Under Big Data Analysis Technology Study on High-Quality Development Level of Agriculture in Sichuan Province

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Abstract. As the core technology of the new era, big data analysis technology has a significant impact on the agricultural competitiveness of a region. Promoting the high-quality development of agriculture is of great significance to the construction of Rural Revitalization in Sichuan under big data analysis technology. Based on the definition of high-quality agricultural development, this paper constructed five dimensional index system including agricultural technology innovation and agricultural structure coordination. We then selected the panel data of 21 cities from 2010 to 2018 in Sichuan and used the comprehensive index model to calculate the index weight and development level. The results revealed that the overall level of high-quality agricultural development showed a fluctuating upward trend, the highest score was 1.87 times of the lowest score, and the gap between cities was obvious. Furthermore, the level of the five dimensions was not balanced, particularly agricultural openness. Therefore, we can improve high-quality agricultural development level by promoting the application of agricultural machinery and increasing investment in science and technology. Specifically, local cities and neighbouring cites should use big data technology to break administrative barriers to cooperate with each other, establish agricultural big data analysis database, and strengthen capital investment in big data technology construction.

Keywords: big data analysis technology · high-quality agricultural development · comprehensive index model · Sichuan

1 Introduction

Big data analysis technology is the core component of Internet technology, which has a deeper and further impact on agriculture. In particular, the Internet of things has changed the way of digital reporting and greatly improved the speed of information dissemination. As a basic industry, agriculture has the function of stabilizing people's will, consolidating society and strengthening national construction. In 2016, the 13th five year plan for the development of national agricultural informatization made a clear plan for the work of agricultural big data. In 2018, the Ministry of Agriculture and Rural Affairs of the People's Republic of China proposed "agricultural development quality year". High-quality agricultural development will be the key direction of national agricultural

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development in the future, but Sichuan, as a major agricultural province in China, is facing the problems of unreasonable agricultural structure and unprofitable grain production. Agricultural revitalization is the core and foundation of Rural Revitalization in Sichuan, and agricultural development can provide inexhaustible power for Rural Revitalization. And Chengdu is a high-tech gathering place, and the technical level of big data analysis is in the forefront of the country. As the foundation of the national economy, agriculture is moving towards high-quality development, which brings inexhaustible power to the high-quality development of agriculture. Stimulating the vitality of agricultural elements and finding the advantages and disadvantages of high-quality development of local agriculture are the primary tasks of agricultural development in Sichuan. Therefore, based on the background of big data analysis technology, it is of great significance to study the high-quality development of agriculture for Sichuan and even China.

At present, the research on the high-quality development of agriculture focuses on the concept and the measurement of evaluation index [1–3, 5, 6]. However, most literatures confuse the result index and the processing index, and the overlapping of the index gives rise to the serious collinearity of the results (Li et al.,2019). Currently, it is rare to explore the high-quality development level of agriculture in Sichuan under big data analysis technology. Therefore, this paper firstly defines the concept of high-quality development of agriculture, on this basis, then constructs the evaluation index system of Sichuan agricultural high-quality development, distinguishing the result index and process index, and finally uses the comprehensive index model to measure the index weight and development level.

2 Construction of Evaluation System

2.1 Sources of Data

Data are from Sichuan Statistical Yearbook, Sichuan Rural yearbook, yearbooks and statistical yearbooks of each city, Statistical Communiques of National Economic Development and government documents from 2011 to 2019. The missing data were supplemented by multiple linear interpolation.

2.2 Construction of Evaluation Index

Following the principles of systematicness, objectivity and comprehensiveness, considering the availability of data, basing on the connotation of high-quality development of agriculture, the evaluation index system is designed with the new development concept as the core. The content is shown in Table 1.

Table 1. Evaluation index system of agricultural high-quality development in Sichuan

Dimension index	Factor index	Basic index	Explanation of Index	Symbol
Agricultural technology innovation 0.243	Agricultural productivity 0.243	labour productivity 0.075	Gross output value of agriculture, forestry, animal husbandry and fishery/Agriculture, forestry, animal husbandry and fishery practitioners (yuan/person)	+
		Land productivity 0.069	Gross output value of agriculture, forestry, animal husbandry and fishery/Cultivated area (ten thousand yuan /m2)	+
		Grain yield per unit area 0.034	Total grain yield/Sown area of crops (kg/m2)	+
		Unit production rate of livestock and poultry 0.065	Output value of animal husbandry/Total meat production (yuan/kg)	+
Coordination of agricultural structure 0.370	Coordination of agricultural internal industrial structure 0.251	Comparative growth rate of agricultural output value 0.066	Agricultural added value/Added value of agriculture, forestry, animal husbandry and fishery (%)	+
		Proportion of grain crops 0.057	Grain crop sown area/Crop sown area (%)	+
		Proportion of cash crops 0.048	Sown area of cash crops/Crop sown area (%)	+
		Proportion of agriculture, forestry, animal husbandry and Fishery Services 0.080	Gross output value of agriculture, forestry, animal husbandry and fishery services/Gross output value of primary industry (%)	+

