The Exploration and Evaluation Model of Global Food System——"Robust"

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Abstract. The current global food system prioritizes efficiency and profitability, so that even though it produces enough food to feed everyone in the world, large numbers of people still suffer from hunger, and the relentless pursuit of efficiency is contributing to environmental degradation. Shifting food system priorities will affect all of us. To optimize the food system and evaluation, we chose by means of conditional random sampling in 10 countries, using genetic algorithm (GA), to evaluate the stability of a food system factors into chromosomes, and then we optimize describe equity and sustainability of genetic chromosome after observations, shows the results of optimization operation and influence, and the genetic algorithm used in algebra is the realization of the corresponding changes in time. Among them, entropy weight method was used to assign weights of 12 evaluation indexes more objectively and reasonably, and the fitness function H was obtained to measure grain stability. Finally, according to our model, if the fairness and sustainability of the food system are optimized, the stability of the food system will increase. Since the benefits and costs of changing the food system priority are reflected in the changes of chromosomes, in order to explain when such changes occur, we choose to use the entropy-fuzzy comprehensive evaluation model to make a more accurate evaluation of the stability of the food system. Because the lower the stability is, the higher the possibility that the food system's priorities will change, we use the change of the high and low stability to measure the condition point where the food system may change. The difference in chromosomal variation between developed and developing countries reflects the difference in benefits and costs. We selected the United States as the representative of the developed country and China as the representative of the developing country to test the stability of the optimized food system among the 10 countries when discussing the optimization of food system, and tested the model through the gray prediction model, and the test results supported our findings. Finally, we further discuss the extensibility of the model. Because cities don't have the integrity of nations, they have a deletion of chromosomes; However, there are many countries on continents, which can easily cause chromosomal disorder. Therefore, it is easy to get pathological results when popularizing in cities and continents. Therefore, we consider to use Matlab to calculate the chromosome omission and variation first, and then calculate, so that our model has the generality.

1. Introduction

1.1. Background

By prioritizing efficiency and profitability, our current global food system is unstable and has a huge environmental footprint. While theoretically enough food is being produced to feed everyone in the world, 821 million people still suffer from hunger; Environmental problems such as the continuous increase of greenhouse gas emissions have also been ringing alarm bells for us. In this context, we try to reimagine and prioritize the food system to build a sufficiently robust food system model.

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1.2. Restatement of the problem

In the face of complex food system, the main issues we need to consider can be analyzed into four parts in order to more reasonably adjust and optimize the food system for different levels of efficiency, profitability, sustainability and fairness, and provide a robust enough food system model:

- Establish a model to evaluate the food system with changed priorities, optimize the food system for fairness and sustainability, examine the optimization results, analyze the differences between the optimized system and the precursor system, and predict how long it will take to implement such a system.
- Compare and describe the benefits and costs of changing food system priorities, discuss when the change will occur, and further discuss how the benefits and costs differ between developed and developing countries.
- Apply the food system model we have developed to at least one developed country and one developing country to demonstrate the acceptability of the new model.
- On the premise that the new food system is acceptable, the extensibility and adaptability of the model are further discussed.

2. Model

2.1. Entropy weight method

Entropy weight method is an objective weighting method. In the process of application, entropy weight method calculates the entropy weight of each index according to the variation degree of each index, and then corrects the weight of the index by entropy weight, so as to obtain the more objective weight of the index.

We use entropy weight method to determine the weight of 12 indexes.

2.2. Genetic algorithm (GA)

Genetic algorithm (GA) is a method to search the optimal solution by simulating the natural evolution process. Its main feature is to operate the structure object directly, adopt the probabilistic optimization method, and adjust the search direction adaptively, so it has a relatively good global optimization ability.

2.2.1. Traditional genetic algorithms

The basic operation process of the traditional genetic algorithm is mainly divided into four stages. The first stage is initialization. The maximum evolution algebra T is set and M individuals are randomly generated as the initial population $P(0)$. Then, individual evaluation was carried out to calculate the fitness of each individual in the population $P(t)$. Then, the operator is selected to act on the population, and the next generation population $P(t+1)$ is obtained after selection, crossover and mutation operations. Finally, the termination condition is judged. If $t=T$, the individual with maximum fitness obtained in the evolutionary process is output as the optimal solution and the calculation is terminated.

2.2.2. Improvement of genetic algorithm

For the problems to be solved in this paper, we use genetic algorithm to screen and optimize countries not to improve the stability of the food system, but to simulate the optimization of the fairness and sustainability of the food system. And since no large state has collapsed in recent years, there is no screening and culling of individuals. Therefore, we improve the genetic algorithm as follows:

To show that no big country has been destroyed in recent years, we have simplified the roulette process. A probability P is artificially set to make the gene "0" in the chromosome corresponding to the equity and sustainability indexes change to "1" with probability P, while the index corresponding to efficiency and profitability changes "1" to "0" with the same probability. In this way, the national investment in the optimization of the sustainability and equity of the food system is reflected. In general, the more countries invest in the sustainability and equity of the food system, the greater the probability P is. However, probability P is not only related to the degree of investment inclination, but also related to the corresponding time of each round of genetic operation. Generally speaking, the larger the time span set, the greater the value of probability P.

