



# Statistical Analysis of Farmland Big Data Based on Kuznets Curve——Take Hebei Province as An Example

Da Gao<sup>1a\*</sup>, Yadi Liang<sup>1b\*</sup>

<sup>1</sup>School of Finance and Economics, Qinghai University, Xining 810000, China

<sup>a</sup>\*450978645@qq.com, <sup>b</sup>\*503767783@qq.com

## Abstract

After the 14th Five-Year Plan, improving agricultural quality, efficiency and competitiveness has become the focus of current agricultural work. As a major agricultural province, Hebei Province has also issued various relevant policies and schemes to improve the quality and efficiency of agricultural resources in the province. Economic statistical analysis under big data is also an inevitable trend of agricultural development. This paper uses Kuznets curve to sort out the relevant data of farmland environmental protection and economic development in Hebei Province in recent 20 years, and makes statistical analysis on them, in order to provide new ideas for the high-quality development of agriculture in Hebei Province. The results show that the fitting curve between the application of agricultural chemical fertilizer, the use of agricultural plastic film and the use of pesticides and the GDP of the primary industry in Hebei Province shows an inverted "U" shape, which is in line with the Kuznets curve, while the fitting line between the use of pesticides and the GDP of the primary industry shows an inverted "n" shape at the initial stage, which decreases rapidly after reaching the peak in 2017, and shows an inverted "U" shape as a whole. This shows that with economic growth, farmland pollution in this province shows a downward trend.

**Keywords-**Agricultural economy; economic statistics; Kuznets Curve

## 1. Introduction

Hebei Province is located in the plain area of China. By the end of 2018, the cultivated land area had reached 65235000 hectares, accounting for 34% of the land area of the province, and the effective irrigation area was 4495.13 thousand hectares. In the national agricultural green development plan for the 14th Five-Year Plan issued by the Ministry of Agriculture and Rural Affairs, it is mentioned that it is necessary to strengthen the protection and utilization of agricultural resources, strengthen the prevention and control of agricultural non-point source pollution, strengthen the protection and restoration of agricultural ecology, and build a green and low-carbon agricultural industrial chain; According to the action plan on continuously deepening the "four agriculture" to promote high-quality agricultural development (2021-2025) issued by Hebei provincial government, to achieve high-quality agricultural development, give priority to ecology and promote green agriculture. Therefore, the research on farmland environmental protection is of great significance at present [1]. At the same time, the research on farmland

environmental protection should be combined in many aspects. This paper associates farmland environmental protection with economic development, and studies the correlation between them based on Kuznets curve.

## 2. Economic development of Hebei Province

### 2.1 Regional GDP

The economy of Hebei Province will maintain steady growth in 2020. According to the data and statistical results of the National Bureau of statistics, the regional GDP of Hebei Province will be 3.6 trillion yuan in 2020, with an annual growth rate of 3.51%. From 2001 to 2020, the regional GDP grew rapidly in fluctuation, the growth rate reached the highest in 2005, with an annual growth rate of 13.4%. After 2014, the annual GDP growth rate gradually slowed down and remained at about 6%.

## 2.2 Industrial structure

The economic growth of Hebei Province is mainly concentrated in the secondary and tertiary industries, indicating that the economy of Hebei Province is less and less dependent on the primary industry. In 2020, the GDP of the primary industry was only 388.01 billion yuan, an increase of 36.17 billion yuan compared with 2019. The secondary industry was 1359.72 billion yuan,

an increase of 20.35 billion yuan compared with 2019, and the tertiary industry was 1872.95 billion yuan, an increase of 66.3 billion yuan compared with 2019. As can be seen from Figure 1, the tertiary industry grew the fastest and surpassed the GDP of the secondary industry in 2015. Therefore, in recent years, Hebei Province has vigorously developed light industry and paid attention to industrial optimization. The GDP of the three major industries in Hebei Province is shown in Figure 1:

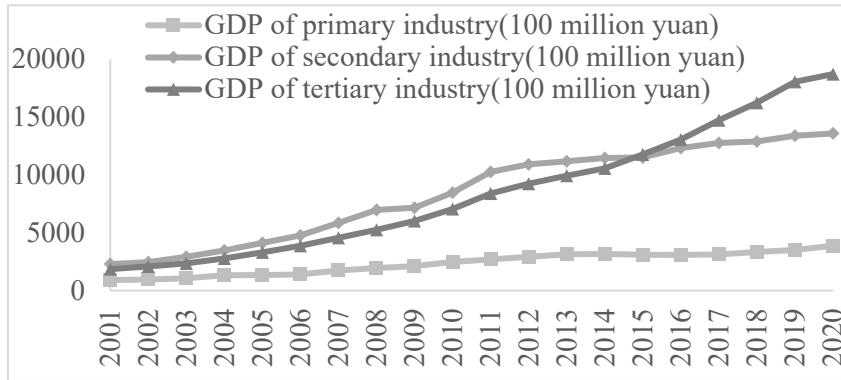


Fig.1 GDP of various industries in Hebei Province from 2001 to 2020

This paper selects the GDP index of the primary industry when studying the Kuznets curve of farmland environmental protection, because the GDP index of the primary industry is closely related to farmland environmental protection, and farmland pollution is directly related to the quality of agricultural products, which can reflect the specific situation of agricultural economic growth under the condition of farmland pollution<sup>[2]</sup>.

## 3. Farmland environmental protection in Hebei Province

### 3.1 Net application amount of agricultural chemical fertilizer

The change characteristics of farmland quality in Hebei Province are studied. Taking the change of net amount of agricultural chemical fertilizer application as an example, the net amount of agricultural chemical fertilizer application in Hebei Province from 2001 to 2020 is shown in Figure 2:

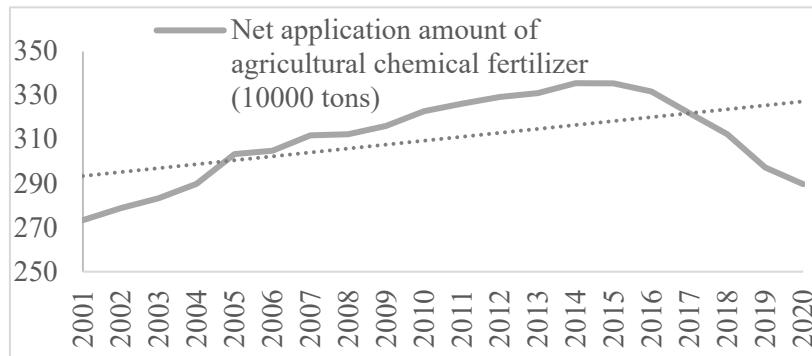


Fig.2 Net application amount of agricultural chemical fertilizer in Hebei Province from 2001 to 2020

It can be seen from the broken line chart of net application amount of agricultural chemical fertilizer in Hebei Province that although the application amount fluctuated from 2001 to 2014, it generally showed an upward trend, reached the peak in 2014, and then began to show a downward trend. The rate of decline was rapid in 2016, and the application amount in 2020 was 289.7

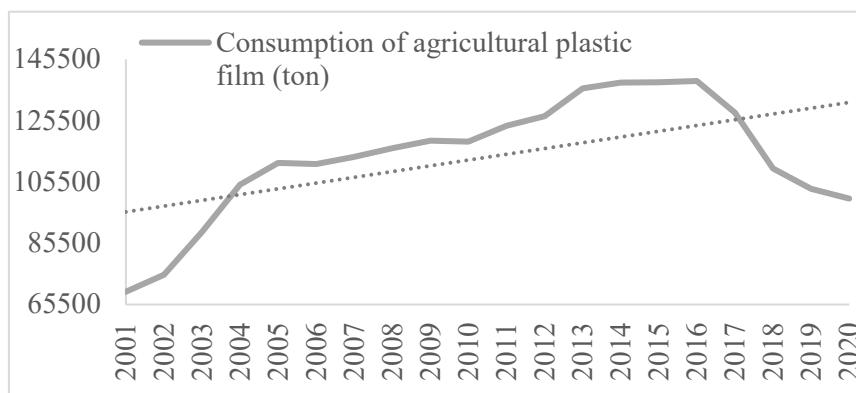
tons, a decrease of 45.91 tons compared with the peak of 335.6 tons in 2014. It shows that Hebei Province has made great efforts in the application, treatment and control of agricultural chemical fertilizer in recent years.

