A Study on Agricultural Carbon Emissions Measurement and Influencing Factors in Linfen City

Wei Chen[1a*], Lijuan Du[1b*], Qian Ma[1c]
[a*]Chenwei0123@126.com, [b*]1752102546@qq.com,[c]1654437134@qq.com

[1]School of Economics and Management, Hebei University of Science & Technology, Shijiazhuang 050018, China

Abstract-Agriculture is a basic industry that supports the construction and development of our national economy. The large-scale agricultural activities in the process of agricultural production will cause a large amount of carbon emissions, which will lead to further deterioration of environmental problems. Linfen's agriculture is dominated by planting industry, and the impact of its carbon emissions on the environment and climate cannot be ignored. This study first measures the agricultural carbon emissions from 2006 to 2020 according to the actual situation of Linfen City, and analyzes the characteristics of changes in agricultural carbon emissions and carbon emission intensity from a time perspective. Then the LMDI model is used to decompose the factors such as agricultural production efficiency and agricultural structure as the factors influencing agricultural carbon emissions in Linfen City, among them, agricultural production efficiency, agricultural structure and population size are the inhibiting factors, agricultural economic development level and urbanization level are the driving factors. Moreover, the advanced impact of the influencing aspects of agricultural carbon emission in Linfen is greater than the inhibiting aspect. When all is said and done, the corresponding countermeasures and suggestions are proposed.

Keywords-agricultural carbon emissions; LMDI model; influencing factors

1 Introduction

In the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), it is stated that the global average surface temperature is likely to increase by 0.3-0.7°C during 2016-2035 compared to 1986-2005. At present, the issue of warming caused by the greenhouse effect has received international attention, predominantly due to the large amount of greenhouse gas emissions. The 14th Five-Year Plan proposes to reduce energy consumption and CO_2 emissions per unit of GDP by 13.5% and 18% respectively, and to achieve carbon peak by 2030 and carbon neutrality by 2060.

The FAO study shows that 80% of agricultural greenhouse gases can be eliminated by developing low carbon agriculture. As the province's most important grain production base, Linfen City is rich in agricultural resources. It is said that in 2019 the city's agricultural output accounted for 12.92% of the province, second only to Yuncheng City. With the growth of agricultural economy, agricultural modernization and mechanization are increasing. Agricultural is also gradually replaced by machinery instead of manual labor, and the process of putting agricultural machinery into use has indirectly increased the consumption of fossil energy. In the agricultural production process, the area sown to crops increases year by year,

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resulting in excessive use of material elements such as agricultural films, fertilizers and pesticides. This series will generate agro-ecological problems and cause a large amount of agricultural carbon emissions, which will eventually make agricultural develop into a high-carbon industry and cause further deterioration of environmental problems. Economic growth is bound to be accompanied by a series of ecological and environmental problems in agriculture. In other words, low-carbon agriculture is an inevitable choice for the development of modern agriculture in Linfen.

2 Literature Review

"Low carbon economy" is originally from the UK 2003 Energy White Paper--"*Our Energy Future: Creating a Low Carbon Economy*". With further research finding that agriculture has a significant impact on low carbon development, the term "low carbon agriculture" has emerged. Low carbon agriculture is a new model of agriculture that aims to reduce greenhouse gas emissions and maximize economic efficiency by adjusting industrial structure, innovating and reforming technology and improving production efficiency. Only we can do this, this model will be likely to achieve sustainable development, energy efficiency, and low-carbon environmental protection. The development of low-carbon agriculture can change farmers' agricultural production methods and make them gradually realize the pollution of the environment by improper agricultural production. Besides, the long-term low-carbon agricultural development will transform the mode of agricultural economic growth and improve the production environment of agricultural [1].

Reviewing the relevant literature, scholars' studies on agricultural carbon emissions mainly focus on the measurement of carbon emissions and the analysis of influencing factors. By calculating agricultural carbon emissions in the main grain-producing regions, He and Fu found that the total agricultural carbon emissions in each region of the main grain-producing regions tended to increase, but the carbon emission intensity was all in a decreasing trend [2]. Xu et al. used the carbon emission coefficient method to measure the agricultural carbon emissions and carbon emission intensity in the process of agricultural modernization in Jilin Province over the past 18 years. They also found that the total carbon emissions showed a significant upward trend with an average annual growth rate of 2.83%, while the carbon emission intensity showed a downward trend [3]. Cao used the LCA method to measure the agricultural carbon emissions in Hubei Province [4].