The influence of other factors on the 12 evaluation indexes was simulated by keeping the small probability of genetic variation operation. Since the fitness is positively correlated with the stability of the grain system, we choose the evaluation function H of the stability of the grain system as the fitness function of the population.

We will use the improved genetic algorithm in Task 1 and Task 2, and the algorithm flow is shown in the following figure.

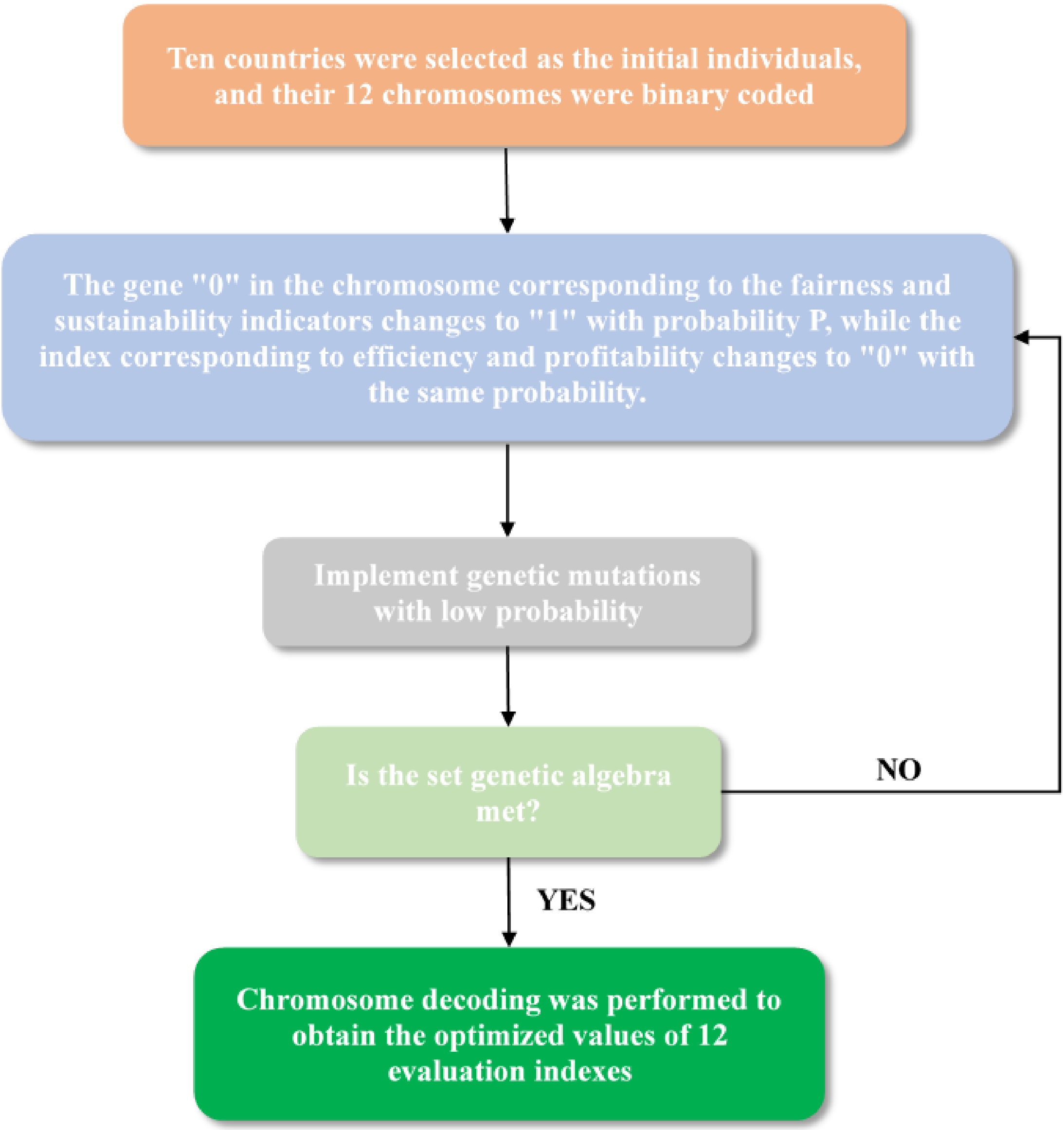

Figure 1. Improved genetic algorithm

2.3. Fuzzy comprehensive evaluation method

As an evaluation method based on fuzzy mathematics, the fuzzy comprehensive evaluation method can realize the conversion between qualitative data and quantitative data according to the membership theory of fuzzy mathematics. It has the advantages of clear results and strong systematicness, and it is suitable for solving various non-deterministic problems.

2.3.1. Traditional fuzzy comprehensive evaluation method

The steps of traditional fuzzy comprehensive evaluation are as follows: firstly, the evaluation index system is constructed; secondly, the weight vector is determined by expert scoring method or AHP; Then, the appropriate membership function is established to construct the evaluation matrix. Finally, the evaluation matrix and weight are combined, and the result vector is explained.

2.3.2. Improvement of fuzzy comprehensive evaluation method

In the process of using fuzzy comprehensive evaluation method, it is inevitable to be affected by subjective factors when the index weight is determined by expert scoring or analytic hierarchy process. Therefore, we choose to determine the index weight vector in fuzzy comprehensive evaluation by entropy weight method to make it more objective and reasonable.

The improved Entropy weight - Fuzzy comprehensive evaluation model will help us to solve the second problem.