### 3.2 Consumption of agricultural plastic film

The use of agricultural plastic film in Hebei Province is also a broken line chart from increase to decrease from 2001 to 2020. The use of agricultural plastic film in Hebei Province is shown in Figure 3:

From Figure 3, the use of agricultural plastic film in Hebei Province showed an overall upward trend from

2001 to 2020, indicating that the white pollution of farmland in Hebei Province is serious, and we still need to strengthen control and treatment. In 2016, the usage peaked at 1338434 tons, compared with 69641 tons in 2001, with an increase of 18%. The growth rate accelerated from 2001 to 2005, and then began to grow steadily. It began to decline gradually in 2017, with a rapid decline rate.

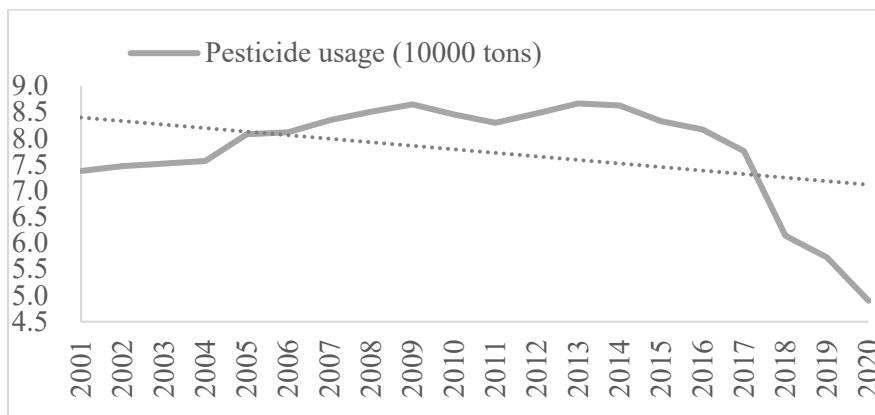


**Fig.3** Consumption of agricultural plastic film in Hebei Province from 2001 to 2020

### 3.3 Pesticide usage

In addition to the above reduced amount of agricultural chemical fertilizer and agricultural plastic film, there have also been significant changes in the

control of pesticide use in Hebei Province in recent years. The pesticide use in Hebei Province from 2001 to 2020 is shown in Figure 4:



**Fig.4** Pesticide usage in Hebei Province from 2001 to 2020

According to figure 4, it can be found that in the past 20 years, the pesticide use in Hebei Province fluctuated greatly and showed a downward trend. Especially after 2017, the pesticide use in Hebei Province decreased rapidly and reached the lowest point in 2020. It shows that the use of pesticides in Hebei Province has been well controlled.

## 4. Empirical analysis of Kuznets curve of farmland environmental protection and economic development in Hebei Province

### 4.1 Index selection and data source

When studying the Kuznets curve of farmland environmental protection in Hebei Province, the economic development index selects the GDP of the primary industry, and the farmland pollution index selects three indexes: the application amount of agricultural chemical fertilizer, the use amount of

agricultural plastic film and the use amount of pesticide to analyze the farmland pollution Kuznets Curve in Hebei Province [3]. All data in this paper are from the National Bureau of statistics, Hebei Provincial Bureau of statistics and Official gazette of Hebei Province. When studying the Kuznets curve of farmland environmental protection, SPSS software is used for regression analysis, and quadratic polynomial and cubic polynomial models are used to analyze whether the relationship between the GDP of the primary industry and the application of agricultural chemical fertilizer, agricultural plastic film and pesticide is consistent with the Kuznets curve [4].

Kuznets curve is representative of quadratic polynomial function relationship, and the formula is:

$$y = \beta_0 + \beta_1 x_t + \beta_2 x_t^2 + u \quad (1)$$

In order to make the model have higher fitting degree, the cubic polynomial function relationship is also studied in this paper. The formula is:

$$y = \beta_0 + \beta_1 x_t + \beta_2 x_t^2 + \beta_3 x_t^3 + u \quad (2)$$

#### 4.2 Kuznets curve analysis of farmland environmental protection in Hebei Province

According to the correlation analysis between the application of agricultural chemical fertilizer, the use of agricultural plastic film and the use of pesticides and the GDP of the primary industry by SPSS, it can be seen from table 4.2.1and table 4.2.2 that the cubic polynomial is more suitable for the Environmental Kuznets curve. From the parameters in the table, it can be seen that the application of agricultural chemical fertilizer, the There is an inverted "U" curve relationship between the use of agricultural plastic film and pesticide and the GDP of the primary industry. The environmental pollution in line with the Kuznets curve will first increase and then decrease with the economic development.

