Analysis on the level and influencing factors of agricultural sustainable development in Qinghai Province

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Abstract. The 14th Five-Year Plan puts forward the priority of developing agriculture and rural areas, comprehensively promoting the strategy of rural revitalization, and points out the need to accelerate the realization of agricultural and rural modernization [1]. The improvement of the level of sustainable agricultural development is one of the main factors to promote the improvement of the level of agricultural modernization. Based on the reality of Qinghai Province, this paper constructed the evaluation index system of the level of sustainable agricultural development in Qinghai Province from five aspects of agricultural economy, resources, environment, society and science and technology [2]. Entropy method was used to calculate the level of agricultural sustainable development in Qinghai Province from 2010 to 2019. The results showed that the level of agricultural sustainable development in Qinghai Province increased greatly from 2010 to 2019, with an overall growth rate of 126.74%. Based on the analysis of the obstacle degree model, the main factors that restrict the level of sustainable agricultural development in Qinghai Province ranked the top six. Thus, countermeasures and suggestions are put forward from four aspects, namely, enhancing agricultural output, improving agricultural environment, adding infrastructure and introducing professional and technical personnel.

1. Introduction
Qinghai Province is located in the northwest of China with complex terrain, which is high in the west and low in the east and low in the north and south. Qinghai Province has a dry climate with less precipitation and longer sunshine hours. The annual average temperature of the whole province is -5.1-9.0°C, and the seasonal variation is not obvious and the winter is long. Affected by the terrain, climate and temperature difference, agriculture in Qinghai province can only sow once a year. With the introduction of a series of policies benefiting farmers, farmers’ efforts and scientific and technological innovation, agriculture in Qinghai Province has been improved in some aspects (as shown in Figure 1, Figure 2, Figure 3 and Figure 4).

As can be seen from Figure 1, the agricultural productivity of Qinghai Province showed an overall upward trend from 2010 to 2019, remained almost flat from 2013 to 2015, and improved from 2016 to 2019. As can be seen from Figure 2, agricultural land productivity in Qinghai Province increased continuously from 2010 to 2019, during which time it fluctuated greatly. In 2014, agricultural land
productivity reached the peak, and then began to fluctuate and declined greatly, until 2017 it began to increase. As can be seen from Figure 3, the per capita net income of rural residents in Qinghai Province increased significantly from 2010 to 2019, reaching 11,343 yuan in 2019, with an overall growth rate of 137.35% compared with 4,779 yuan in 2010. As can be seen from Figure 4, the total power of agricultural machinery in Qinghai Province is on the rise from 2010 to 2019, indicating that the agricultural planting process is more dependent on scientific and technological equipment. In conclusion, from the four aspects of agricultural labor productivity, agricultural land productivity, rural residents’ per capita net income, and the total power of agricultural machinery, it can be concluded that the agricultural development in Qinghai Province has improved greatly and the development situation is good from 2010 to 2019.

2. Calculation of sustainable agricultural development level in Qinghai Province

2.1. Index system construction

The level of agricultural sustainable development will be one of the important factors affecting the level of agricultural modernization. After analyzing the actual situation of Qinghai province to the author, based on the connotation of sustainable development theory, according to the principle of index system building, including scientific and systematic, representative and operability principles, and based on the existing research results, from the economy, resources, environment, society, science and technology five aspects to determine agricultural sustainable development level of Qinghai province. The specific index system is as follows [3][4] (Table 1).

2.2. the entropy value method

Entropy method is a common method used to measure the sustainable development of agriculture at present, and this method will be adopted in this paper for measure analysis [5][6]. The specific calculation process is as follows:

1) Standardized processing of original data:
   Positive indicator data: \[ X_{ij} = (X_{ij} - \min(X_j)) / (\max(X_j) - \min(X_j)) \] (i = 1,2,...; j = 1,2,...m)
   Negative index data: \[ X_{ij} = (\max(X_j) - X_{ij}) / (\max(X_j) - \min(X_j)) \] (i = 1,2,...; j = 1,2,...m)

2) According to the formula, \[ R_{ij} = x_{ij} / \sum_{i=1}^{n} x_{ij} \] (i = 1,2,...; j = 1,2,...m), the proportion of each index is calculated;

3) According to the formula, \[ e_j = -(\ln m) \sum_{i=1}^{n} R_{ij} \ln R_{ij} \] (i = 1,2,...; j = 1,2,...m) calculate the entropy value of the JTH index;
(4) According to the formula \( g_j = 1 - e_j \) (j =1,2... M) Calculate the difference coefficient of the j index;

(5) Based on the difference coefficient of each index calculated above, the formula \( w_i = (1 - e_i) / (n - \sum_{j=1}^{M} e_j) \) (i =1,2,…n) calculate the weights of each index (Table 1);

(6) Based on the formula: \( U_i = \sum_{j=1}^{M} w_j R_{ij} \) (i =1,2,…n) calculate the comprehensive score of agricultural sustainable development (Table 2).

