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Evaluation of agricultural modernization in Gansu province

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Abstract: *Based on the research of a large number of related documents, this paper expounds the current situation of agricultural modernization in Gansu Province; Based on the actual situation of modern agricultural development in Gansu Province, combined with the connotation and characteristics of agricultural modernization, the evaluation index system of agricultural modernization in Gansu Province was established. The specific indicators selected are the current situation of agricultural output, agricultural input, rural socio-economic development and sustainable agricultural development. Based on the statistical data of 14 cities and prefectures in Gansu Province in 2018, the factor analysis method and SPSS24.0 software are used to calculate the relevant data and evaluate the development level of agricultural modernization in Gansu Province. And it mainly makes a horizontal comparative analysis on the level of agricultural modernization development of 14 cities and prefectures in Gansu Province in 2018. Through analysis, the following conclusions are drawn: in 2018, the development level of agricultural modernization in Gansu Province showed a gradual decline from west to east, with obvious regional differences; at present, the level of agricultural modernization in Gansu Province mainly depends on the input and output in agricultural production.*

Keywords: *Evaluation index, Gansu Province, Development level, Agricultural modernization*

1. Introduction

The agricultural added value of Gansu Province in 2018 increased by 5.0% compared with 2017, while the agricultural investment increased by 20.5% compared with the previous year. The total grain output of the province has reached more than 11.5 million tons, the grain planting area has reached 39 million mu, and the grain output has increased for 15 consecutive years. The planting area of characteristic advantageous industries is 31.55 million mu, of which the total yield of corn reaches 453 million kg and the total production area of corn seed production reaches 1.21 million mu.[1] At present, both the total yield of corn and the total planting area rank first in China; The planting area of traditional Chinese medicine is 3.517 million mu, and the output reaches nearly 1.2 million tons. Gansu Province has a complex terrain and landform, which provides good conditions for the comprehensive development and diversified operation of agriculture, forestry, animal husbandry, fishery. Although this terrain and landform may have adverse effects on agricultural production, from the perspective of commercial agriculture, Gansu Province has abundant species resources, different natural environments in different regions The diversified environmental climate types and distinctive comparative advantages of resources have laid a solid foundation and favorable conditions for the development of modern agriculture with regional characteristics in Gansu Province.[2] Therefore, we should take advantage of the unique comparative advantage of the region, change our concepts and seize the opportunity in time to realize the sustainable and stable development of agricultural modernization in Gansu Province.

2. Current situation of agricultural development in Gansu Province

2.1 Agricultural resources

Gansu Province is located in the northwest of China, more than 1600 kilometers long from east to west, and more than 500 kilometers long from north to south. Gansu Province has a vast land area, ranking the seventh in the country, with a total land area of 425900 square kilometers.[3] Gansu Province also has rich solar and thermal resources and the advantage of large temperature difference between day and night, which provides a very favorable external condition for further developing characteristic high-

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quality and efficient agriculture. The total area and output of corn in Gansu Province rank first in China, the total area and output of apple planting rank second and fifth, and the total area and output of potato planting rank third and second. At the same time, Gansu Province is also a major grain growing province in China. By the end of 2018, the grain planting area had reached more than 2.6 million hectares.[4]

2.2 Situation of agricultural labor force

Gansu Province is rich in labor force. By the end of 2018, the number of employees in the primary industry was nearly 8.4 million, accounting for 53.90% of the total employed population.[5] In addition, there are about 8 million rural labors who are currently in a structural semi unemployment and recessive unemployment, which is caused by the rise in the wages of unskilled workers, and the large amount of labor resources saved has also promoted the processing and production of labor-intensive agricultural products.

2.3 Economic crops and special products

Gansu Province is at a relatively high level in terms of the total planting area and total output of various characteristic agricultural products. In particular, corn seed production, potatoes, wine grapes, olives, beer raw materials, fruits and vegetables, edible lilies and animal husbandry in Gannan have excellent quality and good development prospects.[6] In terms of the output of traditional Chinese medicine, Gansu Province ranks among the top in the country. Among them, there are five kinds of large quantities of traditional Chinese medicine, namely Dangshen, rhubarb, angelica, licorice, and astragalus membranaceus. [7]

3. Construction of evaluation index system of agricultural modernization level in gansu province and introduction of methods

3.1 Construction principles of evaluation index system

3.1.1. Scientific Principle

The structure of the indicator system is scientific and reasonable, which is closely related to the quality and effect of the comprehensive evaluation. Therefore, the indicator system should be constructed scientifically and reasonably to ensure that the basic connotation and development requirements of modern agricultural development are reflected in a standardized and accurate way.[8]

3.1.2 Simplicity Principle

The total number in the system should be moderate, the content must be properly simplified, and the data must be accurate. The combination of quantitative and qualitative indicators is available, which also makes the indicator system easier to operate, simple and clear, and convenient to use.