2.4. Grey prediction model

The grey prediction model can establish the grey differential prediction model through a small amount of incomplete information, and make a fuzzy long-term description of the law of development of things. It has the characteristics of high precision, simple operation and easy to test.

In the third task, we will use the grey prediction model to test the entropy-fuzzy comprehensive evaluation model.

3. Model Establishment and Results

3.1. Task 1- Optimization, comparison and prediction of food systems

We have a lot of indicators to measure the stability of a food system, but in the subject, in order to more clearly in this paper, the optimization of fairness and sustainability of change, make the new model food system more robust, we combined with the actual situation, separately from the efficiency, profitability and sustainability and equity four aspects for the 12 more detailed indicators, so that they can more fully include social, economic and ecological three aspects of content.

Table 1. Stability evaluation index of grain system

The target layer	Level indicators	The secondary indicators
Food system stability	Efficiency	Agricultural machinery (x_1)
		Output value of agriculture (x_2)
		Crop output (x_3)
	Profitability	Food profit (x_4)
		Food cost (x_5)
		Food exports (x_6)
	Sustainability	The population density (x_7)
		Food safety (x_8)
		Greenhouse gas emissions (x_9)
	Fairness	Incidence of poverty (x_{10})
		Food security (x_{11})
		Per capita share of food (x_{12})

In order to make the model more objective, the entropy weight method was adopted to give weights to the first-level and second-level indicators. Firstly, the second-level index data was standardized according to the World Bank and FAO databases:

$$Y_{ij} = \frac{x_{ij} - \min(x_i)}{\max(x_i) - \min(x_i)} \tag{1}$$

In the formula (1), Y_i represents the normalized value of each data. Then find the information entropy of each index:

$$E_{ij} = -\frac{1}{\ln n} \sum_{i=1}^{n} p_{ij} \ln p_{ij} \tag{2}$$

Among it

$$p_{ij} = \frac{Y_{ij}}{\sum_{i=1}^{n} Y_{ij}} \tag{3}$$

If $p_{ij} = 0$, then define:

$$\lim_{p_{ij} \to 0} p_{ij} \ln p_{ij} = 0 \tag{4}$$

Therefore, we calculate the weight of each index through information entropy:

$$W_i = \frac{1 - E_i}{k - \sum E_i}, (i = 1,2, \ldots 12) \tag{5}$$

Finally, the entropy value and entropy weight of 12 second-level indicators and the entropy weight of first-level indicators are obtained by means of MATLAB tools:

Table 2. Entropy weight results

	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	x_{11}	x_{12}
Second-index entropy	0.8715	0.9283	0.9547	0.8973	0.9307	0.9286	0.9041	0.9442	0.8667	0.9162	0.9547	0.9008
Second-weight	0.1282	0.0715	0.0452	0.1025	0.0692	0.0712	0.0957	0.0557	0.1330	0.0836	0.0452	0.0990
First-weight	0.2449			0.2429			0.2844			0.2278		

After determining the weight, we set the food system stability index H:

$$H = \sum_{i=1}^{12} x_i W_i \tag{6}$$

In order to explain the robustness of the food system after the change of priority in a more reasonable and fair way, we take the number ratio of developed and developing countries in the world as the random sampling ratio, and select 2 developed countries and 8 developing countries from countries with large differences in food stability index, with a total of 10 samples.

Calculate the grain stability index of each sample in 2000, and the results are as follows:

Table 3. Stability indices for 10 countries

Japan	**America**	**China**	**Malaysia**	**Brazil**	**Arab Republic of Egypt**	**India**	**Philippines**	**Russia**	**Cuba**
176.605	172.596	124.404	80.323	60.008	107.610	132.361	72.039	33.844	35.328

We then normalized the 12 index scores for the 10 countries in 2000, unifying their magnitude of magnitude in the calculation and scaling it up by 100 times to improve the accuracy (by 100 times at genetic end). We converted the scores of 12 indicators from these countries to a total of 120 chromosomes. In these chromosomes, we artificially changed the gene "0" to "1" with a probability of $P = 0.03$ on the chromosomes corresponding to the fairness and sustainability indicators (a total of 60), and then changed the gene "1" to "0" with the same probability on other chromosomes. Finally, genetic mutation was performed with a small probability of $P' = 0.01$.

We carry out 5 iterations of the above operations to simulate the equity and sustainability of the food system optimized by investment for 5 years, and calculate the food system stability index H' of the 10 countries after 5 years of optimization and the difference ΔH of the food system stability index of the 10 countries before and after the optimization operation

$$\Delta H = H' - H \tag{7}$$

The results are as follows:

Table.4. Running results

H'	233.142	178.161	123.190	104.867	79.111	167.224	184.637	76.693	166.865	86.182
ΔH	56.537	5.565	-1.214	24.545	19.103	59.614	52.276	4.654	133.021	50.855

To get a better sense of the stability of these countries' food systems, we drew a radar chart based on these data:

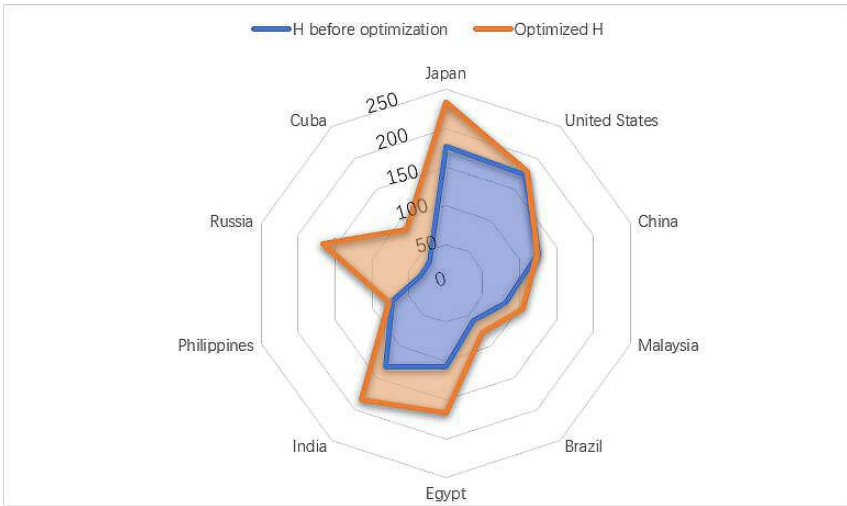

Figure 2. Radar chart

As can be seen from Figure 2, after the fairness and stability of the food system were optimized in the simulation, the food system stability score of most countries increased, while the food system stability score of China decreased slightly.

We according to the analysis of as many as 12 food system, simulates the genetic after 12 countries and 12 indexes of without genetic simulated comparison, found that fairness and sustainability index corresponding secondary index rising value to some extent, and other indicators values have varying degrees of decline, thus we can determine that changed after the priority between the food system and original system is that different countries will be mainly for the following institutional change:

- The state will pay more attention to equity, spend more resources on cross-regional distribution of food, improve food security for the poor, reduce the incidence of malnutrition, and narrow the food gap between the rich and the poor.
- The state will further optimize the survival, export and import of grain, ensure the stable supply of national grain and improve the stability of the grain system.
- The state will pay more attention to the living standards and living conditions of the poor people, provide them with more job opportunities or jobs, and improve their living security.
- The state will pay more attention to the sustainability of the food system, introduce appropriate environmental protection policies to reduce greenhouse gas emissions in agriculture, reduce the use of harmful chemicals, and pay attention to forest protection and biodiversity restoration.

Finally, as shown in the figure 3, the realization time of the optimized food system was explained by the genetic mutation probability P and the degree of chromosomal variation previously set. A system implementing the required length are usually performed by investment and the system implementation of the standards to decide, when we set up to simulate the genetic a corresponding real time through a year later, the size of P is mainly related to tilt of the resources, the investment, the greater the corresponding values of P, the greater the then the shorter the time needed to complete the implementation of this system. However, the standard for the implementation of the system is reflected in the degree of chromosomal variation. The higher the standard, the greater the difference between the simulated chromosome and the initial chromosome.

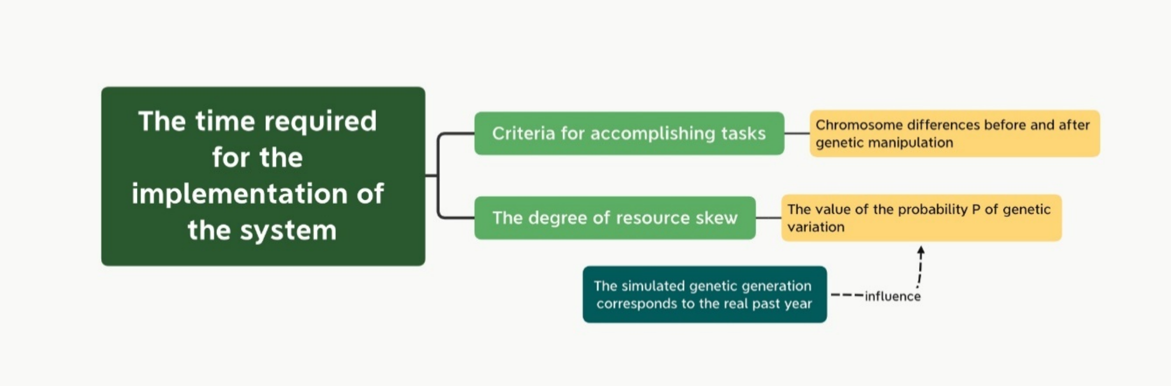

Figure 1. Description of forecast years

Therefore, based on data analysis and literature reading, we predicted the time to optimize the system in accordance with the above ideas and set the time as 5 years.

3.2. Task 2-Evaluate the pros and cons, costs and benefits of the new food system[3-4]

According to the first task, we have used the entropy weight method to determine the weight of 12 indicators. After determining the weight, we reasonably set the comment set as:

$$A = \{a_1, a_2, a_3, a_4\} \quad (8)$$

Comments set respectively corresponding to the meaning of {very stable, relatively stable, relatively unstable, very unstable}.

In the fuzzy comprehensive evaluation method, if the membership degree of the ith element in the factor set U to the first element in the evaluation set A is r_{i1}, then the result of the single factor evaluation of the ith element can be expressed by the fuzzy set as:

$$R_i = (r_{i1}, r_{i2}, \dots, r_{in}) \quad (9)$$

Using m single factors to evaluate the set $R_1, R_2, R_3, \dots, R_m$ is the row composition matrix R_{m*n}, which is called the fuzzy comprehensive evaluation matrix.

