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Research on Food Security Evaluation Model based on data implicit Distribution Mining algorithm

Weiyao Li[1], Ziqi Bao[2], Jinyan Zhang[1]

[1]*School of Communication Engineering, Beijing Jiaotong University, Beijing 100044*

[2]*School of Economics and Management, Beijing Jiaotong University, Beijing 100044*

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Abstract: In recent years, the global food crisis has become increasingly serious. Therefore, we hope to build a new model of grain supply system to maximize the overall benefit of grain under the constraints of objective conditions. We first collect agricultural data from countries with different levels of development. Then, we use entropy method and TOPSIS model to construct the evaluation model of grain supply system, and compare the internal analysis and weight of different data. After comprehensively measuring the four aspects of grain production conditions, environmental sustainability, fairness and profit, we apply the model to value evaluation. The results show that sustainability and equity are important indicators.

1. Introduction

In recent years, with the outbreak of the world food crisis [1], the Food and Agriculture Organization of the United Nations raised the issue of food security for the first time and defined food security. That is, the ultimate goal of food security should be to ensure that all people can buy and afford the basic food they need at any time [2].

For a long time, the total world grain output fluctuates around 2 billion tons every year. At the same time, the world's population is growing at a rate of 1.3% [3]. As a result, the number of hungry people around the world has been increasing since the beginning of this century. In this paper, to solve the problem of world food security as a starting point, in view of its complexity, arduousness and long-term solutions as the goal. Unlike most studies, the research content of this paper aims to pursue higher efficiency and efficiency, and the research on environmental protection and social equity is also within the scope of this paper.

2. Optimization model based on environment and output value

When the team members analyze the opposite effects of the environment and output value, there are many impacts due to the environment and output value, and often both have negative effects. Through literature analysis, the following three aspects have the most significant impact on the environment and output value. Analyze them individually as variables:

- Amount of fertilizer applied to crops
- Crop planting density

● Amount of pesticide plastic used

Through the literature [4], it is found that the use of chemical fertilizers, farming density, pesticides and plastics in different countries are not only related to the geographic location of the country, but also closely related to the degree of development of the country or region. According to the reference, we found that the three indicators of impact mainly have a positive impact on the output value, but have a negative impact on the environment (land fertility). We list the symbols and notations used in this paper in Table 1.

Table 1: Symbols and Definitions

Symbols	Meanings	Unit
Y_1	yield	Ten thousand plants
X_1	Fertilizer usage	g/hm^2
X_2	Planting density	Ten thousand plants/hm^2
X_3	pesticides and plastics	g/hm^2

We can know through a large amount of literature analysis that soil fertility is mainly related to chemical fertilizers, cultivation density, and independent variables of cultivation rotations. Under normal circumstances, soil fertility is inversely proportional to the three related factors. And through the literature, it was found that the specific gravity impact factors were 3:2.2:1.1.

We assume that the health value of land fertility is Y, and the full score index is 100. According to the amount of fertilizer used, the intensity of cultivation density and the number of rotations form a functional relationship [5]:

$$Y_2 = 100 - 0.3 * X_1^3 + 0.4 * X_2^{2.2} - 0.3 * X_3^{1.2}$$

3. Multi-objective linear regression analysis to obtain profit and distribution relationship

Based on the data, we used multiple linear regression analysis to obtain the relationship between the grain production environment and grain output and the use of different fertilizers, pesticides, plastic films, and environmental quality under different cultivation densities.According to the Gauss-Markov linear model:

$$\begin{cases} Y = X\beta + \varepsilon \\ E(\varepsilon) = 0, \mathrm{COV}(\varepsilon, \varepsilon) = \sigma^2 I_n \end{cases}$$

$$Y = \begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{bmatrix}, X = \begin{bmatrix} 1 & x_{11} & x_{12} & \cdots & x_{1k} \\ 1 & x_{21} & x_{22} & \cdots & x_{2k} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 1 & x_{n1} & x_{n2} & \cdots & x_{nk} \end{bmatrix}, \beta = \begin{bmatrix} \beta_0 \\ \beta_1 \\ \vdots \\ \beta_k \end{bmatrix}, \varepsilon = \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \vdots \\ \varepsilon_n \end{bmatrix}$$

Obtain the multiple linear regression plane equation:

$$y = \beta_0 + \beta_1 x_1 + \cdots + \beta_p x_p$$

Use the least square method to find the estimator of $\beta_0, \ldots, \beta_k$as the sum of squared deviations

$$Q = \sum_{i=1}^{n} (y_i - \beta_0 - \beta_1 x_{i1} - \cdots - \beta_k x_{ik})^2$$