(*continued*)

Table 1. (*continued*)

Dimension index	Factor index	Basic index	Explanation of Index	Symbol
	Coordination of agricultural external industrial structure 0.119	Proportion of primary industry 0.043	Gross output value of primary industry/Regional GDP (%)	+
		Comparative productivity of primary industry 0.034	Proportion of primary industry output value /Proportion of primary industry practitioners (%)	+
		Binary contrast coefficient 0.042	Refer to Liu Rui and Guo Tao's algorithm (Liu and Guo,2020)	−
Green Agricultural Environment 0.187	Green Agricultural Environment 0.187	Consumption rate of agricultural resources 0.074	Intermediate inputs in agriculture, forestry, animal husbandry and fishery/Regional GDP (%)	−
		Forest coverage 0.057	Forest area/Land area (%)	+
		Cultivated land area per capita 0.056	Cultivated area/Total registered residence population at Year-end (m2/ person)	+
Agricultural development opening 0.097	Agricultural investment opening 0.097	Fixed investment ratio of agriculture, forestry, animal husbandry and fishery 0.097	Fixed investment in agriculture, forestry, animal husbandry and fishery/Regional GDP (%)	+
Agricultural achievement sharing 0.103	Agricultural income sharing 0.065	Rural Engel coefficient 0.032	Total food expenditure of rural households/Total household consumption expenditure (%)	−

(*continued*)

Table 1. (*continued*)

Dimension index	Factor index	Basic index	Explanation of Index	Symbol
		Urban-rural income difference coefficient 0.033	Urban per capita disposable income/Rural per capita disposable income (%)	−
	Rural consumption sharing 0.038	Rural consumption ratio 0.038	Total rural retail sales/Total retail sales of social consumption (%)	+

Note: " +" indicates that the higher the index value, the higher the level of high-quality agricultural development; "-" indicates that the smaller the index value, the lower the level of high-quality agricultural development. The number represents the index weight.

3 Measuring the High-Quality Development Level of Agriculture in Sichuan

3.1 Comprehensive Index Model

Firstly, it is vital to make the data dimensionless and standardized. The data in this paper are all positive, so the Range Statistics Method is selected.

Positive index:

$$Z_{aij} = \frac{X_{ij} - m_j}{M_j - m_j} \tag{1}$$

Negative index:

$$Z_{aij} = \frac{M_j - X_{ij}}{M_j - m_j} \tag{2}$$

X_{ij} is the original value of index, m_j is the minimum value of j index, M_j is the maximum value of j index, Z_{aij} is the standardized value of index.

Secondly, calculate the contribution of j index of the i-th city in sample period m:

$$P_{aij} = \frac{Z_{aij}}{\sum_{a=1}^{m} \sum_{i=1}^{k} Z_{aij}} \tag{3}$$

where m equals 9, k equals 21.

Thirdly, calculate the entropy of the j index:

$$E_j = -k_1 \sum_{a=1}^{m} \sum_{i=1}^{k} P_{aij} \ln P_{aij}, k_1 = \frac{1}{ln(m \times k)} \tag{4}$$

Fourthly, calculate the information entropy of j index:

$$d_j = 1 - E_j \tag{5}$$

Fifthly, calculate the weight of j index:

$$W_j = \frac{d_j}{\sum_{j=1}^{n} d_j} \tag{6}$$

Finally, calculate the comprehensive score of each city:

$$T_{mi} = \sum\nolimits_j \left(W_j Z_{aij}\right) \tag{7}$$

3.2 Analysis on the Results of High-Quality Development Level of Agriculture

The results are as follows Table 2. From 2010 to 2018, the overall level of high-quality development of agriculture of 21 cities in Sichuan Province showed a fluctuating upward trend, and the average score of each city was relatively stable with little fluctuation. The overall level of maintained between 0.31 and 0.56, the highest score was 1.87 times of the lowest score, and the gap between cities and states was obvious.

