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Original Research Paper

Analysis on the Factor Decomposition of Carbon Emissions Caused by Chinese Agricultural Land Use and the Emission Reduction Measures

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ABSTRACT

Carbon emissions lead to high pollution and climate change. As an important part of land resources, agricultural land has become an important source of carbon emissions and has caused serious environmental pollution, which should not be neglected. Although agriculture has smaller potential than the industrial sector in reducing carbon emissions, its effects on emission reduction and positive external effects on society will be far better than those of the industrial sector. Therefore, to explore the factors of carbon emissions caused by Chinese agricultural land use, we reveal the microscopic mechanisms of carbon emissions from agricultural land use, propose concrete emission reduction measures, and adopt important theories such as behaviour of farmers and environmental externality. The paper measures the amount of carbon emissions caused by agricultural land use in China from 2002 to 2013 and uses Kaya identical equation to analyse the driving factors of carbon emissions that arise from agricultural land use from the national and provincial levels. The research results indicate that carbon emissions caused by agricultural land use in China has remarkable growth rate, fertilizers are the main carbon source of carbon emissions of agricultural land in Xinjiang, and carbon emissions from agricultural land use have obvious timing characteristics. Furthermore, the level of agricultural economic development, agricultural structure change, and scale of agricultural labour force may result in varying degrees of carbon increment in agricultural land. This paper also notes foreign experience and properly establishes a policy system for reducing carbon emissions caused by agricultural land use. By measuring and grasping the historic rules and spatial characteristics of carbon emission caused by Chinese agricultural land use, the paper decomposes and studies the factors influencing carbon emission and clarifies these factors from a quantitative aspect. The study also summarizes and analyses carbon emission reduction technology and characteristics from two aspects: reducing emissions and increasing carbon sink. This research will inspire and serve as a reference for relevant future works.

INTRODUCTION

Global climate change caused by carbon emissions has significant adverse impacts on human society and economic development. Climate change is a major global concern in political, economic, and scientific fields, among others. The report of the UN Intergovernmental Panel on Climate Change stated that the increase in the earth's average temperature is likely to be caused by human activities, and is the core factor being the increased emission of human-induced greenhouse gases. Moreover, global climate change brings unprecedented crises to humans and ecosystems; these crises include extreme weather, melting glaciers, thawing permafrost, dying coral reefs, rising sea levels, ecosystem changes, deadly heat waves, water shortages, frequent droughts and floods, intensified desertification, expanded soil erosion area, deteriorated mountain hazards, and changes in atmospheric composition. These crises exert tremendous negative impacts on human survival and development, as well as social and economic activities. Many countries have reached a consensus on implementing carbon emission reduction to address the effects of climate change. Developed countries have implemented compulsory emission reduction whereas developing countries have adopted voluntary mitigation actions. Countries have reached a wider consensus on the world's long-term goals, financial and technical support, transparency, and other topics. Meanwhile, specific countries have developed their own reduction targets. Hence, to fulfil the commitment of reducing carbon emission, various departments of China, including all industrial sectors, as well as production and resource utilization services, should implement appropriate degrees of carbon reduction and duly contribute to China's greenhouse gas reduction.

As an important component of land resources, agricultural land is the basis of human life and production. The rational use of agricultural land can achieve both economic and ecological benefits, but unreasonable agricultural land use activities will reduce economic benefits and cause serious environmental pollution, increase carbon emissions, and become the direct cause of global warming. Chinese agriculture has achieved rapid development since China's re-

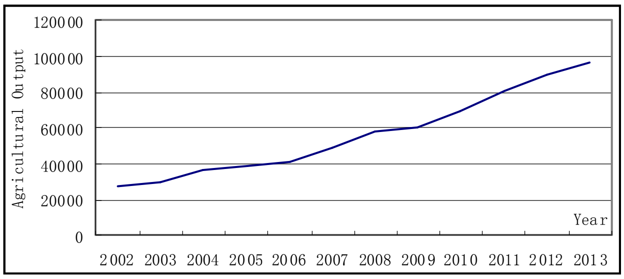

Fig. 1: China's Agricultural Output Value from 2002 to 2013 (one hundred million CNY)

