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A More Complete Food System

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Abstract: In order to make the **food system** more perfect, we first evaluated the existing food system that focuses on profitability and efficiency in two aspects: selecting the number of hungry people and the value of food production as attributes to construct the **TOPSIS model** evaluation selection In the food systems of 102 countries, it was found that there is a significant gap in the scores of different countries. Statistics show that since 1972, the annual output of food has fully met the needs of the world's population, and **unreasonable distribution** is the key to the existence of the **food crisis** [1]. We also made a reasonable explanation with data in terms of freight and yield per hectare, and made relevant suggestions. In the end, we selected Japan in developed countries and China in developing countries to verify our optimization model, and concluded that the current food system rating can be improved by improving the grain transportation process.

1. Introduction

With the continuous growth of the population and the deterioration of the global environment, extreme weather has become more frequent, land desertification has become serious, biodiversity has been reduced, and the trend of reduced food production has appeared, all of which have exacerbated the emergence of the food crisis. Although the current food produced on the earth is sufficient to support a huge population, the unfair and unreasonable distribution system has caused a large number of people in an environment of extreme food insecurity.Therefore, after scoring and evaluating the existing food system, it is more important to re-establish a more equitable and environmentally friendly global food system.

2. Model establishment and solve

2.1 Basic processing of data

We collected data on the total hungry population and per capita food output value of 102 countries, and multiply the country’s total population by per capita food output value to get the country’s total food output value for scoring purposes. When scoring, it is assumed that the score has a negative linear relationship with the total hungry population, and the total food output value has a positive linear relationship with the score. Under the percentile system, the country with the least number of hungry people scores 100 points on this indicator, and the country with the most hungry people scores 0 points; the country with the highest total food output value scores 100 points, and the country with

the lowest total food output value scores 0 points [2]. The specific formula is:

$$X = \frac{\max-\min}{100} * x \tag{1}$$

Among them, max is the actual value corresponding to the highest score among all countries of the indicator, min is the actual value corresponding to the lowest score among all countries, and x is the actual value of the country.

Normalize the decision matrix with original weights, that is:

$$r_{ij} = \frac{x_{ij}}{\sum_{i=1}^{m} d_{ij}} \tag{2}$$

Since we do not know the weight of the number of hungry people and the total food output value, we use the information entropy method from an objective point of view to give the two factors a reasonable choice. After normalization, each column vector of the decision matrix R obtained by the normalization is regarded as the probability distribution of information. According to the definition of entropy, the entropy of each country on the attribute x_j is:

$$E_j = -k \sum_{k=1}^{m} r_{ij} lnr_{ij}, k = 1/lnm, j = 1,2 \cdots\cdots n \tag{3}$$

Generally, the greater the difference between the attribute values X_j and the smaller E_j, the greater the effect of X_j in distinguishing the pros and cons of the scheme. So define$F_j = 1 - E_j, 0 \leq F_j \leq 1$.Is the discrimination degree of attribute X_j, and further takes the normalized discrimination degree as the weight ω_j of attribute X_j, namely:

$$\omega_j = \frac{F_j}{\sum_{j=1}^{n} F_j}, j = 1,2 \cdots n \tag{4}$$

So far, the attribute weight has been determined in a more objective way TOPSIS method calculation results get quantitative analysis of food system evaluation results.

1. Multiply the element x_{ij} of the decision matrix after the modularization by the attribute weight ω_j to obtain $V_{ij} = r_{ij}\omega_j$, forming a matrix y2.

2. The largest element and smallest element of each column of y2 constitute a positive ideal solution (v^+) and a negative ideal solution respectively(v^-), respectively represented by the optimal vector and the worst vector.

3. Euclidean distance between scheme Ai and positive ideal solutio:

$$S^+ = \sqrt{\sum_{j=1}^{m} (v_{ij} - v_j^+)^2} \tag{5}$$

And distance from negative ideal solution:

$$S^- = \sqrt{\sum_{j=1}^{m} (v_{ij} - v_j^-)^2} \tag{6}$$

4. Define the closeness of the country Ai to the positive ideal solution as:

$$c_i^+ = \frac{s_i^-}{s_i^+ + s_i^-}, 0 < c_i^+ < 1 \tag{7}$$

The score data of 102 countries are calculated, and the normalized results are shown in Figure 1. According to the results of the evaluation, we can see that there is a significant gap in scores between different countries, and the overall average score is not high, suggesting that we need to optimize the existing food system.

