RE-OPTIMIZING FOOD SYSTEMS

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Abstract: *at present, the world food system is unstable, some countries and regions still have unsolvable food problems, and the current food system has caused serious environmental problems. We will re-optimize the food system to produce more food on the premise of improving the environment. We mainly solve the following four problems.*
Key words: *AHP, Entropy weight method, GA, Stepwise regression.*

First of all, according to the efficiency, profitability, fairness and sustainability, we collected the data of seven indicators of total grain output, average yield per hectare, grain price, per capita cultivated land area, forest coverage rate, fertilizer use and meat production from FAO website, and analyzed the data trends of food exporting countries, importing countries and self-sufficient countries in the world through data visualization. We come to the conclusion that the total grain output of grain exporting countries remains stable, the average output per hectare gradually increases, and the per capita cultivated land area decreases. The total grain production and average yield per hectare of food importing countries are obviously lower than those of food exporting countries, and the per capita cultivated land area has an increasing trend. Food self-sufficient countries are basically stable in terms of total amount and per capita cultivated land area every year, and the average output per hectare fluctuates greatly every year.Then, we established the evaluation system of the current world food system by using the seven indicators in the first step, and determined the weights of the seven indicators by AHP and entropy method. Combined with the data of the world food in these seven indicators, we scored the efficiency, profitability, fairness and sustainability of the current food system. We draw the conclusion that the current food system scores higher in efficiency and profitability, which are 0.3961 and 0.3245 respectively. The scores of fairness and sustainability are low, which are 0.1365 and 0.0082 respectively.

Next, we changed the priority order of the current food system and optimized the food system from the aspects of sustainability and efficiency. In the aspect of sustainability, we seek the optimal solution by finding the minimum value of fertilizer use, the maximum value of forest cover and the minimum value of meat production. In terms of efficiency, we seek the optimal solution through the lowest purchase price of grain. We use genetic algorithm to generate 80 individuals. After 100 iterations, the crossover probability is 0.5 and the mutation rate is 0.1. And the time taken to realize the optimized result is predicted by stepwise regression. After optimization the total output increased by 5.38%, the average area yield increased by 2.67%, the grain price decreased by 6.35%, the per capita cultivated land area increased by 5.36%, the forest coverage rate increased by 5.97%, the fertilizer consumption decreased by 12.36%, and the meat yield decreased by 6.23%. It is predicted that this will be achieved in 19 years.Finally, we apply the optimized model to developed countries-the United States and developing regions-South America and China. It is found that for developed countries, the efficiency and sustainability change little, but they still improve. For developing regions, the efficiency and sustainability have been significantly improved, so the model has better scalability and adaptability.