form and opening-up; China's agricultural output continued to grow from 2002-2013, as shown in Fig. 1. However, the emission amount of greenhouse gases arising from agricultural land use is huge, and is more than the total emission amount of global anthropogenic greenhouse gases. Therefore, agricultural land use has great potential for emission reduction. Agricultural land use activities are important sources of greenhouse gases, and are more likely to be affected by climate change. The disasters triggered by global climate change give rise to the extreme instability of China's land productivity and growing risk of changes in its agricultural production layout and structure. The scope and extent of crop pests will expand, water shortages will become more prominent, and the potential desertification of grassland will be intensified. Although agriculture has smaller potential than the industrial sector in reducing carbon emissions, the effect of its emission reduction and positive external effect on society will be far better than that from the industrial sector. Compared with other production activities, carbon emission reduction in agricultural land use not only reduces the emission amount of greenhouse gases into the atmosphere, but also improves soil nutrients, soil structure, and environment, as well as the positive environmental externalities from improved agricultural land resource and environment. Agricultural land is also the foundation and prerequisite for other economic departments to carry out production activities Optimized use of agricultural land resource and environment is an important prerequisite for sustainable development of agricultural economy.

Therefore, reducing carbon emissions caused by agricultural land use is an important factor for China to achieve emission reduction targets, and is an important prerequisite to achieve sustainable economic and social development. We analyse the characteristics of agricultural land resources, establish a calculation system for agricultural carbon emissions, estimate and analyse the historical evolution and spatial characteristics of such emissions, further explore economic incentives and underlying causes of agricultural land use, and study the technical path of carbon emission reduction and policy system construction. These steps will provide important theoretical bases for China to perform resource, environment, and climate work, as well as develop future emission reduction policies.

RELATED WORK

A literature review has revealed that scholars believe that carbon emissions caused by production activities in agricultural land is an important source of greenhouse gases, and that it has a significant effect on global warming. Therefore, most studies focus on two aspects: the factors that affect carbon emission of production activities in agricultural land, and the measures to save energy and reduce carbon emissions of agricultural production activities. In terms of the former aspect, foreign scholars considered the change in agricultural land use to be an important factor that affects carbon emissions and leads to climate change.

Historically, agricultural production increased atmospheric carbon emissions by transforming natural ecosystems, especially tropical forests, into agricultural land. For example, Duxbury argued that agricultural development and agricultural production practices led to emission of greenhouse gases; the proportion of emitted CO_2, CH_4 and N_2O accounts for approximately 25%, 65% and 90%. Furthermore, ruminants and combustion as well as rice field and biomass burning are the major sources of agricultural carbon emissions (Duxbury 1994). West indicated that the atmospheric concentration of carbon dioxide increased, which is caused mainly by the combustion of fossil fuels and deforestation of agricultural land (West 2002). DeFries and other scholars estimated the carbon changes in tropical land during the 1980s and 1990s and found that the changes in land use mode of tropical regions contributed to the increase in carbon flux, but because of the lack of information on the changing forest area, no accurate calculation of tropical deforestation and regeneration exists (DeFries 2002).

Lal (2004a) used empirical studies to prove that changes in agricultural land use and land coverage and agricultural production contribute to 20% of global carbon emissions. Johnson believed that agricultural carbon emissions mainly come from agricultural waste, enteric fermentation, manure management, agricultural energy use, burning of rice paddy, and biomass (Johnson et al. 2007). Schuur (2008) considered the sustained increase in the amount of carbon emissions in agricultural sector to be the most important factor causing global warming. Schahczenski (et al. 2009) indicated that the carbon emissions that arise from agricultural development cause serious atmospheric pollution, and proposed relevant measures. Stone indicated that since the 1950s, climate change in the United States has been caused by changes in land use structure (Stone 2009). After studying the control measures of carbon emission caused by agricultural production activities, Paustian determined that many natural ecosystems have transformed to artificial ecosystems in history, thereby increasing the atmospheric carbon content (Paustian et al. 1998). Therefore, more efforts should be focused on reforestation and actively restoring natural ecosystems when reducing and transforming natural ecosystems into artificial one.