Note: Xij is the standardized value of the j index in the I year, UI represents the comprehensive score of agricultural sustainable development in the I year of the study area, and Wj is the weight of the j index.

### Table 1. Evaluation index system of agricultural sustainable development level in Qinghai Province

| The target layer | Rule layer | Index layer | Index attribute | Weight of each indicator |
|------------------|------------|-------------|-----------------|-------------------------|
| Sustainable development of agriculture in Qinghai province | The economic system (Y1) | Agricultural productivity (X1) | + | 0.037916339 |
| | | Per capita grain output (X2) | + | 0.048252483 |
| | | Per capita vegetable production (X3) | + | 0.048518281 |
| | | Meat production per capita (X4) | + | 0.054259385 |
| | | Agricultural land productivity (X5) | + | 0.047920014 |
| | | Proportion of agricultural production in GDP (X6) | + | 0.049205198 |
| | Resource system (Y2) | Per capita net income of rural residents (X7) | + | 0.038461628 |
| | Environmental system (Y3) | Agricultural land use rate (X8) | + | 0.0235197 |
| | | Arable land per capita (X9) | + | 0.041481956 |
| | | Effective irrigation rate (X10) | + | 0.059269278 |
| | Environmental system (Y3) | Fertilizer application amount (X11) | - | 0.05481466 |
| | | Pesticide dosage (X12) | - | 0.045873425 |
| | | Usage amount of agricultural film (X13) | - | 0.057206379 |
| | | Forest coverage (X14) | + | 0.132568875 |
| | The social system (Y4) | Proportion of agricultural population (X15) | + | 0.035854661 |
| | | Road density (X16) | + | 0.047256556 |
| | | Urbanization rate (X17) | + | 0.041127408 |
| | Technology Systems (Y5) | Total power of agricultural machinery (X18) | + | 0.04670886 |
| | | Number of farm tractors per capita (X19) | + | 0.039852134 |
| | | Number of agricultural harvesters per capita (20) | + | 0.050232982 |

Note: The data are from Qinghai Statistical Yearbook and Qinghai Annual Bulletin.

As can be seen from Table 1, the agricultural economic system is mainly reflected by the per capita grain output, per capita vegetable output, per capita meat output, agricultural land productivity, agricultural production value in GDP and other indicators. The agricultural resource system is reflected by the effective irrigation rate index. The agri-environment system is reflected by the application amount of chemical fertilizer, pesticide, agricultural film and forest coverage rate. The agricultural social system is reflected by the highway density index; The agricultural science and technology system is reflected by the number of agricultural harvesters per capita. In Table 1, there are six indexes of weight is greater than 0.05, of which the economic system contained in meat production 1 per capita indicators, resource system contains 1 authors effective evaluation index, environmental system contains find river, the usage and the forest coverage rate of three indicators, the system of science and technology include agricultural harvester per capita 1 indicators; It shows that the construction of environmental system has become a new focus of sustainable agricultural development in Qinghai.
Table 2. Comprehensive evaluation of agricultural sustainable development level in Qinghai Province

| Year | The economic system | Resource system | Environmental system | The social system | Technology Systems | Agricultural sustainable development level |
|------|---------------------|-----------------|----------------------|------------------|-------------------|--------------------------------------------|
| 2010 | 0.021414239         | 0.013877406     | 0.027009957          | 0.005955474      | 0.002341613       | 0.070688689                                |
| 2011 | 0.02855453          | 0.017926455     | 0.021806626          | 0.007402412      | 0.005772732       | 0.081464775                                |
| 2012 | 0.031849863         | 0.021690259     | 0.0252313152         | 0.009286388      | 0.007038125       | 0.092387786                                |
| 2013 | 0.034571407         | 0.012200429     | 0.014347783          | 0.0098981        | 0.008803874       | 0.079621593                                |
| 2014 | 0.038339051         | 0.007818422     | 0.01446522           | 0.014095055      | 0.011942329       | 0.08681379                                 |
| 2015 | 0.030581353         | 0.010191793     | 0.01193682           | 0.015186852      | 0.01435306        | 0.082208739                                |
| 2016 | 0.036818695         | 0.010779382     | 0.02831754           | 0.014727554      | 0.01818592        | 0.10882909                                |
| 2017 | 0.028957155         | 0.009646833     | 0.12872079           | 0.015485156      | 0.019766721       | 0.102576656                                |
| 2018 | 0.031507624         | 0.010807099     | 0.054080985          | 0.015935366      | 0.022929547       | 0.135260622                                |
| 2019 | 0.04213939          | 0.009332857     | 0.0686641            | 0.016266268      | 0.025678056       | 0.16028067                                 |