Scholars believe that factors affecting agricultural carbon emissions are economic level, labor force size, technology level, etc. BRUVOLL and MEDIN argue that economic growth leads to a significant increase in carbon emissions [5]. Lantz and Feng's study, based on five-region panel data for Canada, shows that GDP per capita is independent of CO_2, but it has an inverted U-shaped relationship with population and a U-shaped relationship with technology [6]. Soytas and Sari study the long-run Granger causality between economic growth, CO_2 emissions and energy consumption in Turkey, controlling for gross fixed capital formation and labor force. Its outcome demonstrates that income lacks a long-run causal relationship with carbon emissions [7].

Using the LMDI model, Ding et al. examined the factors influencing agricultural carbon emissions in Jiangxi Province. The results showed that the level of agricultural economy was the most important driver of the increase in agricultural carbon emissions in Jiangxi Province.

Agricultural production efficiency was the most important driver of the decrease in agricultural carbon emissions in the region, while the structure of agricultural production and the size of agricultural labor force as a whole played a suppressive role in agricultural carbon emissions [8]. Using the STIRPAT model, Li and Ma found that each 1% change in urbanization rate, rural population, affluence, agricultural industry structure, and the number of agricultural technicians would cause 1.04%, 0.82%, 0.23%, 0.18%, and 0.13% changes in agricultural carbon emissions in Jiangsu Province respectively [9]. Based on a static panel STIRPAT model, Fu and Du show that there is a positive relationship between population size, GDP per capita and energy consumption intensity and carbon emissions. But there is an inverted "U" shape relationship between urbanization and carbon emissions [10]. Zhao used a multiple regression model finding that the main influencing factors of agricultural carbon emissions come from economic development aspects, such as unit agricultural energy consumption, agricultural population GDP per capita and other characterization indicators. In addition, the number of agricultural researchers play a role in the reduction of carbon emissions [11]. Yang and Chen constructed a multivariate regression model to analyze the factors influencing agricultural carbon emissions in Gansu Province, finding that the total output value of agriculture, forestry, animal husbandry and fishery has a significant positive driving effect on the growth of agricultural carbon emissions in Gansu Province, while the quality of agricultural laborers has a significant effect on agricultural emission reduction in Gansu Province [12]. Huang used the ISM model and entropy-gray correlation analysis model to analyze the influencing factors of provincial agricultural carbon emissions. The results show that population size, rural education level and the degree of natural disasters belonged to the fundamental influencing factors, which will directly or indirectly affect the remaining 12 influencing factors explored. Improving population size, rural education level and the degree of natural disasters will have a positive impact on China's carbon emissions [13]. By constructing a VAR model and using impulse response function and variance decomposition method, Qiu and Lu conducted an empirical study and found that environmental regulation and technological progress are the reasons for the decrease of agricultural carbon emissions, while agricultural economic growth is the reason for the increase of agricultural carbon emissions [14].

3 Research Methodology and Model Construction

3.1 Agricultural Carbon Emissions Measurement

3.1.1 Method of Measurement

In the field of agriculture, greenhouse gas emissions cover the entire process from production to waste disposal. In this study, by reviewing the relevant literature and taking into account the actual situation of agriculture in Linfen, we selected agricultural fertilizer, pesticide, agricultural plastic film, agricultural diesel, agricultural tillage and agricultural irrigation as agricultural carbon emission sources. The amount of agricultural fertilizer usage (converted into pure amount), pesticide usage, agricultural film usage, agricultural diesel usage, total sown area of agricultural crops, and sown area of food crops are used as metrics of agricultural fertilizer, pesticide, agricultural plastic film, agricultural diesel, agricultural tillage, and agricultural irrigation respectively. The study has further calculated agricultural carbon emissions by using the carbon emission coefficient method. The estimation formula is as follows.

$$C_i = C_{it} \times \beta_i \tag{1}$$

$$C = \sum C_i = \sum (C_{it} \times \beta_i) \tag{2}$$

$$C_m = \frac{C_{it}\beta_i}{AG} \tag{3}$$

Where C indicates total agricultural carbon emissions; C_i is the carbon emissions from category i carbon emission sources; C_{it} is the consumption of carbon emission sources of category i in year t; C_m indicates carbon emission intensity and AG is agricultural output; β_i indicates the carbon emission factor of the i carbon emission factor of the carbon emission source category(it is shown in Tab.1).