Civerolo et al. (2000) stated that emissions of anthropogenic CO_2 from terrestrial ecosystems as well as from fossil fuels and industrial pollution should be reduced to limit the concentration of carbon dioxide in the atmosphere. Sauerbeck discussed the possibility of reducing emissions generated by agricultural resources, and considered that in addition to reducing carbon emissions, agriculture can use soil organic matters to slow down the increase in atmospheric carbon dioxide and produce biomass materials that can be used as fossil fuel substitutes (Sauerbeck 2001). Six et al. (2004) determined that no-till management should be implemented because soil carbon sequestration could be an important practice to offset greenhouse gas emissions. Woomer found that the transformation of land use mode is an important factor to produce agricultural land carbon emission (Woomer et al. 2004). Lal (2004b) argued that the strategies of increasing soil carbon pool include soil remediation, forest regeneration, no-till farming, planting crops, nutrient management, application of fertilization and sludge, improved grazing, soil and water conservation and harvesting, efficient irrigation, as well as agriculture and forestry practices. Searchinger stated that after transforming a large area of agricultural land into conservation tillage, including no-till practice, agricultural activities can absorb 1% of emissions from fossil fuels in the next 30 years (Searchinger et al. 2008). Kindermann predicted that tropical deforestation causes approximately one quarter of anthropogenic carbon emissions, and posited that increasing the economic potential of advertising could avoid deforestation (Kindermann et al. 2008).

A review of domestic and foreign studies indicates that scholars reached a consensus that agriculture is one of the main sources of greenhouse gas emissions. However, these studies indicate certain problems. These studies used macroeconomic data and did not consider the different economic development levels of different countries and regions, nor did it distinguish the income level, stage of development, historical conditions, and background of agricultural production in countries and regions. These did not also consider the special conditions and interests of backward areas. Therefore, the current paper studies and analyses the factors that affect carbon emissions from agricultural land use, and then proposes specific policies to achieve China's agricultural land carbon emission reduction.

MODEL INTRODUCTION AND DATA DESCRIPTION

Introduction to Kaya Identical Equation Model

The driving factors of carbon emission are analysed using the regression and factor decomposition models. Because the fitting results of regression model are influenced significantly by the model set, it is prone to deviation. Therefore, this paper adopts factor decomposition model (Kaya identical equation) to decompose carbon emission factors of Chinese agricultural land. The method was first proposed by the Japanese professor Yoichi Kaya in 1989 during a Seminar on the Intergovernmental Panel on Climate Change. The carbon emissions generated by human activities are affected by carbon emission intensity, energy intensity, level of economic development, and population size. The paper follows its analytical framework and combines agricultural production with actual carbon emissions; the total amount of carbon emissions from agricultural land is expressed by the following formula:

$$C = EI \times SI \times DI \times L \quad ...(1)$$

$$EI = \frac{C}{P}, SI = \frac{P}{A}; DI = \frac{A}{L} \quad ...(2)$$

In Formula (1), *EI*, *SI*, *DI*, and *L* represent the efficiency factor of agricultural carbon emissions, agricultural structural factor, agricultural economic development level, and the scale of agricultural labour force, respectively. In Formula (2),*C, P, A* represent the amount of carbon emissions, amount of agricultural land use, the output value of farming, total output value of forestry, animal husbandry and fishery industries, and the scale of agricultural labor force, respectively.

However, because of the different biological characteristics and crop yields of agricultural products, simply adding the production yield or scale is unsuitable. Therefore, we compare output values. Because the residual cannot be explained perfectly, the residual is removed temporarily. The results are not affected, and we can obtain the following Formula (3).

$$\Delta C = \Delta EI + \Delta SI + \Delta DI + \Delta L \quad ...(3)$$

$$\Delta C_T = C_T - C_{T-1} = EI_T \times SI_T \times DI_T \times L_T - EI_{T-1} \times SI_{T-1} \times DI_{T-1} \times L_{T-1} \quad ...(4)$$

After deforming Formulas (2) and (4), the following formulas can be obtained:

$$\begin{cases} \Delta EI = (EI_T - EI_{T-1}) \times SI_{T-1} \times DI_{T-1} \times L_{T-1} \\ \Delta SI = EI_{T-1} \times (SI_T - SI_{T-1}) \times DI_{T-1} \times L_{T-1} \\ \Delta DI = EI_{T-1} \times SI_{T-1} \times (DI_T - DI_{T-1}) \times L_{T-1} \\ \Delta L = EI_{T-1} \times SI_{T-1} \times DI_{T-1} \times (L_T - L_{T-1}) \end{cases} \quad ...(5)$$