3.1.3 Comparability Principle

The level of social development, agricultural production and natural environment in different regions are quite different. Therefore, the indicator setting should not only be comparable, but also conform to the actual situation in different regions.

3.1.4 Representativeness Principle

The selection of indicators should take into account the exact embodiment of the characteristics of agricultural modernization. Therefore, agricultural input and production level, economic structure and socio-economic development are the main contents of the evaluation system. [9]The evaluation system should be constructed from reality, and the specific situation of agricultural modernization development in Gansu Province should also be fully considered.

3.2 Index system construction

According to the national agricultural modernization standards and the significance of agricultural modernization, we can know that the development of industrial system, the transformation of science and technology, the improvement of business forms and the concept of modernization are very important in promoting the further development of agricultural modernization. [10]At the same time, we should focus on strengthening the development of new specialized farmers and accelerating the improvement of

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agricultural mechanization to promote the overall efficiency of agriculture and the comprehensive competitiveness of agriculture. This is not only the requirement of China's agricultural modernization, but also the requirement of Gansu's agricultural modernization. On the basis of an objective analysis of the meaning and characteristics of the level of agricultural modernization in Gansu Province, with reference to relevant literature, and in combination with the reality of the development of agricultural modernization in Gansu Province (as shown in Table 1), an evaluation index system is established to evaluate the level of agricultural modernization in Gansu Province. [11]The evaluation index system is divided into three levels. First, the first level is a comprehensive indicator of the development level of agricultural modernization, and the second level is four first level indicators, which are analyzed from different perspectives of agricultural modernization development. The third level is the subdivision of the second level indicators, with a total of 12 third level indicators.

Table 1: Index system construction

Third level indicators	Calculation formula	Company	attribute
Effective irrigation rate (c1)	Effective irrigation area/cultivated area	%	+
Total power of agricultural machinery per unit cultivated land (c2)	Total power of agricultural machinery/cultivated land area	Kw/hm²	+
Number of labor force per unit cultivated land (c3)	Number of agricultural employees/area of cultivated land	Person/hm²	+
Land output rate (c4)	Gross agricultural output value/cultivated land area	10000 yuan/hm²	+
Grain output per unit area (c5)	Total grain output/sown area	t	+
Agricultural labor productivity (c6)	GDP of primary industry/number of primary industry employees	10000yuan/person	+
Engel coefficient of rural residents (c7)	Food consumption/total consumption	%	+
Urbanization level (c8)	urban population/total population	%	+
Per capita income of farmers (c9)		RMB/person	+
Unit fertilizer application amount (c10)	Total amount of fertilizer used/cultivated area	t/hm²	+
Disaster rate after disaster (c11)	Disaster area /affected area	%	+
Forest coverage (c12)	Forest area/total land area	%	+

3.2.1 Research method

The research method adopted in this paper is factor analysis, which is a statistical analysis technology. It describes the relationship between multiple factors or indicators with a few factors, so as to simplify the dimension reduction of more complex problems.

Let $X=(X_1,\cdots X_n)$ T be an observable random vector, E (X)=α， α=（$\alpha_1\cdots\alpha_m$）T,D(X)= Σ, And let $F=(F_1\cdots F_m)$ T (m<n) be an unobservable random variable, E (F)=0, D (F)=Im (that is, the variance of each component of F is 1 and is not correlated with each other). Also setβ=（$\beta_1,\cdots, \beta_n$) Not relevant to F, and E（β）= 0

$$D(\beta)=\mathrm{diag}(\theta_1^2,\ldots\theta_p^2) \quad =A \tag{1}$$

It is assumed that the random vector X conforms to the following model, namely the orthogonal factor model:

$$\begin{cases} x_1-\alpha_1=\lambda_{11}F_1+\lambda_{12}F_2+\ldots+\lambda_{1m}F_m+\beta_1 \\ x_2-\alpha_2=\lambda_{21}F_1+\lambda_{22}F_2+\ldots+\lambda_{2m}F_m+\beta_2 \\ \cdots\cdots \\ x_p-\alpha_p=\lambda_{p1}F_{p1}+\lambda_{p2}F_{p2}+\ldots+\lambda_{pm}F_m+\beta_p \end{cases} \tag{2}$$

Then the model is expressed as:

$$X+\alpha=AF+\beta \tag{3}$$

In formula (3), $F=(F_1,\cdots,F_m)^T$, $F_1,\cdots$, Fm is called X common factor; β=（β_1， ⋯， β_p）^{T}, β_1， ⋯， β_P is X special factor; The factor load matrix is: matrix A=（λ_{Ij}) pxm is the coefficient matrix to be estimated, λ_{Ij} (i=1, ⋯, p; j=1, ⋯, m) is called the load of the ith variable on the jth factor. Rotate the

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factor load to obtain the factor score function and calculate the factor value. Calculate the comprehensive factor score by taking the proportion of the characteristic root value as the weight.