Tab.1 Carbon emission factors of agricultural carbon emission sources

Agricultural Carbon Emission Sources	Carbon Emission Factor	Data Source
Agricultural fertilizer	0.8956kgC/kg	West T O, Oak Ridge National Laboratory, USA [15]
Pesticides	4.9341kgC/kg	Oak Ridge National Laboratory, USA [15]
Agricultural plastic films	5.18kgC/kg	Institute of Agricultural Resources and Ecological Environment, Nanjing Agricultural University
Agricultural diesel	0.5927kgC/kg	IPCC United Nations Intergovernmental Panel on Climate Change
Agricultural tillage	312.6kg/hm^2	College of Biology and Technology, China Agricultural University
Agricultural irrigation	266.48kg/hm^2	Duan et al. [16]

3.1.2 Data Sources

The data on agricultural fertilizers (converted into pure amount), pesticides, agricultural plastic films, agricultural diesel, agricultural output value, total sown area of crops and sown area of grain crops in Linfen are all obtained from "*Linfen Statistical Yearbook* (2007-2021)", where the actual use of agricultural fertilizers (converted into pure amount), pesticides, agricultural plastic films and agricultural diesel in the current year is used. The agricultural output value is at comparable prices, with 2006 as the price base year.

3.2 LMDI Model Construction

The main methods to analyze the factors influencing carbon emissions are STIRPAT model, LMDI model and econometric model. STIRPAT models and econometric models may have non-smoothness and heteroskedasticity in the analysis of time series data leading to large values of the residuals of the model, which cannot be well estimated accurately. Compared with the above methods, the LMDI model is more accurate, mainly because it decomposes the indicators to obtain the various factors affecting them, and the resultant equation does not contain the residual term. This model that Ang proposed has two decomposition methods: multiplicative decomposition and additive decomposition, both of which have the same structure and are interconvertible. The LMDI decomposition method is widely used because it has the advantages of factor that includes reversibility, elimination of residual terms, and consistency between segmental and total effects. Therefore, this study adopts the LMDI model to analyze the factors influencing agricultural carbon emissions in Linfen City.

The Japanese scholar Yoichi Kaya first proposed Kaya's constant equation in 1989. This study is based on the kaya constant equation and uses the LMDI decomposition method for analysis. According to the actual situation of Linfen City and the rapid development of urbanization in China, this study takes into account the level of urbanization. The formula is shown in Equation (4):

$$C = \frac{C}{AG} \times \frac{AG}{BG} \times \frac{BG}{P} \times \frac{P}{AP} \times AP \tag{4}$$

In the above equations, $CI = \frac{C}{AG}$, $AI = \frac{AG}{BG}$, $BI = \frac{BG}{P}$, $PI = \frac{P}{AP}$

Therefore, there are shown in Equation(5):

$$C = CI \times AI \times BI \times PI \times AP \tag{5}$$

Where C represents total agricultural carbon emissions; AG corresponds agricultural output; BG is total output value of agriculture, forestry, animal husbandry and fishery; P indicates total population; AP corresponds the population engaged in agriculture, along with the population size factor; CI is agricultural production efficiency factors; AI represents agricultural structural factors; BI indicates the factor of the level of agricultural economic development and PI is urbanization level factor.

Taking the logarithm, there are shown in Equation (6):

$$\ln C = \ln CI + \ln AI + \ln BI + \ln PI + \ln AP \tag{6}$$

The summation decomposition is performed and the differential decomposition is shown in Equation (7):

$$\Delta \mathrm{C}_T = C_t - C_0 \tag{7}$$

Where C_T represents the total change in agricultural carbon emissions; C_t and C_0 indicate the agricultural carbon emissions in the reporting and base periods respectively.

The decomposition results of the contribution value of each factor are as follows.

$$\Delta CI = \frac{C_t - C_0}{\ln C_t - \ln C_0} \times \ln \frac{CI_t}{CI_0} \tag{8}$$

$$\Delta AI = \frac{C_t - C_0}{\ln C_t - \ln C_0} \times \ln \frac{AI_t}{AI_0} \tag{9}$$

$$\Delta BI = \frac{C_t - C_0}{\ln C_t - \ln C_0} \times \ln \frac{BI_t}{BI_0} \tag{10}$$

$$\Delta PI = \frac{C_t - C_0}{\ln C_t - \ln C_0} \times \ln \frac{PI_t}{PI_0} \tag{11}$$

$$\Delta AP = \frac{C_t - C_0}{\ln C_t - \ln C_0} \times \ln \frac{AP_t}{AP_0} \tag{12}$$

Where t represents the reporting period and 0 is the base period.