In Formula (5), ΔEI represents the change in the amount of carbon emission when the emission efficiency factor changes but other factors are constant changes from T-1 to T period. ΔSI refers to the change in carbon emission amount when only agricultural structural factor changes but other factors do not change from T-1 to T period. ΔDI represents the change in the amount of carbon emissions when only the level of agricultural economic development changes but other factors do not change from T-1 to T period. ΔL represents the change in carbon emission amount when only the scale of agricultural labor force changes but other factors do not change from T-1 to T period.

Data Sources and Processing Instruction

Carbon emission amount: Generally, carbon emissions from agricultural land use mainly come from six aspects. 1. Direct or indirect carbon emissions in agricultural land during the production and use of chemical fertilizer. 2. Carbon emissions from the process of pesticide production and use. 3. Carbon emissions caused by the production and use of agricultural films. 4. Carbon emissions caused by the application of agricultural machinery and the direct or indirect consumption of fossil fuels, mainly agricultural diesel. 5. Carbon emissions caused by agricultural land ploughing. 6. Carbon release formed by the indirect loss of fossil fuel caused by electricity during the irrigation process. Data on the six aspects are collected from the China Rural Statistical Yearbook (2003-2014).

Output values of planting, agriculture, forestry, animal husbandry and fisheries, agricultural labor force: Data on the three indicators are collected from China Statistical Yearbook (2003-2014). We use GDP to compare prices and use the price in 1999 as the price benchmark year to eliminate the effects of price changes.

ANALYSIS AND DISCUSSION OF RESULTS

National carbon emission factor decomposition from 2002 to 2013: Based on Formulas (3)-(5) and collected data, and using the correlation analysis tool, the decomposition results of influencing factors of carbon emissions from China's agricultural land use are obtained as given in Table 1.

Table 1 shows that despite the annual increase in carbon emission reduction, the efficiency factor, structural factor, and scale of labor force suppress the amount of carbon emission to a certain extent, but the effect is limited. Generally, scale of labor force exerts the largest impact on carbon emissions from agricultural land use, followed by structural factor and production efficiency factor. With the recent optimization of agricultural production efficiency and agricultural structure, carbon emissions from agricultural land use have been gradually reduced. The non-agricultural transfer of agricultural labor force has facilitated the scale operation of agriculture and the reduction of carbon emissions from agricultural land use. However, the level of agricultural economic development has become the most important factor in increasing carbon emissions from agricultural land use. Such a result is consistent with those from many studies on resources and the environment and economic development. At present, China's economic development and environment quality remain at turning points; environment quality will deteriorate with economic development. Therefore, with the development of China's agricultural economy, carbon emissions generated by agricultural land use will increase. In future, the development of agricultural economy will remain the main factor for carbon increment because of issues on China's agricultural land use.

Table 1: Decomposition of influencing factors of carbon emission arising from China's agricultural land use (unit: ten thousand tons).

Year	Efficiency factor	Structural factor	Economic development level	Scale of labor force
2002	183.45	-236.58	496.67	-168.94
2003	245.63	-368.45	578.94	-195.68
2004	128.35	-184.67	689.64	-203.84
2005	196.35	-536.21	785.46	-294.67
2006	-6.53	-278.64	801.23	-368.94
2007	-12.65	-574.68	845.61	-456.45
2008	-36.98	-875.46	947.83	-568.94
2009	-187.65	-968.45	1203.36	-674.85
2010	-268.95	-1024.91	1456.97	-781.12
2011	-368.74	-1365.78	1865.23	-845.21
2012	-482.12	-1475.54	2031.49	-801.56
2013	-423.68	-1567.98	2689.64	-704.54

Decomposition of carbon emission factors by region: Table 2 shows that taking 2002 as the base period, from the perspective of the cumulative contribution of influencing factors of carbon emissions from agricultural land use in one year, the development of all the agricultural economy of all the provinces leads to carbon increment. The efficiency factor leads to carbon increment in Zhejiang, Anhui, Hainan, Chongqing, Sichuan, Guizhou, Tibet, Inner Mongolia, Xinjiang, and other provinces. The efficiency factor achieves a certain level of carbon emission reduction in other provinces. The structural factor leads to carbon increment in Shanghai, Hunan, Gansu and other provinces and cities. The structural factor achieves a certain level of carbon emission reduction in other provinces. The scale of labor force leads to carbon increment in Heilongjiang, Liaoning, Guangdong, Hainan, Guizhou, Yunnan, Tibet, Inner Mongolia, Qinghai, Xinjiang, and other provinces and cities. The scale of labor force reaches a certain level of carbon emission reduction in other provinces.