4. Empirical analysis

4.1 Source of statistical data

Take the relevant statistical data of agricultural modernization development in Gansu Province in 2018 as an example. The data are mainly from Gansu Statistical Yearbook, Gansu Rural Economic Yearbook and China Statistical Yearbook. C1-C12 indicators are calculated and analyzed by SPSS24.0 software follow as *Table 2*:

Table 2: Original Data Sheet of Agricultural Modernization in Gansu Province

Indicator items	Unit	Zhangye City	Wuwei City	Tianshui City	Baiyin City	Jinchang City	Jiayuguan City	Lanzhou City
Effective irrigation rate (c1)	%	34.60	100.01	89.32	34.30	10.05	76.20	73.41
Total power of agricultural machinery per unit cultivated land (c2)	KW/ha	5.661	38.353	14.374	5.752	3.978	11.834	8.056
Number of labors per unit cultivated area (c3)	Person/ hectare	1.75	2.75	1.09	1.56	2.54	1.85	1.22
Land output rate (c4)	10000yuan/ha	2.114	13.381	2.690	2.234	2.405	4.738	3.240
Grain output per unit area (c5)	T/ha	1.464	6.435	6.089	3.063	3.062	4.313	5.081
Agricultural labor productivity (c6)	10000 yuan/person	1.207	4.856	2.466	1.427	0.947	2.560	2.649
Engel coefficient of residents (c7)	%	28.40	32.20	26.60	30.90	28.20	32.10	29.20
Urbanization level (c8)	%	81.03	93.65	70.47	50.62	41.65	42.31	47.55
Per capita income of farmers (c9)	10000 yuan	1.2367	1.9291	1.4434	0.9057	0.7693	1.1518	1.3710
Unit fertilizer application amount (c10)	T/ha	0.170	0.137	0.231	0.168	0.193	0.437	0.303
Disaster rate after disaster (c11)	%	72.00	0.00	25.53	58.86	66.39	62.69	81.01
Forest coverage (c12)	%	13.81	12.43	18.88	13.56	23.12	10.23	15.68

4.2 Data inspection and standardization

Three major tests were carried out for indicators, including reflection matrix test, KMO test and Bartlett test. The following figure (Table 3) shows that the kmo value is 0.611, greater than 0.6. Although it is not very large, it can still be carried out. Bartlett's value is 0.000, which is less than the given significance level a. This means that the original hypothesis is rejected and the previous variables can be factor analyzed.

Table 3: Test

Kaiser-meyer-01kin measure of adequacy		0.611
Bartlett ball test	Approximate chi square	94.980
	df	28
	Sig.	0.000

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4.3 Factor extraction

Through calculation (Table 4), three common factors were extracted by principal component analysis. The cumulative variance contribution of the extracted three common factors reached 88.142%, meeting the basic standard that the cumulative variance of the process was greater than 85%.

Table 4: Total variance

Composition	Initial characteristic value			extracting sum of squares for loading			rotating sum of squares for loading		
1	4.593	57.415	57.415	4.593	57.415	57.415	4.545	56.817	56.817
2	1.507	18.834	76.249	1.507	18.834	76.249	1.271	15.886	72.703
3	0.951	11.892	88.142	0.951	11.892	88.142	1.235	15.439	88.142
4	0.472	5.902	94.044						
5	0.362	4.526	98.569						
6	0.050	0.630	99.200						
7	0.047	0.587	99.787						
8	0.017	0.213	100.000						
Extraction method: principal component analysis									

The load value matrix needs to be rotated by each factor to facilitate the research and calculation of practical problems caused by common factors. Rotates using the maximum quartic value. After four wheel rotation, the factor load matrix of rotation is obtained. It can be seen from the following table (Table 5 and Table 6) that the load value of the first common factor F1 is higher from X1 to X4. X3 and X4 reflect the output of agricultural production, while X1 and X2 reflect the input of agricultural production. Therefore, the first common factor F1 is named as the "modernization factor of agricultural input and output". The largest load of X7 is the second public factor F2, which reflects the current situation of sustainable agricultural development. Therefore, the second public factor is named "modernization factor of sustainable agricultural development". The third public factor F3 has the largest load on X5, and because X5 reflects the Engel coefficient of rural residents, the third public factor is named "the factor of modernization of rural social life".