The total effect is shown in Equation (13):

$$\Delta \mathrm{C}_T = \Delta CI + \Delta AI + \Delta BI + \Delta PI + \Delta AP \tag{13}$$

The decomposition result of the contribution of each factor is as follows.

$$E_{CI} = e^{\frac{\ln C_t - \ln \mathrm{C}_0}{C_t - C_0} \times \Delta CI} \tag{14}$$

$$E_{\mathrm{AI}} = e^{\frac{\ln C_t - \ln \mathrm{C}_0}{C_t - C_0} \times \Delta AI} \tag{15}$$

$$E_{\mathrm{BI}} = e^{\frac{\ln C_t - \ln \mathrm{C}_0}{C_t - C_0} \times \Delta BI} \tag{16}$$

$$E_{\mathrm{PI}} = e^{\frac{\ln C_t - \ln \mathrm{C}_0}{C_t - C_0} \times \Delta PI} \tag{17}$$

$$E_{\mathrm{AP}} = e^{\frac{\ln C_t - \ln \mathrm{C}_0}{C_t - C_0} \times \Delta AP} \tag{18}$$

Where E_{CI} represents the contribution rate of agricultural production efficiency effect; E_{AI} indicates the contribution rate of agricultural structure effect; E_{BI} corresponds the contribution rate of the level of agricultural economic development effect; E_{PI} indicates the contribution rate of urbanization level effect; E_{AP} is the contribution rate of population size effect.

4 Analysis of Empirical Results

4.1 Total Carbon Emissions and Its Changes

The results show that the cumulative agricultural carbon emission in Linfen City reaches 7,884,500 tons from 2006 to 2020. From Fig.1, it can be seen that from 2006 to 2020, the agricultural carbon emissions of Linfen city generally show a trend of "continuous increase - continuous decrease". The agricultural carbon emissions in Linfen city can be divided into two periods.

The first period is 2006-2014, when carbon emissions from agriculture in Linfen continued to rise. Agricultural carbon emissions increased from 490,600 tons to 557,200 tons, with a growth rate of 13.58% and an average annual growth rate of 1.60%. The main reason for this phenomenon is that with the increase of arable land area, farmers use a lot of pesticides, agricultural fertilizers, agricultural plastic films and agricultural diesel. This phenomenon indicates that the agriculture in Linfen City during that period was an extensive development mode, which pays less attention to the environmental pollution caused by the development of agriculture. Instead more importance was attached to the income brought by the agricultural development.

The second period is 2015-2020, when Linfen's agricultural carbon emissions show an overall downward trend. Agricultural carbon emissions decreased from 557,200 tons to 511,200 tons, a decrease of 46,000 tons, with a decline rate of 8.26% and an average annual decline rate of 1.43%. The area of cultivated land is increasing in this period. On the contrary,the use of pesticides, agricultural fertilizers, agricultural plastic films and agricultural diesel fuel is gradually decreasing, which indicates the government of Linfen City is aware of the impact of agricultural development on the environment, increasing the protection of ecological environment and developing towards resource-saving and environment-friendly.

From the perspective of the chain growth rate, the tread is overall "W-shaped - fluctuating down". In 2011, the total agricultural carbon emissions in Linfen were increased by 3.3% compared with 2010, which is the largest increase. The largest decrease of 2.90% was seen in 2017 compared to 2016.

