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Evaluation on Sustainable Food Security in Henan against the Background of Low-Carbon Economy

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Abstract

New requirements for sustainable food security are set against the background of Low-Carbon Economy (LCE). LCE Influences on sustainable food security include “Minimization” principle and “Recycling” principle. The present situation of sustainable food security in Henan Province is analyzed quantitatively. Preliminary conclusion is that, energy consumption in grain production and proportion of agricultural population in Henan Province is relatively large, the level of deep processing of agricultural products is too limited. On this basis, suggestions on sustainable food safety are given， such as the development of water-saving agriculture, reduction of energy consumption in agriculture and so on.

Key words: Sustainable Food Security; Low-carbon Economy; Agriculture; Food Security;Factor Analysis

1. Introduction

The concept "sustainable food security" was proposed on the world's sustainable food security meeting, in September 2001, in Bonn, Germany.

Sustainable food security is based on the sustainable development strategy, which is guaranteed to meet the health requirements of contemporary people, without endangering the needs of future generations. Grain and other major food production should be based on the protection of agricultural ecological environment for sustainable development. LCE Influences on sustainable food security become clear today. LV Aiqing, and BIAN Xinmin[1], used the method of analytic hierarchy process (AHP) to assess sustainable food safety in Jiangxi Province. XU Shiwei[2] analyzed the contents of food security, which mainly embodied a stable production capacity, reasonable structure of food varieties, the higher rate of food self-sufficiency and healthy food consumption pattern,etc..Li Daoliang, Fu Zetian[3] studied the case on sustainable food security in China from 1978 to 1998 with Fuzzy

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Evaluation Method and Comprehensive Index Method. Zach Willey, Bill Chameides [4] researched Harnessing Farms and Forests in the Low-Carbon Economy, and put forward steps in Determining Greenhouse Gas Offsets.

2. Data

This data comes from "Henan Statistical Yearbook"(2009). The main choice of indicators, are as follows：
X1： Total Power of Agricultural Machinery (10000kw)；
X2： Consumption of Chemical Fertilizer by 100% Effective Component (10000tons);
X3： Electricity Consumption in Rural Areas (100 million kwh)；
X4： Grain Insemina-tion Area (1 000 hectares)； X5： Effective Irrigated Area (1000 hectares)；
X6： Employed persons in Rural Area (10 000persons)；
X7： Urban Household Engel's Coefficient (%)； X8： Disposable Income Index (%)；
X9： General Price Index of Agricultural Means of Production;
X10： Area Covered (1000 hectares)；
X11： Rural Household Engel's Coefficient (%)； X12： Grain Yield (10 000 tons).

3. Methods

The data is analyzed by SPSS 13.0 statistics software. 12 factors are selected to evaluate sustainable food security degree with the method of factor analysis.

3.1 Data Treatment

Index system to evaluate sustainable food security in Henan Province includes positive indexes and negative indexes.

positive indexes: AXi=(Xi-MinXi)/(MaxXi-MinXi) (1)

negative indexes: AXi=(MaxXi-Xi)/(MaxXi-MinXi) (2)

With this approach, the various indicators fluctuated in range of 0～1. X7,X10 and X11 are negative indicators, others are positive.

3.2 Conditions of Factor Analysis

KMO test result is 0.773, Chi-Square value of Bartlett's test results is 718.866, and sig. value is 0.000. It indicates that there is strong correlation between variables, which is suitable for factor analysis.

3.3 Factor Extraction and Naming

The method of factor extraction is Principal Components Analysis. All factors whose eigenvalues exceed 1 are extracted. The method of Factor Analysis Rotation is Varimax Method.

Table1 Rotation Sums of Squared Loadings

Total	% of Variance	Cumulative %
8.004	66.698	66.698
1.433	11.940	78.638
1.387	11.556	90.194

As shown from Table 1, there are 3 factors whose eigenvalues exceed 1.That is to say, 3 Principal Components are extracted, whose Cumulative Rotation Sums of Squared Loadings is 90.194%.

Table 2 Rotation Sums of Squared Loadings

		f1	f2	f3
	AX1	0.961	0.155	0.192
	AX2	0.980	0.143	0.076
	AX3	0.962	0.151	0.194
	AX4	0.105	0.027	0.981
	AX	0.932	0.131	0.228
	AX5	0.943	0.220	-0.041
	AX6	0.976	0.117	0.004
	AX7	0.947	0.156	0.056
	AX1			
1		0.773	0.069	0.510
	AX8	0.041	0.857	0.134
	AX9	0.956	0.113	0.041
	AX1			
0		0.253	0.714	-0.087

According to Table 2，Component 1(f1) includes AX1, AX2, AX3, AX5, AX6, AX7 and AX12, which can be described as conditions of production factor, whose variance contribution rate is 66.698%. Component 2（f2）consist of AX8 and so on, called Farmers Disposable Income factor, whose variance contribution rate is 11.940%. Component 3（f3）includes AX4, able to be named Grain Insemina-tion Area factor, whose variance contribution rate is 11.556%.