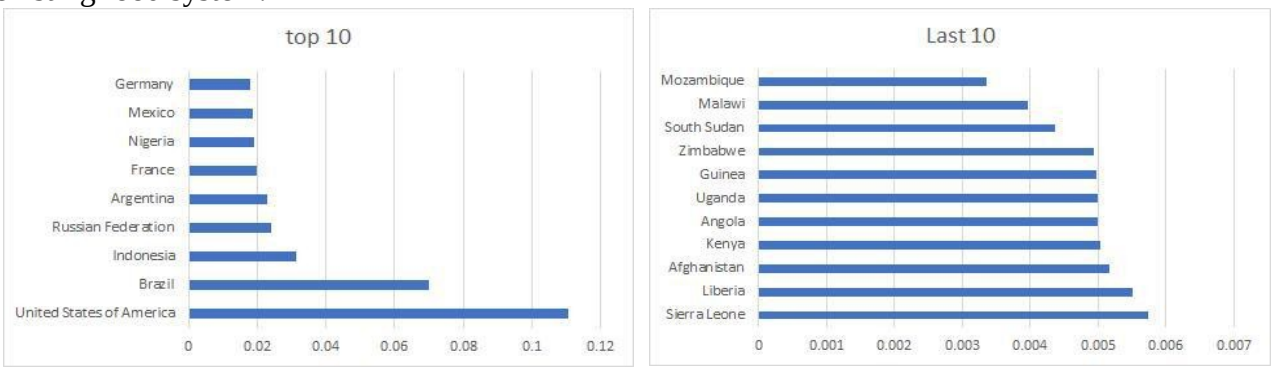

Figure 1: Some countries score

2.2 How to reduce hunger

The food importing countries are basically developing countries (70% of the top ten), while the food exporting countries are mostly developed countries (50% of the top ten). This determines the imbalance in the international grain transportation market. Developed countries have absolute advantages in grain pricing and have a strong position in international trade.

Next we want to optimize our food transportation system. If you do not consider whether countries can afford high freight, both importing and exporting countries have the same bargaining power. We assume that countries around the world adopt more advanced container transportation methods, and roughly estimate the freight rate as 125.24RMB/t4. The first one is to use advanced technology to reduce freight.

The second development technology makes full use of arable land.

India is the country with the largest number of hungry people. About 190 million people are hungry. India imports 214678kt of grain (wheat) and exports 40,619,19kt of grain (wheat). The area of arable land is about 160 million hectares. If you want to achieve all 12.48 if one billion Indians can eat enough, they need 18220.8kt of grain, plus the difference in exports, at least 213161.8kt of grain will be produced. Therefore, it is required that the amount of grain to be produced per hectare is approximately 13.32 tons of grain, and it is necessary to vigorously develop technology to increase the yield per hectare of arable land.

2.3 Apply the model to developed and developing countries

2.3.1 Developed country-Japan

The total population of Japan was 126.9 million in 1997, 128.5 million in 2007, and 127.2 million in 2017. It can be seen that the total population has not increased significantly. The grain yield per hectare was 3.5 million in 1997, 3.1 million in 2007, and 2.8 million in 2017. It is speculated that Japan’s food production has a downward trend. The total food output value in 1997 was 19714 million dollars in 2007, 18 424 million dollars in 2007 and 17 344 million dollars in 2017, which also showing a decreasing trend [3].

Applying our initial evaluation model with two indicators of hungry people and total food output value, Japan's score is not high. The total number of hungry people in Japan in 2015 was about 0.5 million, which is not a small number, and the future food security trend is not optimistic. This

conclusion can be verified from the next data: In 2016, Japan’s food self-sufficiency rate was only 39%, which means that most of the food that Japanese people meet their daily needs comes from imports, and the proportion in recent years has been about 60%.

2.3.2 Developing country-China

The total population of China was 1290.3 million in 1997, 1376.3 million in 2007, and 1459.4 million in 2017. It can be seen that the total population continues to grow. The grain yield per hectare was 159.9 million in 1997, 163.2 million in 2007, and 186.7 million in 2017. Food production has been increasing to meet the needs of the increasing population [4]. Correspondingly, China's annual food output value was 323.481 million dollars in 1997, 468,779 million dollars in 2007, and 616.893 dollars in 2017, which has nearly doubled in 20 years, with a significant increase.

China's food self-sufficiency rate is over 85%, of which the staple food self-sufficiency rate exceeds 95%. Food rations are basically self-sufficient, and oilseeds are dependent on imports, mainly genetically modified soybeans.

Therefore, we can judge that China's situation is relatively safe from the perspective of total food.

3. Conclusions

Firstly, we used the TOPSIS model to evaluate the food systems of 102 countries through the number of hungry people and the total value of food production.

According to the results of the evaluation, we can see that there is a significant gap in the scores of different countries, the overall average score is not high, and there is a lot of room for improvement overall, suggesting that we need to optimize the existing food system.

Secondly, we selected a lot of data to estimate whether the current lack of total food is a key factor in the existence of hungry people in the world. The data shows that unreasonable distribution is the key to this problem.

Finally, we applied the model to developed countries, Japan, and developing countries, China, and found that both are possible. Optimizing the distribution of food by adjusting the freight rate proved that our model is feasible.

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