Table 5: Factor load matrix after rotation

	Composition		
	1	2	3
X1	0.933	-0.258	-0.104
X2	0.896	0.330	0.215
X3	0.739	0.365	-0.247
X4	0.938	0.053	0.122
X5	-0.021	-0.076	0.976
X6	0.951	-0.082	-0.103
X7	0.499	0.795	-0.007
X8	-0.540	0.561	-0.374

4.4 Comprehensive evaluation of agricultural modernization level

Firstly, combined with the explanatory total variance table, the comprehensive evaluation formula is obtained by taking the contribution rate of three factors' variance as the weight. Secondly, the comprehensive factor score of agricultural modernization in each region is calculated by using the weight coefficient of each public factor.

Comprehensive evaluation formula:

$$F=56.817/88.1428*f1+15.886/88.142*f2+15.439/88.142*f3 \quad (4)$$

$$F=0.6446*f1+0.1802*f2+0.1751*f3 \quad (5)$$

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Table 6: Component score coefficient matrix

	Composition		
	1	2	3
Effective irrigation rate	0.933	-0.258	-0.104
Total power of agricultural machinery per unit cultivated land	0.896	0.330	0.215
Grain output per unit area	0.739	0.365	-0.247
Agricultural labor productivity	0.938	0.053	0.122
Engel coefficient of rural residents	-0.021	-0.076	0.976
Urbanization level	0.951	-0.082	-0.103
Unit fertilizer application amount	0.499	0.795	-0.007
Disaster rate after disaster	-0.540	0.561	-0.374

As shown in Table 7, first of all, there is a significant regional difference in the comprehensive factor scores of agricultural modernization level in Gansu Province, among which Gannan Tibetan Autonomous Prefecture has the lowest score and Jiayuguan City has the highest score. In addition, Jiayuguan City has a large difference from Jinchang City, which is 0.585007909; Secondly, in terms of the factor scores of modernization of rural social life, Jiuquan City scored the lowest and Jiayuguan City scored the highest. Among the 14 regions, 6 regions scored positive, while the remaining 8 regions scored negative. The difference between the highest score and the lowest score was 4.17383; thirdly, in terms of the factor score of agricultural sustainable development modernization, Jinchang City has the highest score and Gannan Tibetan Autonomous Prefecture has the lowest score. The difference between the highest score and the lowest score is 2.61908523; finally, in terms of modern factors of agricultural input production, Longnan City has the lowest score and Jiayuguan City has the highest score. The difference between the highest score and the lowest score is 3.11192; from the difference of factor scores in various regions, the factor of rural social modernization has the largest regional difference.

Table 7: Comprehensive score of agricultural modernization level by region

year	f1	f2	f3	F	rank
Jiayuguan City	2.32838	1.84436	-1.01989	1.654644681	1
Jinchang	1.01842	0.82484	1.51072	1.069636772	2
jiuquan	1.27778	-2.32947	0.06491	0.415252235	3
Zhangye City	0.59830	-0.78750	0.82102	0.387517282	4
Wuwei City	0.56250	-0.38072	-0.55184	0.197354572	5
Pingliang	-0.83646	0.65395	1.06475	-0.234902601	6
Baiyin City	-0.29091	-0.07054	-0.30826	-0.254208220	7
Lanzhou City	-0.29637	-0.87358	0.52193	-0.257069275	8
qingyang	-0.71302	0.68676	0.41249	-0.263631541	9
Tianshui City	-0.77067	0.28307	0.72005	-0.319683913	10
Linxia Prefecture	-0.40452	-0.45041	-0.33711	-0.400945435	11
Longnan City	-1.00995	0.86107	-0.03201	-0.501453907	12
dingxi	-0.67994	-0.14318	-0.36540	-0.528071900	13
Gannan	-0.78354	-0.11866	-2.50136	-0.964440552	14

5. Conclusions and suggestions

5.1 Conclusions

Based on the results of the above analysis, it is concluded that the comprehensive factor determining the development of agricultural modernization in Gansu Province is the modernization factor of agricultural input in Gansu Province. From the results of data calculation in the above comprehensive evaluation formula, it can be seen that the highest contribution rate to agricultural modernization is the agricultural input-output status, with the contribution rate reaching 64.46%. The other two factors are the agricultural sustainable development status, with the contribution rate of 18.02%, and the rural socio-economic development status, with the contribution rate of 17.51%. Therefore, it can be proved that the current level of agricultural modernization in Gansu Province is closely related to the input and output in agricultural production.