Chengdu, Deyang, Mianyang and Neijiang keep high scores, ranging from 0.482 to 0.573. The economic level of Chengdu, Deyang and Mianyang ranks the top three in the province, with strong economic foundation, high level of scientific and technological development, superior geographical location and strong comprehensive strength, which leads to high level of agricultural quality development. Zigong, Guangyuan and Dazhou maintain a medium level of development, ranging from 0.392 to 0.508, with small fluctuations. The economy of the three cities is at a medium level, and the agricultural development conditions are second only to Chengdu, Deyang and Mianyang.

Ganzi, Liangshan, Aba and Panzhihua have been in the low development level, in the range of 0.371–0.489. The four cities belong to Panxi Economic Zone and Western Sichuan Economic Zone, with weak economic foundation, backward science and technology, lacking of agricultural technical talents, and closed traffic. They are rich in climate resources, but the temperature difference between day and night is large, which is not conducive to crop cultivation. The topography of mountainous areas affects the use of agricultural machinery, so the level of agricultural development is low. The agricultural development level of Luzhou, Bazhong, Suining, Yibin and Nanchong has been greatly reduced, but the regional GDP has always been in the forefront of the province. It shows that the economic foundation is relatively strong. However, the role of promoting agriculture is insufficient, and the contribution of science and technology, talents, funds and other factors to agriculture needs to be strengthened.

The development level of Ziyang, Meishan and Guang'an is gradually rising. The three cities are agricultural cities with strong agricultural development foundation. The agricultural economy accounts for a large proportion. They have maturely cultivated the pillar industries of local agriculture. Meanwhile they are close to Chengdu, Deyang and Mianyang, with convenient transportation and support of perfect policies. They are easy to attract agricultural technology and agricultural leading enterprises to promote agricultural development. Leshan and Ya'an fluctuate greatly, the fluctuation range is obvious, and the high-quality development level of agriculture is declining. The reason is that Ya'an and Leshan are located in the southwest, close to Liangshan and Ganzi,

Table 2. The result of high-quality development level of agriculture

	2010	2011	2012	2013	2014	2015	2016	2017	2018
Chengdu	0.4818	0.5419	0.5289	0.5213	0.5031	0.5391	0.5597	0.5296	0.5400
Zigong	0.4335	0.4960	0.4685	0.4381	0.4502	0.4361	0.4571	0.4171	0.3922
Panzhihua	0.4214	0.4486	0.4008	0.4149	0.3977	0.4086	0.4272	0.4149	0.4001
Luzhou	0.4310	0.4645	0.4070	0.4240	0.4076	0.4352	0.4495	0.4269	0.3875
Deyang	0.5254	0.5647	0.4922	0.5313	0.4730	0.5061	0.5734	0.5185	0.5534
Mianyang	0.5065	0.5299	0.5117	0.5314	0.5193	0.5068	0.5646	0.5383	0.5322
Guangyuan	0.4477	0.4667	0.4866	0.4630	0.4755	0.4547	0.4449	0.4374	0.4238
Suining	0.4904	0.6035	0.5738	0.4801	0.4694	0.4220	0.4444	0.4379	0.4358
Neijiang	0.4909	0.5740	0.5316	0.5132	0.5237	0.5191	0.5706	0.5590	0.5367
Leshan	0.4272	0.4155	0.4322	0.4519	0.4357	0.4349	0.4659	0.4382	0.4270
Nanchong	0.4771	0.4830	0.4741	0.4893	0.4759	0.4301	0.4853	0.4842	0.4868
Meishan	0.4584	0.4535	0.4472	0.4905	0.4782	0.4719	0.5357	0.4938	0.4777
Yibin	0.4089	0.4145	0.4255	0.4389	0.4130	0.4064	0.4530	0.4567	0.4050
Guang'an	0.4206	0.4579	0.3975	0.4176	0.4064	0.4134	0.4569	0.3997	0.4563
Dazhou	0.4394	0.5085	0.4750	0.5015	0.4770	0.4561	0.4851	0.4677	0.4890
Ya'an	0.5167	0.5334	0.5147	0.5883	0.5328	0.4478	0.4904	0.4280	0.4429
Bazhong	0.3960	0.4760	0.4730	0.4015	0.4027	0.4251	0.4486	0.4808	0.4192
Ziyang	0.4349	0.5081	0.5014	0.4988	0.4972	0.5497	0.4713	0.5120	0.4802
Aba	0.4894	0.4373	0.4251	0.4493	0.4679	0.3920	0.4163	0.3979	0.3834
Ganzi	0.3353	0.3171	0.3175	0.3316	0.3678	0.3350	0.3874	0.3764	0.3196
Liangshan	0.3587	0.4093	0.3734	0.3888	0.3719	0.3780	0.3948	0.3844	0.3687

with inconvenient transportation, weak economic foundation, lacking of leading enterprises and driving force for agricultural development. Natural and economic conditions determine the instability of agricultural development level of them,and their agriculture has great vulnerability.