The index value for the world to increase the overall level of representative, to consider the common situation of developed countries and developing countries, we reasonably with the proportion of the number of developed countries and developing countries around the world (about 0.14:0.86) as the standard, countries around the world under the 12 indexes of data sorting, interception and aggregation in proportion, with a divided by the interception of data aggregation data, get the corresponding weight of each index, as indicators of membership degree m。

The weight set is composed of the weights of the 12 factors obtained in the first question:

$$W = \{w_1, w_1, \dots, w_{12}\} \quad (10)$$

Here we choose the principal determinant fuzzy comprehensive evaluation model, that is, in the matrix operation, take the small first, then take the large, to get the evaluation matrix of the evaluation set U:

$$U = W^\circ R_{m*n} \quad (11)$$

$$u_j = \vee_{i=1}^{n}(a_i \wedge r_{ij}) \quad (12)$$

We used the above fuzzy comprehensive evaluation model for the world food system, took the data of 2000 as an example, substituted the data into Matlab for calculation, and obtained the following results:

Table.5. Result of fuzzy comprehensive evaluation

Comments	Very stable	Relatively stable	relatively unstable	very unstable
Evaluation score	0.1282	**0.1330**	0.1282	0.1025

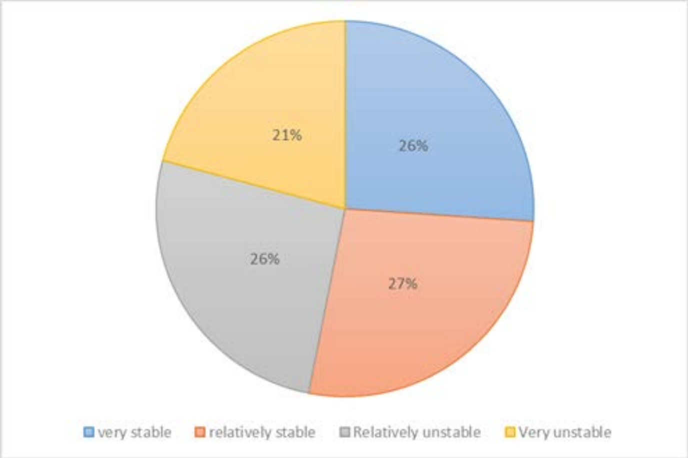

Figure 2. Data circle pie chart

It can be seen from the evaluation results that the world food system is more likely to be in a relatively stable state in 2000. The probability of a change in food system priorities at this time is not very high, but there is still a certain possibility of a change.

In the end, through data visualization and analysis of the changes of 12 indicators, we discuss the difference between the benefits and costs of developed and developing countries in the process of food system optimization changes.

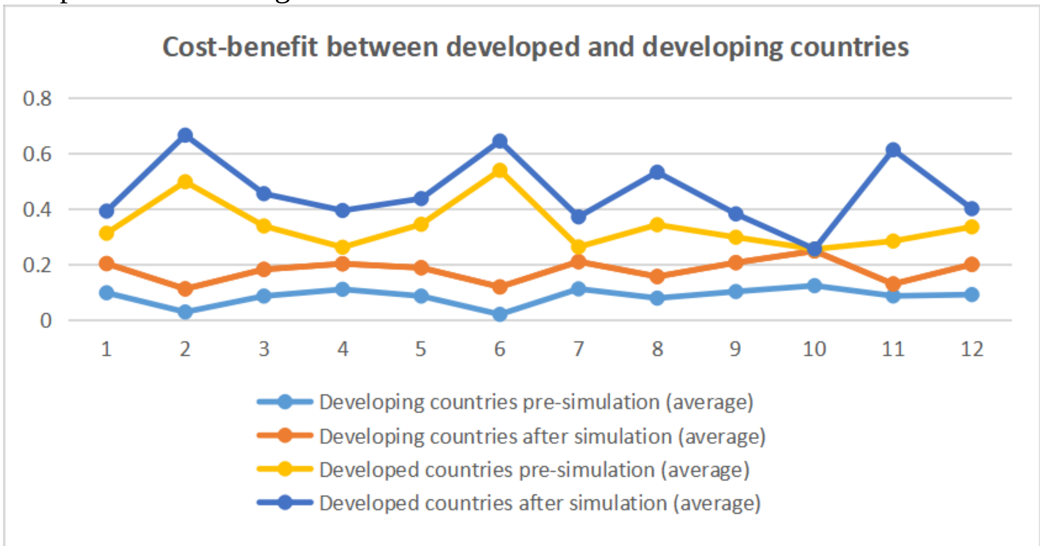

Figure 3. Cost vs. benefit variance

According to Figure 5, we can draw these conclusions:

- On the whole, as developing countries compared with developed countries, economy, science and technology strength is relatively lack, can be used for human food system optimization, items, such as resource input on the average will be less than developed countries, so the developing countries in the process of optimization of the indicators of costs that are lower than the developed countries, so that the income gained by the developing countries from also far less than the developed countries.

- From the point of profitability index, developing countries because is mainly devoted to the stage of economic development (on average), various aspects system is not perfect enough in the developed world, optimize the process of the food system as well as the continuous development process, to a certain extent, so the process is beneficial to developing countries to improve the profit, but will make the optimization of sustainability and equity in some developed countries in terms of profit level.
- From the perspective of equity index, since the original food system in developed countries mainly reflects efficiency and profit, compared with developing countries, developed countries will spend more cost to optimize the system's sustainability and equity, and can also greatly improve the relevant income.