3.4 Calculation of factor scores

The factors extracted in the final solution are saved as new variables with the method of regression for calculating the factor scores.

The accumulative variance contribution of three factors is taken as weights to calculate the F value of all regions.

$$F = (66.698\%F1 + 11.940\%F2 + 11.556\%F3)/90.194\% \quad (3)$$

By the above formula (3), the corresponding F value in various regions can be calculated. According to the size of F values, a comprehensive evaluation of each year can be conducted for evaluating level of sustainable food security in Henan Province. The results are shown in Fig. 1:

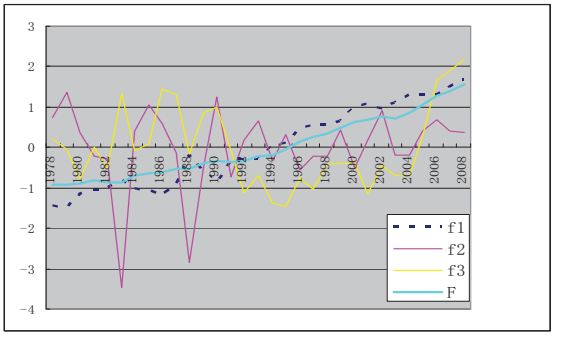

Fig.1 Factor scores of f1, f2, f3, and F

4. Results

As shown in Fig. 1, from 1978 to 2008, conditions of production factor（f1）show rising trend, which is a major factor to determine F trends in Henan Province.

Farmer's Disposable income factor (f2) has a larger fluctuation, without obvious upward trend.

Grain Insemina-tion Area factor (f3), whose fluctuation is large, has an upward trend after 2004.

Agriculture is one of greenhouse gases sources, while climate change threatens agricultural production and food security.

4.1 Low-Carbon Economy and grain production in Henan

Carbon emissions in every unit GDP are used for measuring development of Low-Carbon Economy. There is no direct indicator to measure the level of Low-carbon economy in the agriculture field.

Among the indicators of reflecting production conditions, AX1 AX2 AX3 shows the level of development of Low-Carbon Economy.

AX1, AX2 and AX3 need to consume coal, electricity, petroleum and other energy sources. This will improve the level of carbon dioxide and Nitrogen emissions.

Production conditions must be improved in order to keep sustainable food security in Henan. Against the background of Low-carbon Economy, energy consumption should be lowered, which may reduce food production now. Therefore, food production should not only meet the requirements of agricultural development, but also the requirements of Low-Carbon Economy.

4.2 Proposals on sustainable food security development in the context of Low-Carbon Economy in Henan

LCE influences on sustainable food security include "Minimization" principle and "Recycling" principle. "Minimization" principle should be complied with in agricultural production, which requires to reduce the use of land, water, fertilizer, pesticides, oil, coal and other resources. Recycling principle demands that the by-products and organic waste should be used again after all kinds of agricultural products are processed.

4.2.1 Reduction of Energy Consumption in Agriculture

During year 2005-2008,Total Energy Consumption of Farming, Forestry, Animal Husbandry, Fishery and Water Conservancy is 461, 483, 472, and 478 (10 000 tons of standard coal equivalent). In order to ensure sustainable food security in Henan, we must reduce energy consumption levels.

4.2.2 Water-saving Agriculture

The proportion of agricultural water consumption in the total water volume is 57.9%, 65.4%, 57.4% , and 55.4% from 2005 to 2008. Other uses include Industry Consumption and Biological Protection. Agricultural consumption of water occupies the major part of the total water use. Therefore, water-saving agriculture is beneficial to promote sustainable food security.

4.2.3 Lower Proportion of Agricultural Population

Decreasing proportion of agricultural population reflects the transformation process from the agricultural society to industrial society, which will help improve agricultural productivity, raise farm income levels and to protect food production sustainable development.

From 1978 to 2008, agricultural population goes down from 86% to 64% in Henan. The proportion of agricultural population is so high that it should be reduce further.

In short, sustainable food safety in Henan was assessed based on 12 indexes available. Results showed that it was increasing during the period of 1978─2008.Against the background of Low-Carbon Economy, recommendations to maintain sustainable food security in Henan, include the development of water-saving agriculture, reduction of energy consumption in agriculture, lower proportion of agricultural population and so on.

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