Agricultural & Forestry Economics and Management (2021) Vol. 4: 16-20
Clausius Scientific Press, Canada
DOI: 10.23977/agrfem.2021.040104
ISSN 2616-2202

Re-optimization of food system

Xiaohui Shi, Ping Man, Xinlong Wang, Quanqiang Wei, Yuzheng Fan

School of Information Science and Engineering, Zaozhuang University, Zaozhuang, Shandong 277100

Keywords: entropy weight TOPSIS, food security, comprehensive evaluation, PSO

Abstract: As one of the hot issues in the world, food security has been widely concerned by the international community. Food security is not only a symbol of a country's stable development, but also the most basic guarantee for human survival. With the increase of global population and the continuous deterioration of the environment, the situation of food security has become very serious. At present, the global food security situation has not yet alleviated, and some indicators are even deteriorating. Therefore, this paper constructs an agricultural system evaluation model to find the best way to solve the problem of global food security. In order to better optimize the grain system, according to the principle of fair and sustainable development, this paper uses the principal component analysis method and entropy-based TOPSIS method to establish an agricultural system evaluation model. First of all, the food security index data of 20 representative countries in the past five years are selected and processed by PCA. Then use the PSO model to optimize each grain system, then calculate the ranking through the agricultural system evaluation model, and then calculate the change coefficient of each index after n optimization. Finally, the grey prediction model is used to predict and analyze the change coefficient, and it is found that it takes 5-7 years to realize the optimized system.

1. Introduction

In recent years, with the gradual expansion of the use of the global food system, food production and distribution have become more efficient, but it is estimated that about 821 million people go hungry every day, even in rich countries [1]. In view of this problem, we believe that for developed and developing countries, the production costs of different foods are different, and the purchasing power of different people is also very different. However, for countries with less arable land, high-yield cultivation of cost crops is also inevitable. The adaptability of different crops is also different. Each country has its own diet structure, and the process of changing the food system is bound to have a certain impact [2]. Therefore, while protecting the environment, further optimizing and improving the production sequence of the existing food system has become the focus of attention of all countries, and strive to produce more food for everyone's use. Therefore, it is of great significance to study and plan a new food security evaluation index system and evaluation methods.

Thus it can be seen that the global food security situation is still not optimistic. Therefore, this paper looks for the most suitable food supply priority according to the different demand, supply, market and other factors of different countries, as well as the applicability and effectiveness of the agricultural system evaluation model. Sexual behaviour should be further improved to promote global food security.

2. Principal Component Analysis

The principal component analysis is a statistical method that starts from multiindex analysis and uses statistical analysis principles and methods to extract a few comprehensive indicators that are not related to each other while maintaining a large amount of information provided by the original indicators [3]. Through this method, the dimensionality reduction processing of the indicators in the agricultural system evaluation system can eliminate the relevant influence between the evaluation indicators and reduce the workload of indicator selection.

Assuming n samples, each sample has m target factors, xj(j=1,2,...,n) m self-observed value × xij (i=1,2,...,m), forming the original data matrix X= (xij)n×m, as shown below:

The first step is to standardize the evaluation index data. To eliminate the influence of different dimensions, first, construct a sample array, and perform the following standardized transformations on the sample array elements:

$$z_{ij} = \frac{X_{ij} - X_j}{S_i}, i = 1, 2, \cdots m, j = 1, 2, \cdots, n \tag{1}$$

xj and Sj represent the mean and standard deviation of the jth target sample, respectively.

$$x_j = \int_n^1 \sum_{j=1}^n x_{ij} S_j^2 = \sum_{n=1}^1 \sum_{j=1}^n \left(x_{ij} - x_j\right)^2 \tag{2}$$

The second step is to calculate the correlation between the matrices [4]. Based on the standard data matrix Z = (zij), the correlation coefficient of the matrix R = (rij) is calculated. Where rij is the correlation coefficient between the target factors of xi and xj.

$$r_{ij} = \frac{1\sum_{k=1}^n z_{ki} z_{kj} = k_{k=1}^n \left(x_{ki} - x_i\right)\left(x_{kj} - x_j\right)}{\sum_{k=1}^n \left(x_{ki} - x_i\right)^2 \left(x_{kj} - x_j\right)^2} \tag{3}$$

The third step is to calculate the number of principal components. Assuming that m principal components need to be retained, the cumulative principal component values are usually adopted:

$$\sum_{i=1}^m \lambda_i / \sum_{i=1}^p \lambda_j \geq 85 \backslash \% \tag{4}$$