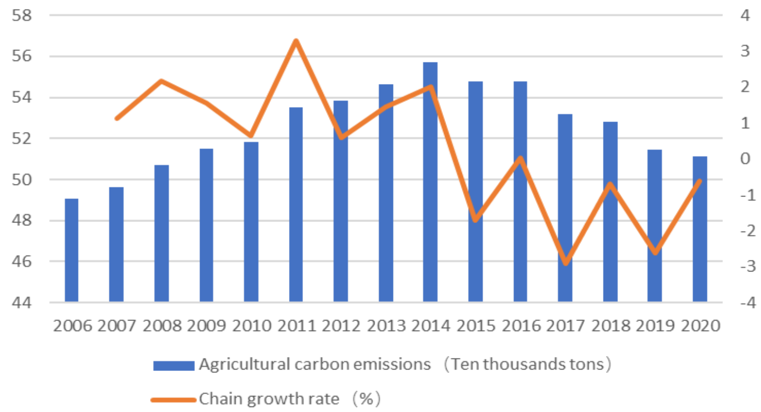

Fig.1 Changes in agricultural carbon emissions and chain growth rate in Linfen City

4.2 Carbon Emissions Intensity and Its Change

Agricultural carbon emission intensity indicates the carbon emissions produced per unit of agricultural GDP. Higher carbon emission intensity means lower agricultural production efficiency, indicating that more energy and material inputs need to produce each unit of agricultural GDP. The highest carbon emission intensity of agriculture in Linfen was 1.13 tons per 10,000 yuan in 2006, and the lowest was 0.48 tons per 10,000 yuan in 2020.From Fig.2, it can be seen that overall agricultural carbon emission intensity in Linfen City is in a decreasing trend. The agricultural carbon emission intensity in Linfen can be divided into two periods.

The first period is 2006-2014. The decline rate is 50.44% from 1.13 tons per 10,000 yuan in 2006 to 0.56 tons per 10,000 yuan in 2014. During this period, the growth rate of agricultural output value in Linfen was 129.69%, while the growth rate of agricultural carbon emission was 13.58%, and the growth rate of agricultural output value was much larger than carbon emissions. Therefore, the main reason for the reduction of agricultural carbon emissions in Linfen during this period is the significant growth of agricultural output value. In the analysis of agricultural carbon emissions in Linfen, it is mentioned that the agriculture in Linfen City is still extensive developed at this stage.

The second period is 2015-2020. Agricultural carbon emissions intensity rebounded slightly in 2015 and declined year by year. The carbon emission intensity decreases from 0.62 tons per 10,000 yuan in 2015 to 0.48 tons per 10,000 yuan in 2019, with a decline rate of 22.58%. The growth rate of agricultural output value is 20.67%, and the decline rate of carbon emission is 8.26%. Although the change of agricultural output value is slightly larger than carbon emission in this period, there is a favorable trend of agricultural development in Linfen City.

In terms of the chain growth rate, the decrease in carbon emission intensity of agriculture in Linfen City was larger in 2010, with a decrease of 0.22% compared to the previous year. The chain growth rate of carbon emission intensity was positive in 2015, with the largest increase of 0.11% compared to the previous year.

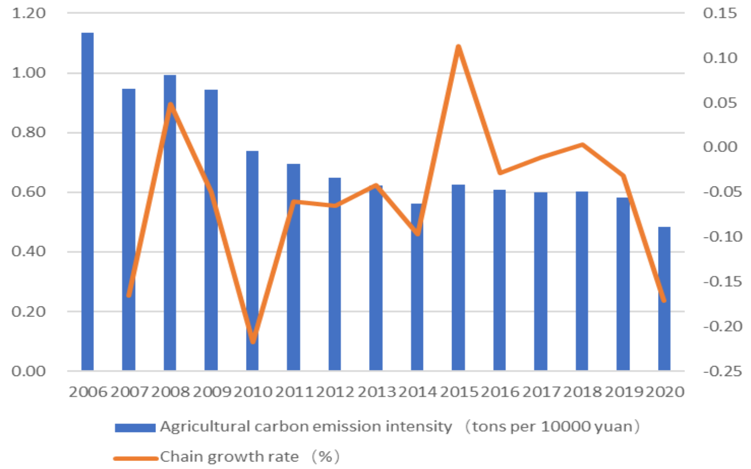

Fig.2 Changes in agricultural carbon emission intensity and chain growth rate in Linfen City

4.3 Analysis of Carbon Emission Impact Factors

From Tab.2, it can be seen that the cumulative increase of carbon emission from agriculture in Linfen City is 20.30 million tons during 15 years, indicating that the promoting effect is greater than the inhibiting effect.