3.3. Task 3-Case testing and model validation

3.3.1. Test cases

In this task, we have chosen China and the United States as representatives of developing and developed countries, respectively.

Due to the first task of genetic algorithm to choose 10 countries included in the China and the United States, the optimization of system equity and sustainability of grain problem has been solved, so the fuzzy comprehensive evaluation model is set up respectively in the United States and China, respectively, to score the food system stability of the two countries, then using the grey forecasting model, for the two countries' grain stable system index H linear fitting and forecasting, developing trend of the analysis of the two countries to the changes of system stability index, in order to support we use fuzzy comprehensive evaluation model of China and the United States food system stability evaluation.

Compared with the proportion of developed and developing countries to determine the index membership at the world level, at the national level, we use the proportion of first-tier cities, second-tier cities and non-first-tier and second-tier cities to determine the index membership. Similarly, the national weight set will also change. Entropy weight method is still used to obtain the corresponding weight of 12 indicators at the national level. The subsequent calculation refers to the application process of the fuzzy comprehensive evaluation model in the second question.

We also take the data of 2000 as an example, and finally get the stability evaluation of the food system of China and the United States as follows:

Table.6. Evaluation results of China and the United States

	Very stable	**Relatively stable**	**relatively unstable**	**very unstable**
China	0.1539	0.2293	0.1829	0.1293
US	0.2782	0.2101	0.1702	0.1289

As shown in the figure 6-7, we visualized the data and found that in 2000:

- Compared with China, America's food system is more stable.
- Generally speaking, the food system of both countries is in a relatively stable state.

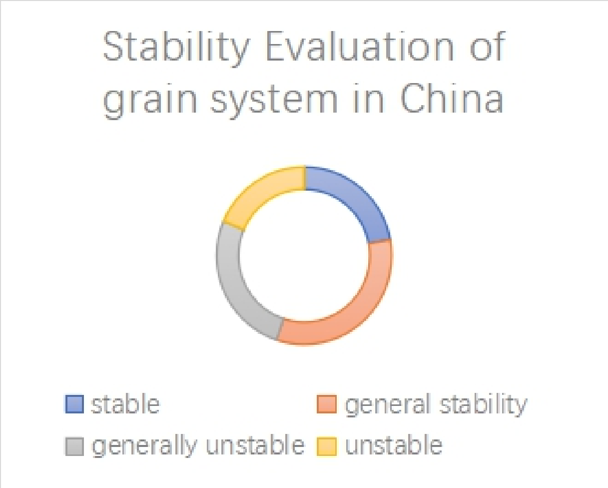

Figure 6

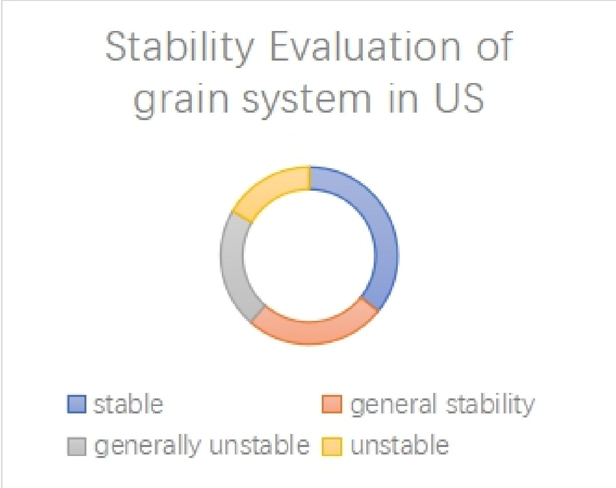

Figure 7

3.3.2. Model Checking

Based on the grain system stability index of China and the United States from 1990 to 2000, we build a grey prediction model, get the fitting curve of the grain stability index of China and the United States, and forecast the stability index of the two countries from 2001 to 2002. Observe whether the fitting curve is smooth and the future trend, and further explain the accuracy of the grain system stability model we established before, so as to test the grain system model.

We take the national stability index H for the period 1990-2000 as the original sequence:

$$x^{(0)} = (x^{(0)}(1), x^{(0)}(2), \dots, x^{(0)}(n)) \tag{13}$$

First, the stage ratio test was done. In order to ensure the feasibility of the modeling method, the stage ratio was calculatedλ:

$$\lambda(k) = \frac{x^{(0)}(k-1)}{x^{(0)}(k)}, \quad k = 2,3, \dots, n \tag{14}$$

Then we introduce the tolerant overlay:

$$\theta = (e^{-\frac{2}{n+1}}, e^{\frac{2}{n+2}}) \tag{15}$$

The $GM(1,1)$ model can be used to verify that all the original exponents fall within the accommodative cover. The reference sequence is accumulated once to generate the sequence $(1 - AGO)$

$$x^{(1)} = \left(x^{(1)}(1), x^{(1)}(2), \dots, x^{(1)}(n)\right)$$

$$= \left(x^{(0)}(1), x^{(0)}(1) + x^{(0)}(2), \dots, x^{(0)}(1) + \cdots + x^{(0)}(n)\right) \tag{16}$$