According to the above formula, the value of K can be calculated,

The fourth step is to extract the principal component m [5],

$$\mathrm{F_k} = \sum_{\mathrm{k=1}}^{\mathrm{m}} \mathrm{u_{kj} z_f} \tag{5}$$

The fifth step is to calculate its comprehensive evaluation value. The formula for the comprehensive evaluation value is:

$$\mathrm{F = b_k F_k} \tag{6}$$

The standardized value can double the characteristic value, and the value of the principal component can be obtained from the data.

$$\mathrm{F_i = a_{1i} X_1 + a_{2i} X_2 + \ldots + a_{pi} X_p i = 1, 2 \cdots, m} \tag{7}$$

Through data dimensionality reduction processing, we can replace the original 17 data indicators with the 5 indicators currently obtained.

3. PSO solves multi-objective optimization

The essence of PSO particle swarm optimization (PSO: Particle swarm optimization) is that in most cases, the improvement of a certain target may cause the performance of other targets to decrease, and it is impossible to optimize multiple targets at the same time. Coordinated trade-offs and trade-offs are carried out between the goals to make all the objective functions as optimal as possible, and the optimal solution of the problem consists of a large number of even infinite Pareto optimal solutions.

$$v_i = v_i + c_1 \times rand \times 0(pbest_i - x_i) + c_2 \times rand0 \times (gbest_i - x_i) \quad (8)$$

$$x_i = x_i + v_i \quad i = 1, 2, \dots, N \quad (9)$$

$$v_i = \omega \times v_i + c_1 \times rand() \times (pbest_i - x_i) + c_2 \times rand() \times (gbest_i - x_i) \quad (10)$$

$$\omega^{(t)} = (\omega_{ini} - \omega_{end})\left(G_k - g\right) / G_k + \omega_{end} \quad (11)$$

To put it simply, with the development of global cooperation and unprecedented economic vitality, our per capita consumption level has greatly increased. Accordingly, the proportion of poor people in most of our countries has been shrinking, and the food security rate has also been greatly improved. The country's food reserves are surplus, but people who are not wealthy can't afford the surplus, and exports lead to an increase in the proportion of people with moderate or severe food insecurity. The government's policy is the main driving force for this change. In the developed echelon of developed countries studied, the number of favorable policy adjustments for export trade is frequent and various. The government adjusts tariffs and eliminates trade barriers, such as the US's agricultural export credit guarantee policy.