Agricultural production efficiency, agricultural structure and population size are the inhibiting factors. The cumulative carbon reduction is 537,550 tons. In descending order of importance, agricultural productivity, agricultural structure, population size. Among them, agricultural productivity achieved a total of 421,150,000 tons of carbon emission reduction in 15 years, accounting for 78.35% of the total cumulative carbon emission reduction, with an annual average of 28,100 tons of carbon emission reduction. The agricultural structure factor suppressed carbon emissions by a total of 78.48 thousand tons during 15 years, with an annual average of 0.52 thousand tons. Except for the increase of carbon emission in 2018, the rest of the years between 2015 and 2020 have suppressed carbon emission, which shows that the policy of adjusting agricultural industry structure in Linfen City has got initial effect. The population size factor suppresses carbon emissions by 37.92 million tons cumulatively from 2006 to 2020, with a contribution rate of 1392.65% and an average annual reduction of 0.25 million tons.

The factors of agricultural economic development level and urbanization level are the driving factors. The cumulative carbon emission is 557.85 million tons. The role of the level of agricultural economic development is greater than that of urbanization. Both them, the level of agricultural economic development is the main factor for the increase of agricultural carbon emissions in Linfen. 541,240 tons of carbon emissions have been increased by the factor of agricultural economic development during 15 years, with a contribution rate of 1522.52% and an average annual increase of 37,200 tons. The level of urbanization contributed to a cumulative increase of 16.61 million tons of carbon emissions from agriculture during the 15 years, with a cumulative contribution of 1403.67% and an average annual increase of 0.11 million tons.

In terms of contribution rate, the contribution rate of agricultural production efficiency is less than 100% except for 2008, 2015 and 2018 when it is greater than 100%.The contribution rates of agricultural structure factor and population scale effect fluctuate less. The curve of agricultural economic development level fluctuates less in the rest of the years, except for 2007-2008, when it decreased more. The contribution of urbanization level is less than 100% in 2009 and 2011-2017.

Tab.2 Contribution values and contribution rates of the effects of various influencing factors on agricultural carbon emissions in Linfen City

Unit: Ten Thousand Tons, %

Year	Agricultural Production Efficiency Factors		Agricultural Structural Factors		Agricultural Economic Development Level Factors		Urbanization Level Factor		Population Size Factor		Total Effect ΔC
	ΔCI	E_{CI}	ΔAI	E_{AI}	ΔBI	E_{BI}	ΔPI	E_{PI}	ΔAP	E_{AP}	
2007	-8.921	0.835	-9.218	0.830	18.391	1.452	0.341	1.007	-0.043	0.999	0.550
2008	2.352	1.049	-2.916	0.943	1.321	1.027	0.046	1.001	0.258	1.005	1.062
2009	-2.543	0.950	0.503	1.010	2.526	1.053	-0.427	0.991	0.704	1.014	0.763
2010	-12.089	0.783	4.337	1.092	6.925	1.151	0.926	1.019	0.217	1.004	0.315
2011	-3.041	0.940	1.415	1.029	3.685	1.078	-0.830	0.983	0.372	1.008	1.602
2012	-3.361	0.934	0.698	1.014	3.435	1.072	-0.306	0.994	-0.172	0.997	0.294
2013	-2.110	0.958	0.515	1.010	2.778	1.058	-0.149	0.997	-0.324	0.993	0.710
2014	-5.032	0.903	1.512	1.031	4.902	1.104	-0.979	0.980	0.580	1.012	0.984
2015	5.295	1.113	-2.333	0.954	-3.429	0.933	-0.663	0.987	0.274	1.006	-0.857
2016	-1.431	0.971	-0.752	0.985	2.546	1.053	-0.581	0.988	0.236	1.005	0.018
2017	-0.525	0.989	-0.223	0.995	-0.375	0.992	-0.559	0.989	0.229	1.005	-1.453
2018	0.148	1.003	0.898	1.018	-0.863	0.983	1.901	1.039	-2.428	0.952	-0.344
2019	-1.594	0.968	-2.197	0.956	2.880	1.060	0.316	1.006	-0.720	0.986	-1.316
2020	-9.263	0.829	-0.088	0.998	9.404	1.210	2.625	1.055	-2.976	0.941	-0.298
Total	-42.115	13.226	-7.848	13.866	54.124	15.225	1.661	14.037	-3.792	13.927	2.029

5 Conclusions

Firstly, this study uses the carbon emission coefficient method to measure the agricultural carbon emissions in Linfen City, and then decomposes the factors of influencing the agricultural carbon emissions in Linfen City through the LMDI model. The main research findings are as follows.