Table 3. Obstacle factors and degree of agricultural sustainable development in Qinghai Province

| Year | Obstacle factor | Project | Ranking of obstacle factors | 1   | 2   | 3   | 4   | 5   | 6   |
|------|-----------------|---------|-----------------------------|-----|-----|-----|-----|-----|-----|
| 2010 | X14             | 2       | X14                          | 18.35% | 7.51% | 6.90% | 6.72% | 6.54% | 6.47% |
| 2010 | X4              | 2       | X4                           | 20.20% | 7.80% | 7.21% | 6.50% | 6.05% | 5.99% |
| 2010 | X20             | 2       | X20                          | 22.10% | 7.99% | 7.44% | 7.01% | 6.82% | 6.49% |
| 2010 | X3              | 2       | X3                           | 20.53% | 8.74% | 7.98% | 6.02% | 5.90% | 5.88% |
| 2010 | X16             | 2       | X16                          | 22.05% | 9.85% | 8.42% | 7.65% | 7.14% | 5.81% |
| 2010 | X18             | 2       | X18                          | 21.20% | 8.72% | 7.59% | 7.39% | 6.44% | 5.83% |
| 2016 | X14             | 2       | X14                          | 15.44% | 10.14% | 8.54% | 8.05% | 6.95% | 6.49% |
| 2016 | X13             | 2       | X13                          | 14.38% | 10.55% | 8.90% | 7.76% | 7.31% | 7.07% |
| 2016 | X2              | 2       | X2                           | 11.94% | 11.91% | 11.88% | 8.94% | 8.22% | 7.95% |
| 2016 | X12             | 2       | X12                          | 17.90% | 17.50% | 14.75% | 12.75% | 10.58% | 10.51% |
Figure 5 Sustainable development level of agriculture in Qinghai Province

As can be seen from Figure 5, the level of agricultural sustainable development in Qinghai Province developed rapidly from 2010 to 2019, with an average annual increase rate of 12.67%, indicating that the level of agricultural sustainable development in Qinghai Province has improved substantially in the past decade, but fluctuated greatly during this period. It can be seen from Table 2 that the comprehensive score of agricultural sustainability decreased from 0.092387786 to 0.079621593 during 2012-2013, with a significant decrease. During 2014-2015, the level of agricultural sustainable development decreased from 0.092387786 to 0.082208739, with a small decline. The main reasons influencing its fluctuation are as follows:

1. **Agricultural economic system analysis**

   As can be seen from Figure 5, the score of agricultural economic system in Qinghai Province increased from 0.021414239 in 2010 to 0.04213939 in 2019, showing an overall upward trend with an average annual growth rate of 9.68%, but with great fluctuations in the meantime. Combined with Table 2, it can be seen that the agricultural economic score decreased from 0.03833905 to 0.30581353 in 2014-2015, and from 0.036818695 to 0.031507624 in 2016-2018. There were fluctuations and large declines in these two periods. It is affected by the per capita grain output and the short-term decline of agricultural land productivity, which causes the short-term fluctuation of the agricultural economic system.

2. **Systematic analysis of agricultural resources**

   As can be seen from Figure 5, the systematic score of agricultural resources in Qinghai Province gradually decreased from 0.013877406 in 2010 to 0.009332857 in 2019, showing an overall trend of decline and an average annual decline rate of 3.28%, which was very large and not conducive to the sustainable development of agriculture. It can be seen from Table 2 that the agricultural resource system showed an upward trend from 2010 to 2012, and the score fluctuated from 2012 to 2019 and decreased to 0.009332857. The specific reason is that the overall score of agricultural resources decreased due to the decrease in agricultural land utilization rate and the decrease in per capita arable land area.