The ranking of high-quality development dimensions of agriculture in Sichuan Province from high to low is coordination of agricultural industrial structure, innovation of agricultural technology, green agricultural environment, sharing of agricultural achievements, and opening of agricultural development. It shows that in recent years Sichuan's agricultural development is changing the traditional development mode, conversely paying more attention to the coordination with the economic structure. And agricultural technology innovation has greatly improved the efficiency of agricultural production and makes vital contributions to agricultural development.

It is worth noting that we should pay attention to the degree of opening of agricultural development. Perhaps because of the limited data acquisition, the small number of indicators leads to the low score of agricultural development opening. But it also reflects

that although the gross output value of agriculture, forestry, animal husbandry and fishery is increasing, the relative growth rate fluctuates greatly. Compared with fixed assets investment in other industries, the proportion of investment is relatively small, and it is not paid enough attention to investment in agriculture. Thousands of factors can lead to this result, but there are three most important reasons, they are long agricultural investment cycle, large capital investment and imperfect agricultural investment environment respectively.

4 Conclusion and Suggestion

4.1 Conclusion

Sichuan's high-quality development of agriculture is facing the urgent situation. Based on the definition of high-quality development of agriculture to establish evaluation system, we used comprehensive index model to calculate the index weight and development level through utilizing the panel data of 21 cities from 2010 to 2018 in Sichuan. The results showed that, there was a significant gap in the level of agricultural development among 21 cities in Sichuan, the highest score was 1.87 times of the lowest, and the overall development level showed a fluctuating upward trend.

It can be concluded from the city level that Chengdu, Deyang, Mianyang and Neijiang maintained a high level of development, with a score of 0.482–0.573. Zigong, Guangyuan and Dazhou maintained a medium level of development, with a score between 0.392 and 0.508. Aba, Ganzi, Liangshan and Panzhihua have been in a low level of development with small fluctuations, and their scores are in the range of 0.371–0.489. The development levels of Luzhou, Bazhong, Suining, Yibin and Nanchong were declining constantly. While those of Ziyang, Meishan and Guang'an were continuously rising, the development level of Leshan and Ya'an fluctuated greatly. The development of the five dimensions was not balanced, particularly we should attach great importance to agricultural openness.

4.2 Suggestion

According to the conclusion, so as to improve the high-quality development level of agriculture in Sichuan Province under big data analysis technology, we propose a series of advice. Firstly it is necessary to introduce advanced agricultural machinery tools, improve farmland regularization standards, and promote the use of agricultural machinery. We will continue to cultivate and introduce excellent agricultural science and technology talents, and establish a supporting mechanism for agricultural science and technology that integrates research and development, trial and promotion, in the same time, build a comprehensive platform for Internet of things, big data and cloud computing, scientifically guide agricultural sowing, fertilization, pest control, collection and storage (Valentinetti, D., & Woodside, A.G.2021; Yuzhen, S,2021).

At the same time, government strengthen capital investment in big data technology construction. They should formulate supporting policies for agricultural development considering local conditions, establish a list of responsibilities for agricultural financial

support, and formulate corresponding supporting policies for agricultural finance. Meanwhile we should rely on cloud computing to build perfect investment and financing channels, take modern agricultural industrial park as the carrier, cultivate local agricultural leading enterprises, vigorously promote the agglomeration of regional advantageous industries, and improve the degree of industrial agglomeration.

Last but not least, all cities should cooperate with each other, learn from mutual strong points, establish a new mode of agricultural industry cooperation and a agricultural big data analysis database, integrating the functions of collection, analysis and storage across regions. Meanwhile each region use big data technology to inject scientific and technological factors into the quality of agricultural products and improve international competitiveness. In addition, government should also give full consideration to create a good investment environment for enterprises and third-party agricultural organizations, such as reducing the interest rate of financial loans and agricultural loans.

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