**Table.1** Results of quadratic regression analysis between farmland environmental protection index and GDP of primary industry in Hebei Province:

Index	Model summary					Parameter estimate			
	R <sup>2</sup>	F	Degree of freedom 1	Degree of freedom 2	Significance	Constant	b1	b2	b3
Net application amount of agricultural chemical fertilizer (10000 tons)	.858	48.381	2	16	.000	200.220	.097	-1.838E-5	
Consumption of agricultural plastic film (ton)	.802	32.429	2	16	.000	3376.629	97.354	-.019	
Pesticide usage (10000 tons)	.568	14.119	2	16	.001	3.511	.005	-1.144E-6	

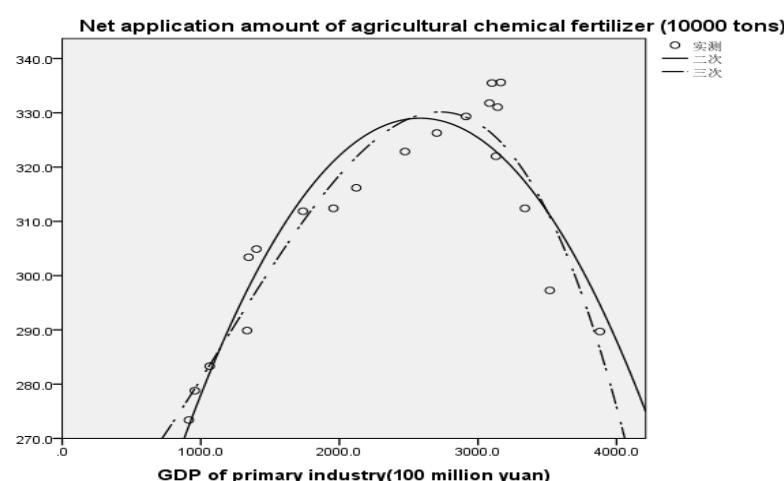
**Table.2** Results of cubic regression analysis between farmland environmental protection index and GDP of primary industry in Hebei Province:

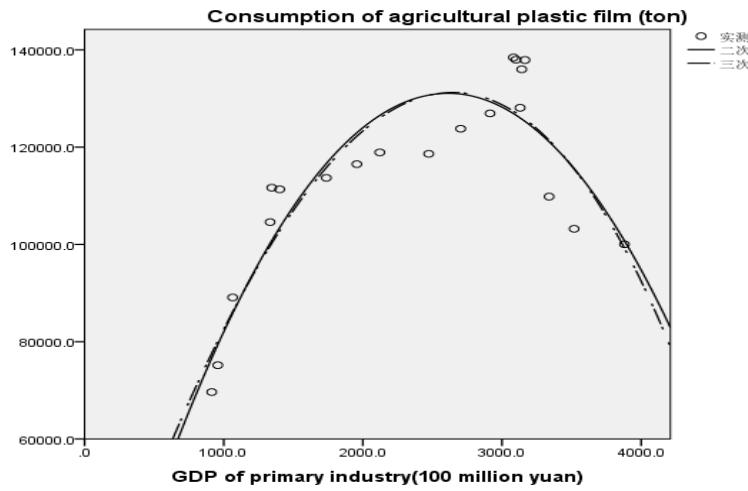
Index	Model summary					Parameter estimate			
	R <sup>2</sup>	F	Degree of freedom 1	Degree of freedom 2	Significance	Constant	b1	b2	b3
Net application amount of agricultural chemical fertilizer (10000 tons)	.892	41.394	3	15	.000	271.983	-.023	4.137E-5	-9.135E-9
Consumption of agricultural plastic film (ton)	.804	20.458	3	15	.000	18528.072	72.042	-.006	-1.929E-6
Pesticide usage (10000 tons)	.738	14.119	3	15	.000	10.204	-0.06	4.428E-6	-8.519E-10

According to figure.5, the net amount of agricultural chemical fertilizer application in Hebei Province is gradually decreasing. At present, the curve has crossed the peak of the inverted "U" curve. After reaching the peak in 2014, the data point has been on the right side of the inverted "U" curve [5]. With the gradual increase of the GDP of the primary industry, the application of agricultural chemical fertilizer decreased gradually.