3. **Agricultural environment system analysis**

   As can be seen from Figure 5, the agricultural environment system score of Qinghai Province increased from 0.027099957 in 2010 to 0.0668641 in 2019, showing an overall upward trend and a high upward rate, with an average annual upward rate of 14.67%. However, there were also large fluctuations during this period. In combination with Table 2, it can be seen that the environmental system showed a downward trend and a large decline of 56.04% from 2010 to 2015, and showed an upward trend and a rapid upward momentum from 2015 to 2019. Now the agricultural ecosystem has become the main construction object to promote the sustainable development of agriculture in Qinghai Province.

4. **Analysis of agricultural social system**
As can be seen from Figure 5, the agricultural social system score of Qinghai Province increased from 0.005955474 in 2010 to 0.016266268 in 2019, showing an overall upward trend and an average annual growth rate of 17.31%, with slight fluctuations during the period. It can be seen from Table 2 that the score decreased from 0.015186852 to 0.014727554 during 2015-2016, with a small decline rate of 3.02%. The specific reason is that the proportion of agricultural population decreased, resulting in short-term fluctuations during this period.

3. Analysis of obstacles to sustainable agricultural development in Qinghai Province

3.1. Obstacle degree model

In order to further determine the obstacle factors affecting the sustainable development of agriculture in Qinghai province, and put forward targeted suggestions and measures conducive to the sustainable development of agriculture in Qinghai province, this paper analyzes the sustainable development of agriculture in Qinghai province on the basis of the use of the obstacle degree model for further diagnosis. Specific calculation is as follows:

\[ I_j = 1 - x_{ij} \]

\[ O_j = \frac{I_j \times w_j}{\sum_{j=1}^{n} I_j \times w_j} \]

Note: \( I_j \) represents deviation degree, namely the gap between this index and agricultural sustainable development; \( O_j \) represents the degree of obstacle, that is, the degree to which the index restricts the sustainable development of agriculture; \( x_{ij} \) refers to the normalized value obtained by the extreme value method; \( w_j \) refers to factor contribution degree, namely the weight of single factor to the overall goal.

3.2. Analysis of obstacles to sustainable agricultural development in Qinghai Province

By calculating the obstacle degree of each factor to the sustainable development of agriculture in Qinghai Province, the main obstacle factors and the change trend of each obstacle factor for the sustainable development of agriculture in Qinghai Province from 2010 to 2019 were obtained (Table 3), so as to clarify the purpose of the main indicators affecting the sustainable development of agriculture in Qinghai Province, and then put forward targeted suggestions.

As can be seen from Table 3, in 2010, the indicators reflecting the obstacles of agricultural economic system accounted for 30%; 13.33% of the indicators reflect agricultural resources system; Indicators reflecting agricultural environmental system obstacles accounted for 41.67%; Indicators reflecting the obstacle of agricultural social system accounted for 6.67%; The index reflecting the obstacle of agricultural science and technology system accounted for 8.33%; Therefore, from 2010 to 2019, the sustainable development of agriculture in Qinghai Province was most affected by agricultural environment and lasted for a long time. To be specific, the occurrence rate of forest coverage rate \( X_{14} \) is 80%, but it did not appear in 2018-2019, indicating that this index is no longer the main influencing factor hindering the sustainable development of agriculture in Qinghai. However, we should continue to pay attention to the construction of forests and expand the forest area. The occurrence rate of effective irrigation rate \( X_{10} \) and chemical fertilizer application amount \( X_{11} \) were 70% and continuous from 2012 to 2018, and the occurrence rate of agricultural film application amount \( X_{13} \) was 60% and continuous from 2014 to 2019, indicating that these three indicators are the main factors restricting the sustainable development of agriculture in Qinghai Province at present. The occurrence rate of per capita vegetable yield \( X_3 \), per capita meat yield \( X_4 \) was 50%, and the occurrence rate of pesticide application amount was 40%, but they did not appear in recent years, indicating that these three indicators are no longer the main influencing factors restricting the sustainable development of agriculture in Qinghai Province. The occurrence rate of four obstacle factors, i.e., per capita grain yield \( X_2 \), agricultural land productivity \( X_5 \),
road density $X_{16}$, per capita number of agricultural harvesters $X_{20}$, is 30%, among which per capita grain yield $X_{2}$ and agricultural land productivity $X_{5}$ still appear in recent two years, indicating that these two indicators are still the main factors hindering the sustainable development of agriculture in Qinghai. The proportion of agricultural production value to GDP $X_{6}$, the occurrence rate of total power of agricultural machinery $X_{18}$ is 20%, the occurrence rate of per capita arable land area $X_{9}$, and the proportion of agricultural population $X_{15}$ is 10%, among which the proportion of agricultural production value to GDP $X_{6}$, per capita arable land area $X_{9}$, and the proportion of agricultural population $X_{15}$ appear in 2019. It shows that these three indexes are the main factors restricting the current sustainable development of agriculture. At present, the use amount of agricultural film $X_{13}$, the proportion of agricultural production value to GDP $X_{6}$, the per capita cultivated land area $X_{9}$, the proportion of agricultural population $X_{15}$, the per capita grain output $X_{2}$, and the effective irrigation rate $X_{10}$ are the main factors that hinder the sustainable development of agriculture in Qinghai Province.