We use the $(1 - AGO)$ sequence to generate the mean sequence:

$$z^{(1)} = \left(z^{(1)}(2), z^{(1)}(3), \dots, z^{(1)}(n)\right) \tag{17}$$

Among it

$$z^{(1)}(k) = 0.5x^{(1)}(k) + 0.5x^{(1)}(k-1), k = 2,3, \dots, n \tag{18}$$

And then we set up the matrix $u = [a, b]^T$, Y is the original data vector$\left[x^{(0)}(2), x^{(0)}(3), \dots, x^{(0)}(n)\right]^T$

$$B=\begin{bmatrix}-z^{(1)}(2) & 1\\ -z^{(1)}(3) & 1\\ \vdots & \vdots\\ -z^{(1)}(n) & 1\end{bmatrix} \tag{19}$$

Through regression analysis, we can get the estimated value of development coefficient a and grey action b:

$$\hat{\mu}=\left[\hat{a},\hat{b}\right]^T=(B^TB)^{-1}B^TY \tag{20}$$

Then we establish the whitening equation of the grey differential equation:

$$\frac{\mathrm{d}x^{(1)}t}{\mathrm{d}t}+ax_t^{(1)}=b \tag{21}$$

Solve out:

$$\hat{x}^{(1)}(k+1)=\left(x^{(0)}(1)-\frac{\hat{b}}{a}\right)\mathrm{e}^{-\hat{a}k}+\frac{\hat{b}}{\hat{a}},k=0,1,\dots,n-1 \tag{22}$$

Take $\hat{x}^{(1)}=\hat{x}^{(0)}=\hat{x}^{(0)}(1)$, and solve out:

$$\hat{x}_{k+1}^{(0)}=\hat{x}_{k+1}^{(1)}-\hat{x}_k^{(1)} \tag{23}$$

In the last step, the predicted value was detected to obtain the standard deviation of the original data S_1, and the standard deviation of the residuals of all the predicted data S_2, and to calculate the posterior error ratio C:

$$C=\frac{S_2}{S_1} \tag{24}$$

We took the data into Matlab programming and calculated, and got the predicted results:

Table.7. Running results

Year	**2001**	**2002**
US	**233.3281**	**242.9247**
China	**97.9574**	**100.3379**

Among them, the posterior error ratio of the American forecast data is 0.096997, and that of the Chinese forecast data is 0.26718, both less than 0.35. Therefore, we believe that the two systems have good prediction accuracy.

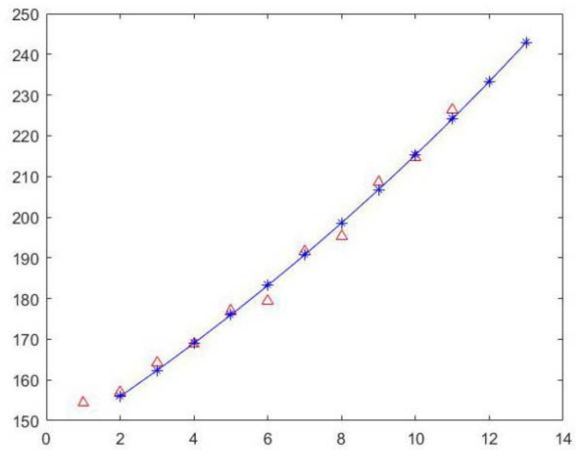

Figure 8. Fitting results for the United States

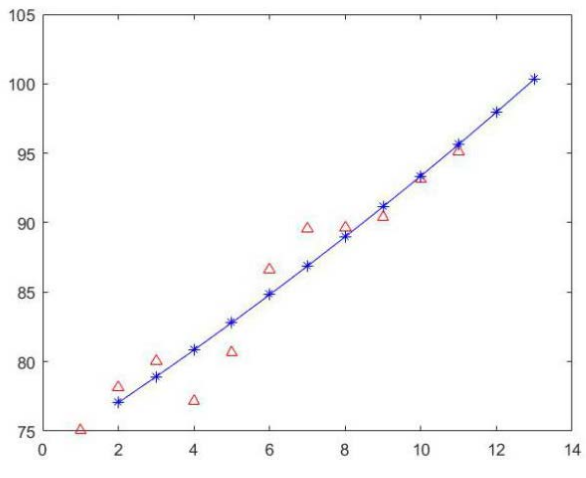

Figure 9. Fitting results for the China

Then we draw the model fitting curve, and get the following results:

As shown in figure 8 to 9, the two nations food system stability index H gradually rise, the country's food system is more and more stable, but in the case of fitting degree is higher, the curve is relatively flat, the current food system is indeed in a steadily improving system stability of the process, but there are still certain possibility changes, in line with our results in the fuzzy comprehensive evaluation model, so we establish the model precision is higher.

3.4. Task 4-Model extension and adaptive optimization

In the fourth task, since we need to discuss the generalizability of the model, we first discuss whether genetic algorithms can work for cities or continents.

