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Study on Grain Yield Changes and Driving Factors in Shanxi Province from 1999 to 2018

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Abstract: In-depth understanding of the changes in grain production in Shanxi Province, and studying its main influencing factors, can provide scientific and reasonable theoretical references for the construction of food security policies.This paper selects the grain output data of Shanxi Province from 1999 to 2018 as the basic data, and uses the principal component analysis method to explore the main influencing factors of grain output change.The results show that the grain output of Shanxi Province has increased in fluctuation, and the development trend of total grain output, per capital grain output and grain output per unit area is basically the same. The results of the principal component analysis divide the 11 factors that affect food production into two principal components, which are the two components of agricultural modernization input and technology level and land input level. From the two component analysis, the agricultural diesel consumption and agricultural machinery are found. The total power and other factors reflect that the improvement of agricultural modernization has an increasingly significant impact on grain production and output, and has a great promotion effect on grain production. The increase in the use of agricultural materials such as fertilizer application, rural employees, and agricultural plastic film usage can increase Provincial grain production.

1. Introduction

With the continuous growth of the world population, the rapid advancement of urbanization and the continuous expansion of land desertification, food plays an increasingly important role, and people's demand for food and other natural resources increases year by year. The relationship between supply and demand of food is a severe challenge.For China's grain production, some experts and scholars have conducted in-depth studies, mostly from the spatial changes of grain production, stage characteristics [1-2], influencing factors [3-4] and other aspects.Song Xiaosong pointed out that agricultural labor force and crop sown area are the most important factors affecting grain output;

Fertilizer increases crop yield to a certain extent, and the control of fertilizer application amount will affect crop yield and pollute the environment [5]. Liu Jiping et al. analyzed the change of grain yield in Jilin Province through spatial autocorrelation model, and found that grain yield in Jilin Province had obvious spatial aggregation, analyzed the main factors affecting the change of grain yield, and found that the influence of chemical fertilizer usage amount and machine-cultivated area and other factors on grain yield showed a gradually increasing trend [6]. Ye Hui et al. believed that the survival of crops is based on natural resources such as water, air and soil, and in addition, the growth factors related to their survival also include scientific and technological production factors such as the mechanization of agricultural science and technology and human factors such as various planting systems formulated by people [7]. Xiao Haifeng et al. found that the planting area of grain, the degree of fertilization and the use of other materials played a direct role in the growth of grain, and the shortage of sown area also greatly limited the output of grain output [8]. Hu Wenhai et al. pointed out that the relationship between effective irrigation area, sown area and disaster area of crops must be studied as a key factor in order to understand the problem of grain yield [9].

Based on the predecessors' research results, from the historical trajectory of shaanxi province grain production (1999-2018), using principal component analysis to explore the driving factors of shaanxi province grain production changes, to find the influence of different driving factors on grain output, for stable system of shaanxi province grain production and related departments to provide theoretical support and scientific basis for food production decisions.

2. Data sources and research methods

2.1 Data sources

The data in this paper are mainly from China Statistical Yearbook (1999-2018) of National Bureau of Statistics of China, and some statistical data are from Shaanxi Statistical Yearbook (1999-2018) of Shaanxi Provincial Bureau of Statistics.

2.2 Research Methods

This paper studied the driving factors of grain yield change in Shaanxi Province by principal component analysis. The core of principal component analysis is dimensionality reduction for all variables, that is, extracting the information reflected by all selected variables as much as possible, and condensing the complex multivariables into several independent comprehensive indexes by means of linear transformation, and the extracted indexes are called principal components [13]. Principal component retains the vast majority of information of original variables (≥85%). Principal component analysis can simplify the complexity of the problem, grasp the main contradiction of the problem, and reveal the law between internal variables of things.The amount of information extracted from each principal component is measured by variance. The greater the variance, the more information of the original variable is contained in the principal component. In general, the first principal component has the largest variance and contains the most information.If the first principal component is not enough to represent the information of the original variable, the second principal component will be selected, but the information represented by the second principal component no longer contains the existing information of the first principal component, and so on, each principal component will remain independent. Therefore, F1, F2...Fm is the first, second, and...For the m principal component, the steps of principal component analysis are as follows:

$$Fp = a_{1i} \times Z_{X1} + a_{2i} \times Z_{X2} + a_{pi} \times Z_{Xp} \quad (1)$$

In the formula, a1i, a2i....., the API (I=1,...,m) is the eigenvector corresponding to the eigenvalue of the X covariance matrix, ZX1, ZX2....., ZXp is the value of the original variable after standardization.Standardization processing is because in practical applications, there are often dimensional differences in indicators, so it is necessary to standardize the original data before calculation to eliminate the impact of dimension.

The data compression and interpretation transformation of principal component analysis are independent of each other, and the effect of principal component analysis becomes more obvious with the correlation between the parameters.Therefore, the research factors, i.e. independent variables, selected in the principal component analysis should have strong correlation with the dependent variables.

3. Interpretation of result

3.1 Analysis of grain yield fluctuation trend in Shaanxi Province in recent years

According to the trend analysis of the grain data of Shaanxi Province from 1999 to 2018, the grain output showed a fluctuating growth trend in general, and the change trend of the per capita grain output and grain yield per unit area was synchronized with the change trend of the total grain output.