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From the data analysis of 14 regions, on the whole, the level of agricultural modernization is showing an obvious trend of gradual decline from the western region to the eastern region, and the differences between regions are also obvious. Among them, Jiayuguan City, Jinchang City, Jiuquan City, Zhangye City and Wuwei City rank the top five in terms of comprehensive scores among all regions. These regions basically belong to the western region of Gansu Province, which is in line with the agricultural natural environment conditions of Gansu Province. The western region of Gansu Province, especially the Hexi Corridor, has relatively flat terrain, convenient water diversion and irrigation conditions, and is sparsely populated, which provides good conditions for promoting the development of agriculture. In contrast, due to its geographical location on the Loess Plateau, the central and eastern regions of Gansu Province are prone to water and soil loss, and some minority autonomous regions such as Gannan Tibetan Autonomous Prefecture, Linxia Hui Autonomous Prefecture and provincial capital cities such as Lanzhou are also concentrated in the central and eastern regions, so the population distribution is relatively dense compared with the western regions. In addition, since the average annual precipitation in these regions has been at a low level, the irrigation cost in these regions remains high, which is not conducive to the intensive operation of agriculture and the further development of agriculture in the central and eastern regions. Therefore, the overall level of agricultural modernization in the central and eastern regions of Gansu Province is relatively backward compared with that in the western regions.

5.2 Suggestions

The agricultural production mode of Gansu Province is affected by the special geographical environment of Gansu Province, and there are large regional differences. Therefore, in order to further effectively promote the process of agricultural modernization in Gansu Province, we must take the regional characteristics of different regions as the starting point, and make full use of the local production conditions, natural resources and geographical environment. In addition, with the gradual opening up of China's agriculture to the outside world, the agricultural development of Gansu Province should also take high standards as a starting point, plan a long-term goal as early as possible, and strive to further accelerate the improvement of the overall competitiveness of distinctive agricultural products of Gansu Province in the international arena. This is one of the effective measures to fill the shortage of geographical advantages, shortage of agricultural production resources and high production costs in Gansu Province.

In order to further improve the comprehensive agricultural production capacity of Gansu Province, it is necessary to increase the national financial input subsidies for agriculture, and combine financial input with strengthening infrastructure construction. It is also restricted by natural conditions such as terrain and climate. At present, the agricultural modernization construction in Gansu Province lags far behind the national average development level, and shows the outstanding characteristics of weak agricultural infrastructure, slow development and low starting point. Therefore, to realize agricultural modernization in Gansu Province, it is necessary to improve agricultural infrastructure. The development of agricultural modernization should take the national sustainable development strategy as the basic guidance, and use science and technology to promote the transformation of agricultural development mode, so as to further improve the comprehensive production capacity of agriculture. We should adjust and optimize the regional industrial layout in a timely manner according to the regional production conditions; The development of green organic agriculture should be based on the special agricultural production conditions in different regions; Promote the construction of modern agricultural demonstration areas centered on base construction, and further promote the large-scale and standardized production of characteristic agricultural products; Cultivate all kinds of new agricultural operation entities, promote agricultural industrialization, and minimize the agricultural production costs brought by geographical location; We must establish and expand the industrial chain, further enhance the added value of agricultural products, and achieve the effect of effective income increase and the growth of agricultural production.

To strengthen the construction of public services and agricultural infrastructure, we must focus on water conservation and high yield, and effectively reduce agricultural costs and risks; Increase support for agricultural product production, strengthen brand support and construction, and further improve the market competitiveness and marketing range of agricultural products with excellent characteristics; In order to minimize the internal losses caused by the lack of long-term market competitiveness among enterprises in the region and drive the further development of agricultural products with regional characteristics, it is necessary to take the six industries with relatively large scale at this stage as the basis for their development; In particular, we should emphasize the idea of sustainable development and encourage the cultivation of green, pollution-free, efficient, water-saving and dry farming organic

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agriculture, which can not only continuously improve the efficiency of agricultural production, but also further enhance the efficiency of agricultural production; Through innovation in the field of science and technology, we should radiate and drive the sustainable and rapid development of characteristic agriculture and circular agriculture with the basic characteristics of resource conservation and high efficiency; Strengthen agricultural technology service system, especially pay attention to standardized production and variety improvement; The education and skills training of rural residents should also be further strengthened and improved to maximize the ability and skills of farmers in scientific farming.

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