4. Conclusions and countermeasures

4.1. Conclusions
This paper makes a comprehensive analysis on the level of sustainable development of agriculture in Qinghai Province. The results show that the level of sustainable development in Qinghai Province has improved greatly from 2010 to 2019. The overall rate of improvement is 126.74%, which fluctuates slightly during the period. Among them, the four subsystems of economy, environment, society and science and technology are on the rise, while the resource system is on the decline, which is the main reason for the fluctuation of agricultural sustainable development. In order to further improve the sustainable development level of agriculture in Qinghai, the author based on entropy method and obstacle factor analysis, put forward countermeasures and suggestions from the following aspects.

4.2. Countermeasures

4.2.1. Increase investment in agricultural science and technology and improve agricultural output. Based on obstacle degree model analysis, the proportion of agricultural production accounts for the proportion of GDP become the main factors to hinder the sustainable development of agriculture in Qinghai, this shows that although the overall agricultural science and technology system has improved, but at the same time in the other indicators of ascension or want to further increase the input of science and technology, and increasing agricultural machinery equipment, agricultural machinery and the introduction of high science and technology, training technical personnel, This will increase agricultural output. In addition, agricultural production and planting technologies should be innovated to achieve low-carbon, sustainable and high-quality agricultural development in Qinghai. At the same time, research and development of new crop varieties to promote the diversified development of crops.

4.2.2. Improve agricultural environment and promote sustainable agricultural development. The ecological environment of Qinghai Province is fragile and in a special geographical position, so there are higher requirements for the environment of Qinghai Province. In 2019, the usage of agricultural film has become the main obstacle to the sustainable development of agriculture in Qinghai, indicating that the excessive use of agricultural film in the process of agricultural planting is not conducive to the sustainable development of agriculture and will damage the ecological environment in Qinghai. Therefore, it is necessary to carry out professional training for agricultural practitioners and related personnel, so as to reduce the use of agricultural film by improving planting technology. Secondly, although the forest coverage rate of Qinghai Province has been improved, its coverage rate is still lower than that of other provinces. Therefore, afforestation area should be further increased. Finally, although the application amount of chemical fertilizers and pesticides has been reduced, in view of the fragile ecological environment in Qinghai Province, the government should formulate and distribute relevant policies to limit the application amount of chemical fertilizers and pesticides, create a good agricultural
environment and promote sustainable agricultural development.

4.2.3. Increase the construction of water conservancy facilities and increase the irrigated area. Qinghai has a dry climate with little rainfall, and the growth of crops depends on water. At present, the construction of water conservancy and related facilities in Qinghai province is not much, which leads to the decrease of irrigated area year by year, which is not only bad for the growth of crops, but also may lead to the decrease of grain production. Therefore, we must increase the construction of water conservancy and related facilities.

4.2.4. Introduce professionals to achieve high-quality and sustainable development. The level of sustainable development of agriculture can not be further promoted without the technical support of technical personnel. The relevant government departments of Qinghai province should introduce professional and technical personnel through the establishment of school farmers, school schools, research institutes, etc., so as to solve the shortcomings of agricultural planting technology in Qinghai province. Secondly, brand of characteristic agricultural products should be built and marketing publicity should be carried out to make agricultural products go out of Qinghai Province on the basis of meeting local needs. On the one hand, farmers' income can be improved and their enthusiasm for production and labor can be mobilized. On the other hand, it can also enhance the visibility of Qinghai Province and contribute to the sustainable development of agriculture in Qinghai Province. Finally, a professional farmer training class should be established to regularly organize farmers to universities or send professional teachers to the village to teach relevant professional courses, so as to cultivate new farmers who are skilled in technology, good at operation and management and love rural agriculture in the new era, so as to realize high-quality and sustainable development of agriculture in Qinghai.

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