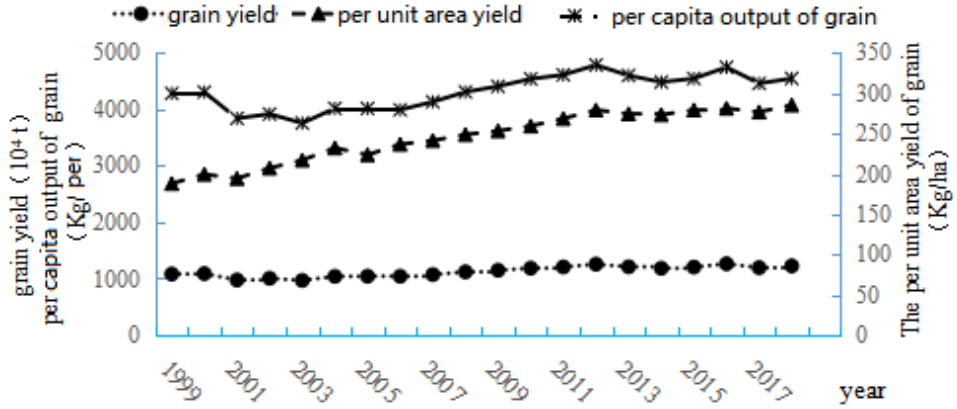

Figure. 1 Dynamics and development trends of grain production in Shanxi Province from 1999 to 2018

This can be seen from Figure 1,over the past 20 years in shaanxi province grain production is roughly divided into three stages: the first phase of 1999-2006, the stage showed a trend of falling volatility and grain production from 26.916 million t to 24.4273 million t,7 years total grain output steadily declining trend, but the drop is small, the overall reduction of 9.24%, falling at a slow pace.In this stage, the overall development trend of yield per unit area showed repeated up-down fluctuation, and there were 2 peaks and 2 valleys in 7 years. The change was not stable, but the overall trend of yield per unit area increased.The general trend of grain output per capita was consistent with the change of total grain output, showing a fluctuating downward trend. It decreased from 299.86Kg/ person in 1999 to 279.52Kg/ person in 2006, with a small decrease of 6.78%.The second stage is from 2007 to 2012. In this stage, the total grain output showed a slow growth trend. The total grain output increased from 10.719,800 t in 2007 to 12.559,200 t in 2012, with an increase rate of 17.2%.The third stage is from 2013 to 2018. In this stage, the development of total grain output is unstable, but the fluctuation range is small. The change of every two years is maintained within 500,000 tons, so the development of total grain output is basically stable in this stage.The yield per unit area and per capita grain yield were consistent with the trend of the total yield of snacks, with small fluctuations

throughout the whole stage. The yield per unit area changed within 90kg every two years, and the per capita grain yield changed within 20kg.

3.2 Principal component analysis results

Select the fertilizer application amount after purification (X1),Total sown area of crops (X2),Consumption of diesel oil for agriculture (X3),Pesticide usage amount (X4),Total power of agricultural machinery (X5),Effective irrigated area (X6),Gross Agricultural Output Value (X7),Rural Employees (X8),Usage amount of plastic film in agriculture (X9),Area sown to grain crops (X10),Area of cultivated land (X11) as the main influence factor of grain output.

Table 1 Principal Component Load Matrix

factors	principal components	
	1	2
X_1	0.968	0.121
X_2	-0.315	0.920
X_3	0.974	0.101
X_4	0.917	0.293
X_5	0.948	0.014
X_6	-0.842	0.127
X_7	0.978	-0.010
X_8	0.964	0.177
X_9	0.983	0.146
X_{10}	-0.631	0.723
X_{11}	0.792	0.065

The main factor in the first principal component has nine, respectively is appropriate amount, agricultural fertilizer after SheChun diesel usage, pesticides, agricultural machinery total power, effective irrigated area, agricultural output, rural workers, agricultural plastic film use and cultivated land area, the correlation coefficient of 0.968,0.974,0.917,0.948,0.842, 0.978,0.967,0.983 and 0.792.The 9 factors mainly reflect the agricultural modernization and agricultural input degree of grain production in Shaanxi Province. Therefore, the first principal component can be defined as the principal component of agricultural modernization and input level, and its contribution is as high as 75.555%, indicating that agricultural modernization input and technical level are the main influencing factors of grain output in Shaanxi Province.The second key factor in the principal component is the total sown area of crops and the sown area of grain crops,the correlation coefficients were 0.920 and 0.723,These two influencing factors mainly reflect the impact of land input on the grain output of Shaanxi Province.In conclusion, the driving factors affecting the evolution of grain in Shaanxi Province can be summarized into two categories: agricultural modernization input, technological level and land input level.

4. Conclusion

(1) The variation characteristics of grain output in Shaanxi Province from 1999 to 2018 are mainly shown in two aspects.First, in the past 20 years, the overall trend of grain output was fluctuating and increasing, but in the past 5 years, the change range of grain output was relatively slow.Second, the dynamic change characteristics of total grain output, per capita grain output and grain output per unit

area are basically consistent.

(2) Agricultural modernization input and technology level and land input level are the main factors affecting the grain yield change in Shaanxi Province.

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