drawn from the above quantitative results.

(1) Correctly view regional differences and promote agricultural development with high quality. Accelerate the construction of agricultural science and technology innovation system.

(2) Optimize the spatial layout of industries. Further improve the agricultural science and technology innovation system, accelerate the promotion and construction of grass-roots agricultural technology system, grasp the grain industry.

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(3) Actively plan agricultural projects to stimulate and attract talents to land. Vigorously promote the construction of a series of agricultural projects of global importance, such as standard farmland and agricultural projects.

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