Generally, most regions in China have achieved carbon emission reduction because of the structural factor; such a reduction indicates that the improved environment brought by China's current industrial restructuring complies with the actual situation of China. The traditional farming-based agricultural land use mode is often accompanied by many inputs and high resource consumption, which lead directly or indirectly to carbon emissions. Under the premise of ensuring food security, reducing the development of conventional farming with high consumption and high carbon emissions has become the direction and trend for agricultural structure adjustment, because it considers both ecological and economic benefits. With the significant optimization of agricultural and rural economic structure, the farming-oriented development of agricultural production structure transforms into coordinated development of agriculture, forestry, animal husbandry and fishery; diversified agricultural business and rural secondary and tertiary industries are emphasized. The focus of rural economic structure transforms from agriculture into low-carbon agriculture. Studies on the influencing factors of carbon emission from agricultural land use are combined with the rational distribution of non-agricultural industries to attain coordinated development and significantly improve the comprehensive benefits of agriculture and rural economy.

From the perspective of typical provinces, Zhejiang is an advanced non-agricultural economy province. Zhejiang's agriculture rapidly developed since China's reform and opening-up, and its agricultural land resource utilization rate increases annually. However, the extensive production mode that has excessive dependence on resource consumption and material inputs still shows no fundamental change. The agricultural output value of Zhejiang is growing rapidly, but the policy to reduce carbon emissions arising from agricultural land use has not been established based on technical application and upgrading of industrial structure. Instead, the policy has been built largely on the intensive production model in traditional agricultural land. Thus, high yield depends largely on high investment, which will inevitably lead to an increase in carbon emissions.

Strengthening publicity and education, and establishing low-carbon awareness for agricultural land use: Worsening climate change and the associated environmental problems caused by carbon emission have attracted increasing attention from society. Given that China proposed to reduce carbon emission per unit of GDP annually, low carbon will become an important label for China's future economic development. In achieving the desired objectives, reducing the carbon emissions caused by agricultural land use will be the best choice for China's agricultural development in the new era. Awareness is the precursor of action; hence, to make the low-carbon concept become deeply rooted in people's minds, low-carbon agricultural land use should quickly become a reality. We must strengthen the implementation and publicity of efforts to reduce carbon emissions through agricultural land use, establish low-carbon awareness, provide better guidance for actual production, and achieve the ultimate goal of reducing agricultural land carbon emissions.

Strengthening financial support to reduce agricultural land carbon emission, increase carbon sink, and build diversified funding channels: Low-carbon agricultural land is a revolution in the development of agriculture. To transform traditional agricultural land use to low-carbon utilization, we should strengthen low-carbon technology innovation and promotion for agricultural land use, and provide considerable financial support to transform traditional agricultural land use to low-carbon utilization. These steps will gradually improve the investment system of low-carbon agricultural land use. Funds are usually collected for emission reduction from government departments and the community by tax, credit, price, investment, and other economic tools, as well as information, technology and services to achieve low-carbon agricultural land use. China should vigorously provide fiscal support for agriculture, adjust national financial allocation structure, include low-carbon agriculture land use in the financial budget, and increase the amount annually. China should also use national financial resources to establish policy-oriented agricultural insurance companies, establish agricultural risk fund, effectively avoid the risks and losses in low-carbon agricultural development, and improve the motivation of the main concerned bodies in devel-

Table 2: Decomposition of factors of carbon emissions from the use of Chinese agricultural land resources by region (Unit: ten thousand tons).