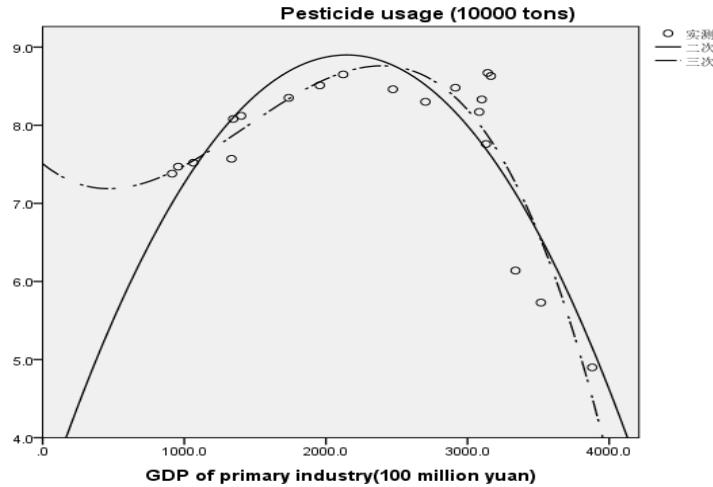
According to figure.6, the whole curve presents an inverted "U" shape. Before 2016, the use of agricultural

plastic film in Hebei Province increased with economic development. After reaching the peak in 2016, it was on the right side of the inverted "U" shape curve. Before 2016, with the increase of the GDP of the primary industry in Hebei Province, the growth rate of agricultural plastic film use accelerated. On the whole, the use of agricultural plastic film in Hebei Province continued to decline after 2016.

**Fig.5** Quadratic and cubic regression curve between net application of agricultural chemical fertilizer and GDP of primary industry in Hebei Province



**Fig.6** Quadratic and cubic regression curve of agricultural plastic film consumption and GDP of primary industry in Hebei Province



**Fig.7** Quadratic and cubic regression curve between pesticide use and GDP of primary industry in Hebei Province

According to figure 7, the whole curve presents an inverted "U" shape, and an inverted "n" shape curve appears in the early stage. With the increase of the GDP of the primary industry, the pesticide use gradually decreases and reaches the lowest point in 2020. On the whole, Hebei Province has paid attention to farmland environmental protection and achieved good results in recent years.

## 5. Conclusion

This paper uses Kuznets curve to study the relationship between farmland environmental protection and economic development, which provides theoretical support for other small and medium-sized cities to protect farmland, improve agricultural water quality and improve rural air quality, and provides new ideas for the government to govern farmland environmental protection. With economic development, the government pays more and more attention to the development of ecological environment. In the early

stage of economic development, with economic growth, agricultural pollution is becoming more and more serious. When the economy grows to a certain extent, with economic growth, agricultural pollution is reduced, and the government pays more attention to farmland environmental protection. It is found that Hebei Province has made great achievements in farmland pollution control in recent years, and the use of pesticides, plastic film and agricultural chemical fertilizer in Hebei Province have decreased year by year. In the future, the Agricultural Department should cooperate with the Environmental Protection Department and Water Conservancy Department to actively control farmland pollution, increase farmland pollution control funds, issue pollution control and anti pollution policies, implement farmland pollution punishment mechanism, and improve people's understanding of farmland pollution.

## References

- [1] Ruiling Han, Lianjun Tong, Weiming Tong, Jianhui Yu. Research progress and review on the relationship between economic and environmental development [J]. China's population, resources and environment, 2012, 22, (02).
- [2] Yanjie Tian. Study on the relationship between environmental pollution and economic growth in Hebei Province [D]. Yanbian University, 2019.
- [3] Jiang Du, Jun Luo. current situation, causes and Treatment Countermeasures of agricultural environmental pollution in China [J]. Research on agricultural modernization, 2013, 34, (01).
- [4] Juaner Li. Kuznets curve of the relationship between economic growth and environmental pollution in Gansu Province [J]. National business information (Research on economic theory), 2016, (02).
- [5] Liang Cheng, Xia Hu, Zongzhi Wang, Kelin Liu. N-type Environmental Kuznets curve of industrial water and its formation mechanism -- Taking Shandong Province as an example [J]. Progress of water science, 2019,30, (05).

**Open Access** This chapter is licensed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (<http://creativecommons.org/licenses/by-nc/4.0/>), which permits any noncommercial use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