(1) From 2006 to 2014, agricultural carbon emissions continue to rise,while carbon emission intensity is in a decreasing trend. During this period, agriculture in Linfen City is an extensive development mode, which pays less attention to the environmental pollution caused by agricultural development and pays more attention to the income brought by agricultural development. From 2015 to 2020, agricultural carbon emissions and carbon emission intensity in Linfen City show a decreasing trend overall. During this period, the government of Linfen City is aware of the impact of agricultural development on the environment, increasing the protection of ecological environment, and moving towards resource-saving and environment-friendly development.

(2) Agricultural production efficiency, agricultural structure and population size are the inhibitory factors of agricultural carbon emissions, among which agricultural production efficiency plays the largest role, followed by agricultural structure, and population size plays a smallest role. The level of agricultural economic development and the level of urbanization are the drivers of agricultural carbon emissions, with the level of agricultural economic development playing the largest role. The driving factors of agricultural carbon emissions in Linfen City have a greater promoting effect than the inhibitory factors.

6 The Main Policy Recommendation

Based on the above findings, this study makes the following recommendations.

(1) Change the way of agricultural economic development. Currently, the economic development of agriculture in Linfen City relies on the large amount of inputs of agricultural production materials, but this can also lead to the increase of agricultural carbon emissions. It is unrealistic to curb carbon emissions by reducing agricultural economic growth, and the focus is improving the quality of agricultural products. So it is especially important to change the way of agricultural economic development. To develop low-carbon agriculture, we must change the traditional extensive agricultural model, fundamentally reduce agricultural carbon emissions, change the unreasonable way of agricultural economic growth and development, and truly achieve sustainable agricultural development.

(2) Optimize the layout of the industrial structure of the plantation industry. Under the condition of ensuring the safety and stability of food supply, people actively plant economic crops such as vegetables, cotton, oilseeds and tobacco, compressing the planting scale of high consumption and high input crops, and expanding the planting area of high-quality, high-yield and high-efficiency crops.

(3) Improve the quality of agricultural labor force. At present, most of the agricultural labor force in Linfen is still educated at junior high school or below, with low education level and lack of awareness and attention to the concept of low carbon agriculture. Therefore, it is important to improve the education level of agricultural labor force and increase the publicity of low-carbon concepts in order that agricultural labor force can realize the importance of protecting ecological environment. On the one hand, with the improvement of social technology, the cell phone penetration rate has reached 90.4% in 2019, and there are more and more self-media platforms. Linfen government can promote the concepts of low carbon economy, low carbon agriculture and sustainable development through radio, newspapers and various self-media (such as TV, microblog, official accounts and short video websites), and also through some lectures and training courses to improve the comprehensive quality of rural population and vigorously promote low carbon lifestyle and production methods. On the other hand, it is important to pay attention to the literacy and agricultural technology level of the rural population itself, and vigorously develop the construction team of agricultural science and technology talents. This requires the government to increase investment in rural education resources, improve the literacy of farmers, and join hands with universities, for example Shanxi Agricultural University should train high-quality agricultural talents and provide professional guidance to farmers through policies such as going to the countryside, so that farmers can truly realize the importance of low-carbon agricultural development and further promote low-carbon

agricultural development.

(4) Improve low-carbon agriculture system. Since low-carbon agriculture started late and the related policies and systems are not perfect, the government needs to formulate relevant laws and regulations and increase financial investment. On the one hand, it should strengthen the legal system of low-carbon agriculture and establish a system of rewards and penalties. The government needs to change its role in the development process of low-carbon agriculture from being a supporter of economic activities to being a supervisor of economic activities. Farmers are driven by their own interests in the process of agricultural production, so they will still destroy the environment to achieve increased production and income. The government should enact laws and regulations on low-carbon agriculture, as well as reward enterprises and farmers who contribute to carbon emission reduction and impose severe penalties on those who destroy the environment, so as to ensure the sustainable development of low-carbon agriculture. On the other hand, financial investment should be increased. The development of low-carbon agriculture needs financial support. The government can subsidize enterprises and farmers who adopt low-carbon agriculture models through low-interest or interest-free loans and loss subsidies, and can also regulate the tax system by imposing heavy taxes on enterprises that neglect environmental protection, so that they will pay attention to the protection of the ecological environment.

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