At the urban level, we know that there are towns where agriculture has barely been developed, due to multiple factors such as location, climate, and biological resources[5]. Towns based on tourism, commerce or industry, for example, score low on indicators of agricultural machinery, crop output and agricultural output, meaning they are more likely to suffer from chromosomal deletion. In general, individuals born with a deletion of a chromosome have a very high mortality rate, and those who survive often carry symptoms, such as a deletion of chromosome 13 that has been linked to multiple myeloma[2]. In genetic algorithm, too, if with lack of chromosome in genetic algorithm, can directly lead to can't normal operation process, because the machine language and does not recognize this kind of situation, each evolutionary need to deal with chromosome encoding and decoding, so the execution to the place where the missing chromosomes, algorithm will either in infinite loop, will either stop counting. By analogy, this applies not only to agricultural machinery, agricultural output and crop output indicators, but also to other indicators.

So we unfortunately conclude that this model cannot be applied to cities.

We then test whether the model can be applied to larger states. Since continents contain countries, it is common sense that a continent has the same resources as a country. We have already mentioned in our hypothesis that continents are not uniform as opposed to countries, so the process of change in the food system of a continent is more chaotic than that of a country. It is difficult to determine the score of equity indicators because a continent contains a larger and more diverse group of people and generally has a wide range of levels of economic development, making it difficult to guarantee per capita food availability.

From continents index value, due to a state is a collection of a large area, you need to consider quite a number of factors, state the problem such as natural disasters happen within the situation is far more than one country, every index factor larger, higher frequency and amplitude is very unstable, so you need to get a continent of accurate and complete data is difficult. On the other hand, a continent is a collection of countries, so the data for the continent can also be obtained from the data for individual countries, so in theory the model can continue to work on the continent. But in fact, under the influence of many factors, there should be a huge error between the obtained value and the real value.

To sum up, we need to modify the current model. In order for the model to be used correctly in towns, we first tested for data omissions, that is, for chromosome deletions. Since cities lack some indicators compared with countries, we do not consider the missing indicators in cities and replace them with another indicator that can reflect the stability of the food system, such as food processing. After replacing the corresponding indicators, the genetic algorithm model can be applied to cities.

Continents and cities are different. The number of cities in the world is so large that it is difficult to count them, but the number of continents is only 7 continents. Therefore, we can store the data records of seven continents in advance. After reading the data, if the data type is found to belong to a continent rather than a country or a city, the current type will be determined as a continent. The next operation is similar to a city. It is only necessary to replace the index which is inconvenient to calculate in the continent with the index which is suitable to calculate in the continent, and then the genetic algorithm can be applied to the continent.

The problems of the fuzzy comprehensive evaluation model are similar to those of the genetic algorithm, including the lack of urban indicators and fuzzy membership evaluation criteria, but the solution is similar to that of the genetic algorithm.

Therefore, the model established by us can be successfully promoted by simple and reasonable modification according to the different conditions of cities and continents, which also reflects the adaptability of the model.

4. Conclusion

Through the establishment of a "Robust" G-FEEM model, our team evaluated the food system after the change of priorities, optimized the system for its sustainability and fairness, and predicted the time to realize the optimization. In order to compare the optimized model with the current model more objectively, we discuss the benefits and costs of optimizing food system priorities and select the United States and China for model testing and model checking to support our findings. Finally, we try to popularize the new food system, consider its limitations in urban and continental promotion, and optimize the model for related problems, so as to increase the universality and adaptability of the new food system.

5. Evaluation of the model

5.1. Strengths

Entropy weight method: The entropy weight method is used to calculate the index weight, and the weight is used as the basis of fuzzy comprehensive evaluation and genetic algorithm. It can avoid the influence of subjective factors brought by artificial scoring, and obtain objective scale.

Genetic algorithm model: The improved genetic algorithm model can more reasonably investigate the results after changing the priority of grain system, and help us to reasonably discuss the implementation time of system change, which has self-adaptability and better global optimization ability.

Fuzzy comprehensive evaluation model: Our team used the improved fuzzy comprehensive evaluation model to solve the problem. At the same time, the advantages of entropy weight method and fuzzy comprehensive evaluation method were integrated, and the requirements of various indicators for judgment were well combined, so that the food system with changed priorities could be evaluated more reasonably.

Grey prediction test: We use the grey prediction model to test the entropy-fuzzy comprehensive evaluation model, and the grey prediction has a higher accuracy than the fuzzy comprehensive evaluation. The final result of the grey prediction is highly consistent with the evaluation model, which also reflects the accuracy and rationality of the entropy-fuzzy comprehensive evaluation model.

5.2. Weaknesses

E - Genetic algorithm: entropy weight will still have a score index, which weakens the objectivity of the final result to a certain extent. Genetic algorithm is prone to inaccurate coding, and the efficiency of genetic algorithm is usually low, prone to premature convergence and other problems.

E-Fuzzy comprehensive evaluation: The calculation amount of fuzzy comprehensive evaluation method is relatively large. When the index set is large, the relative membership degree is often small, which may cause the result to appear hyper fuzzy phenomenon and make the evaluation failure.

6. Future Work

We will improve the stability of the food system evaluation model, do it can eliminate the influence of subjective factors, further and will collect more for determining food system stability index, the optimized food system can more reasonably reflect social, economic, and ecological three aspects of content, to establish a more complete and more realistic genetic system, in order to more accurately know fairness and sustainability of national food changes in the system, at the same time also can better predict the realization of the system change time, improve the potential replication of food system.

At last, we also advocate a series of relevant policy interventions by the state, in order to obtain higher benefits at lower cost and improve the robustness of the national food system to the greatest extent.

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