Choose $\beta_0, \ldots, \beta_k$ to make Q reach the minimum,we gain,

$$\hat{\beta} = (X^{\mathrm{T}} X)^{-1} (X^{\mathrm{T}} Y)$$

Then perform an R test to detect the degree of fit of the function expression:

$$r=\frac{\sum_{i=1}^{n}(x_i-\bar{x})(y_i-\bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i-\bar{x})^2\sum_{i=1}^{n}(y_i-\bar{y})^2}}$$

When $|r|>r_{1-\alpha}$, refuse to accept，If it is within the confidence interval, accept it.

Among them $r_{1-\alpha}=\sqrt{\frac{1}{1+(n-2)/F_{1-\alpha}(1,n-2)}}$.

The figure 1 is an analysis of the error:

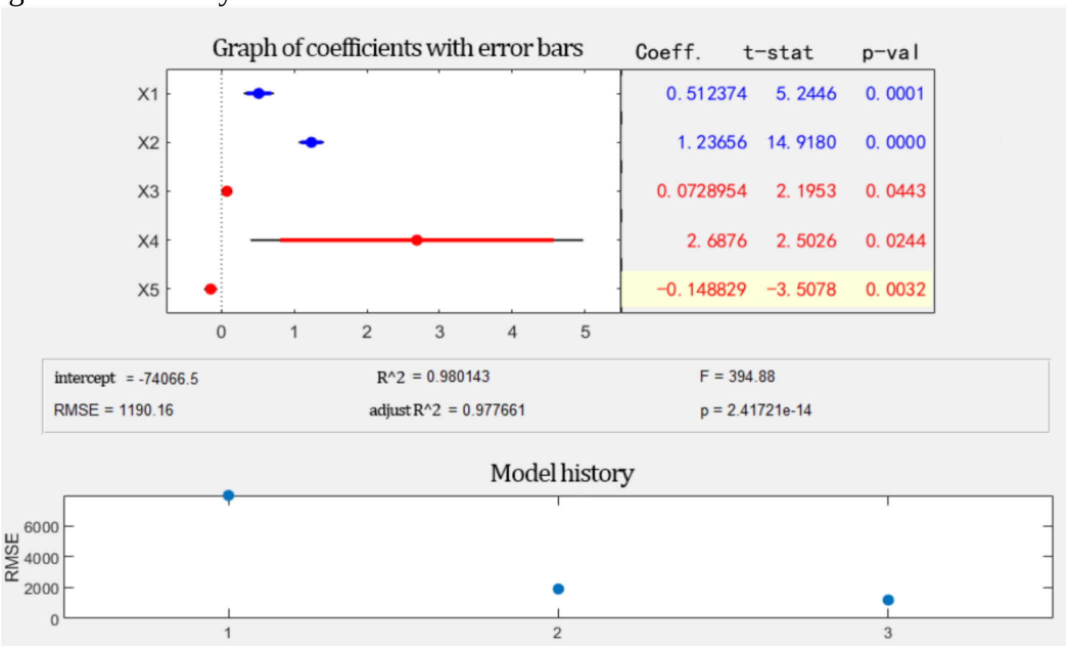

Figure 1: Analysis of the error

4. Comprehensive evaluation model of food indicators

The main methods used are entropy method and TOPSIS model

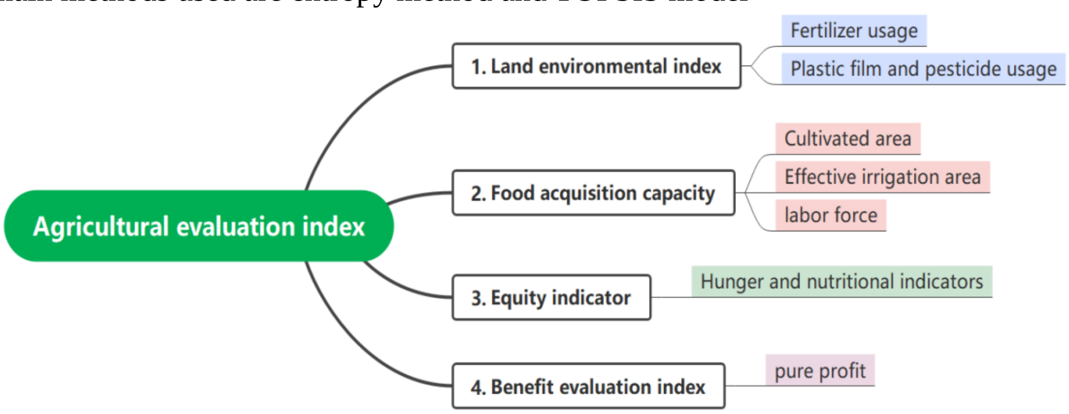

Figure 2: Model frame diagram

In the agricultural price evaluation, we mainly consider the above four types of indicators, and refine the broad categories of indicators, look for representative national data in different continents for relevant processing, and establish a more reasonable evaluation mechanism:

(1) Use the entropy method to determine the weight of each variable

1. Co-trend processing of indicators

For positive indicators: $z_{ij} = \frac{x_{ij} - \min(x_j)}{\max(x_j) - \min(x_j)}$

For negative indicators: $z_{ij} = \frac{\max(x_j) - x_{ij}}{\max(x_j) - \min(x_j)}$

2. Standardized processing of various indicators:

$$z_{ij} = \frac{x_{ij} - \min\{x_{1j}, \dots, x_{nj}\}}{\max\{x_{1j}, \dots, x_{nj}\} - \min\{x_{1j}, \dots, x_{nj}\}}$$

Get the data matrix:

$$X = \begin{bmatrix} 1.54 & 1.57 & 1.12 & 1.14 & 1 & 1.24 & 1.45 \\ 1.38 & 1.07 & 1 & 1 & 2 & 2 & 1 \\ 1 & 1 & 1.47 & 1.31 & 1.98 & 1.01 & 1.37 \\ 2 & 2 & 2 & 2 & 1.95 & 1 & 2 \\ 1.89 & 1.86 & 1.50 & 1.48 & 1.99 & 1.29 & 1.80 \end{bmatrix}$$

3. Calculate information entropy:

$$H(X) = \sum\nolimits_{i=1}^{n} [p(x_i) I(x_i)] = -\sum\nolimits_{i=1}^{n} [p(x_i) \ln(p(x_i))]$$

Calculate the proportion of the i-th item under the j-th index in the index:

$$p_{ij} = \frac{Z_{ij}}{\sum\nolimits_{i=1}^{n} z_{ij}}, i = 1, \dots, n, j = 1, \dots, m$$

Then calculate the entropy value of the j-th index:

$$e_j = -k \sum\nolimits_{i=1}^{n} p_{ij} \ln(p_{ij})$$

Which satisfies: $k = 1/\ln(n) > 0$, $e_j \geq 0$

4. Calculate the information utility value:

$$d_j = 1 - e_j$$

According to the requirements of the topic, obtain the information utility matrix in vector form:

$$dx = [0.0172 \quad 0.0233 \quad 0.0185 \quad 0.0186 \quad 0.0172 \quad 0.0223 \quad 0.0166]$$

5. Calculate the weight of each indicator:

$$w_j = \frac{d_j}{\sum\nolimits_{j=1}^{m} d_j}$$

From this, we can get the weight ratio of each indicator: $W = [0.1288 \quad 0.1747 \quad 0.1381 \quad 0.1389 \quad 0.1286 \quad 0.1669 \quad 0.1240]$

5. Conclusion

The simulation results show that among the evaluation indexes, the factors affecting pesticide plastic damage and distribution fairness are the most significant. This is also in line with the evaluation model of future agricultural development, paying more attention to redistribution and environmental protection, and taking into account other aspects such as benefits and benefits.

References

[1] Luo, N., Lennon, O., Liu, Y., 2021, A Conceptual Framework to Analyze Food Loss and Waste within Food Supply Chains: An Operations Management Perspective.13 (2), pp.927-927.

[2] Fahad, S., Sonmez, O., Saud, S., Wang, D., Wu, C., Adnan, M., Turan, V., 2021, Developing Climate Resilient Crops: Improving Global Food Security and Safety.

[3] Shi, X., Wei, W., Fu, Z., Gao, W., Zhang, C., Zhao, Q., Deng, F., Lu, X., 2019, Review on carbon dots in food safety applications. Talanta, 194, pp.809-821.

[4] Yu, X., Ge, J., Song, W., 2002, Application of Rotating Regression Analysis in Increasing Crop Yield. Mathematical Statistics and Management, 2004(2), pp.7-9.

[5] Mo, H., 1980, Planting density and crop yield-the quantitative relationship between yield and density and its analysis (continued). Journal of Jiangsu Agricultural College, 1980(3), pp. 12-26.