4. Weight optimization result

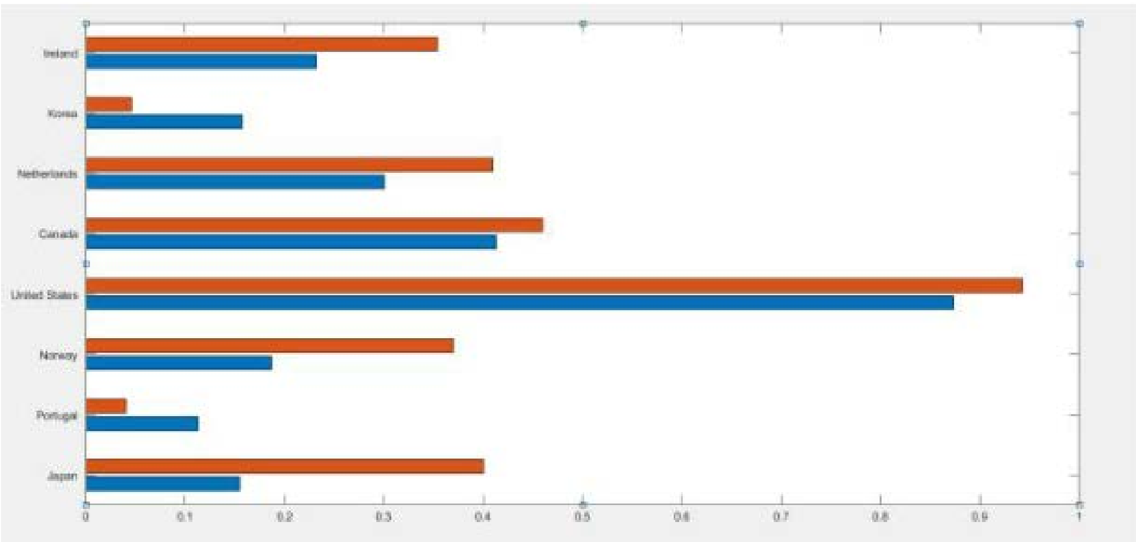

Figure 1: Comparison chart after optimization in developed countries

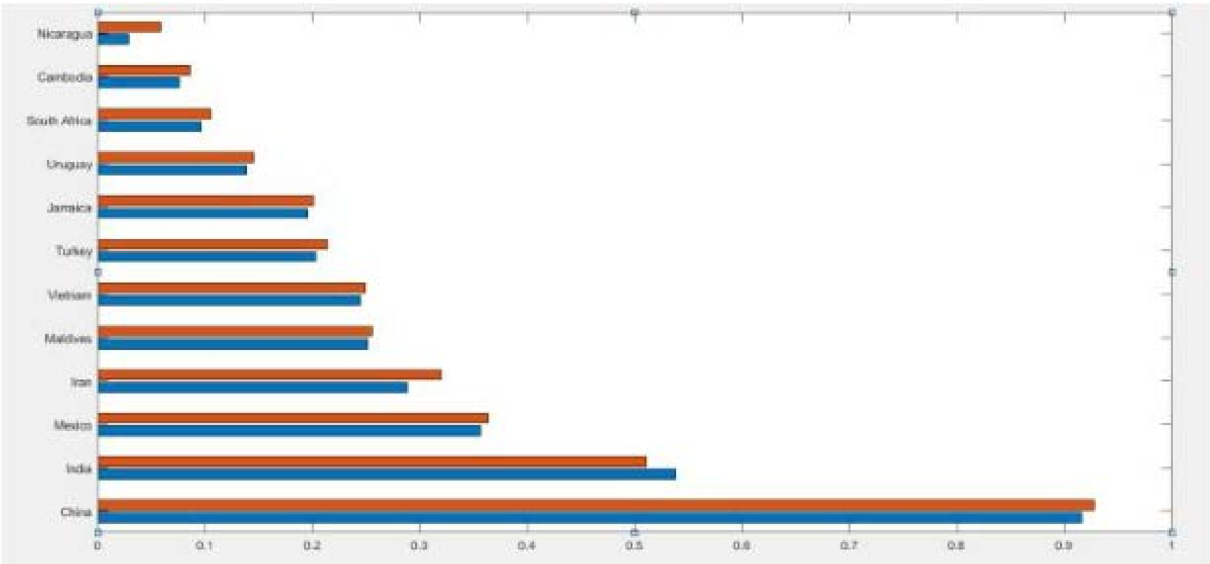

Figure 2: Comparison chart after optimization in developing countries

Through the data obtained by the entropy topsis model, we can clearly see the score (coefficient) ranking of each country and the score (coefficient) ranking of each country in the two echelons (ie developed and developing countries). This kind of data It can enable us to quickly understand the reality of each country. In the following optimization model, we can also make different policy interpretations for countries with different gradients through indicator data changes and coefficient changes.

5. Conclusions

Using the principal component analysis method can eliminate the relevant influence between the evaluation indicators and reduce the workload of indicator selection. The principal component analysis forms mutually independent principal components after transforming the original indicator variables, and the indicators are related.

Based on the different national conditions of different countries, governments of all countries should take corresponding strategic measures to ensure the safety, reliability, and effectiveness of their food systems. Among the echelon countries we studied.The government’s intervention in the grain market. Developed countries adjust grain imports and exports based on futures transactions, which effectively guarantees the stability of the domestic grain supply. When the total domestic grain production is far greater than the total demand, the government will Intervene in certain transactions, and give certain financial subsidies per unit of weight.

References

[1] Yao Chengsheng, Teng Yi, Huang Lin. Construction and empirical analysis of China’s food security evaluation index system [J]. Transactions of the Chinese Society of Agricultural Engineering, 2015, (4):1-10. DOI:10.3969/j.issn. 10026819.2015 .04.001.

[2] Zhao Lei. On the division of developed and developing countries [J]. Geography Teaching Reference for Middle Schools, 2004, (3): 64.

[3] Tang Lixia, Zhao Wenjie, Li Xiaoyun. Deep Logical Analysis of Global Food Security Evaluation System [J]. Journal of Huazhong Agricultural University (Social Science Edition), 2020, (5): 151-159. DOI: 10.13300/j.cnki.hnwkxb. 2020.05.017.

[4] Yang Shaoliang. Research on the evolution and trend of agricultural policies in India [J]. World Agriculture, 2013, (6): 71-74. DOI: 10.3969/j.issn.10024433.2013.06.019.
[5] James Novak, Wang Yu. U.S. Agricultural Policy and Its Controversy [J]. Financial Development Research, 2018, (11): 31-32. DOI: 10.19647/j.cnki.37-1462/f. 2018.11.004.