Province	Efficiency factor	Structural factor	Economic development level	Scale of labor force
Beijing	-22.89	-108.63	7.12	6.49
Tianjin	-20.25	-150.35	551.22	3.89
Hebei	48.06	-52.46	69.74	4.49
Henan	54.77	605.86	64.92	0.81
Heilongjiang	-9.04	-260.80	19.64	-26.76
Jilin	-1.44	658.52	169.76	-0.97
Liaoning	15.82	4.14	13.02	85.81
Shandong	0.71	36.58	36.87	0.13
Jiangsu	-83.32	-18.77	30.64	-392.50
Shanghai	-64.76	185.12	211.37	-64.51
Zhejiang	574.95	-234.07	9.87	237.00
Anhui	-111.89	306.42	14.27	-27.56
Fujian	-49.64	-146.04	6.74	70.44
Jiangxi	-9.80	53.67	45.19	-28.68
Hubei	515.02	-98.69	65.74	117.23
Hunan	-41.67	249.26	15.19	3.70
Guangdong	-19.13	-11.77	64.84	0.47
Guangxi	-44.41	-24.58	86.47	12.80
Hainan	163.07	-26.15	-31.18	81.69
Chongqing	58.65	196.06	69.64	-0.66
Sichuan	-54.90	-41.49	-88.78	1.27
Guizhou	-133.61	-0.06	303.58	1.14
Yunnan	351.38	-24.84	-163.66	8.12
Tibet	-5.73	148.81	687.54	6.76
Shanxi	-26.46	-27.34	-10.55	4.57
Shaanxi	-74.98	-96.91	44.00	-4.12
Inner Mongolia	18.24	100.50	15.92	44.01
Gansu	16.87	7836.89	98.64	0.90
Qinghai	-98.02	413.15	-22.17	20.38
Ningxia	-19.85	-43.28	143.34	-2.03
Xinjiang	568.37	-72.12	5.47	152.33

oping low-carbon agriculture.

POLICY AND RECOMMENDATIONS

Optimizing the agricultural structure adjustment, focusing on environmental protection: Agricultural structure adjustment takes place in the entire process of agricultural economic development and is utilized to increase production yield, reclaim a large area of land, substantially increase the input of chemical fertilizers, pesticides and other chemicals, as well as increase multiple cropping index. These actions not only led to considerable carbon emissions from agricultural land, but also in the further deterioration of inherent desertification, soil erosion, soil salinization and other environmental issues. By attaining agricultural structure adjustment, environmental protection, and emission reduction, China can achieve leapfrog development in its agricultural economy by adding carbon sinks, developing new economic growth points, further strengthening agricultural structure adjustment, constantly optimizing agricultural layout and planting structure, and achieving the diversified and low-carbon transition of agricultural structure. The country can also follow "resource-saving" and "environmentally friendly" agricultural approaches as well as achieve sustainable development of agriculture. The sustainable growth of agricultural economy can be achieved only by effectively changing the existing irrational growth mode of agricultural economy.

Increasing agricultural production utilization efficiency, effectively saving costs, and promoting efficiency: Low agricultural utilization rate is the main reason for high carbon emissions from agricultural land use. Upholding the principle of "minimization, recycling, and re-use", conservation-oriented farming, planting, fertilization, medication, irrigation and dry farming, reduction of agricultural wastes should be developed and promoted constantly. Focus should also be given to soil and water conservation and other low-carbon agricultural technologies. Vigorous promotion of soil testing and fertilizers, application of organic fertilizers, sprinkler irrigation, drip irrigation, low-pressure pipeline irrigation, and other water-saving irrigation methods, fallow, and no-till and other conservation tillage practices improve conditions for agricultural production and greatly advance production capacity. These practices also enhance the ecological environment and reduce the greenhouse gas emissions caused by agricultural land use. However, current efforts are insufficient; China still lacks incentives for farmers to adopt conservation-oriented farming techniques. The country should continue to provide low-carbon compensation for farmers who apply organic fertilizers, save resources, use rural clean energy and renewable energy, utilize agriculture and implement waste recycling and centralized treatment, enable positive external behaviours of energy conservation to be paid for by outside beneficiaries, institutionalize payment, form long-term institutional constraints, and stimulate farmers to adopt and constantly update conservation tillage techniques.

Strengthening publicity and education, and establishing low-carbon awareness for agricultural land use: Worsening climate change and the associated environmental problems caused by carbon emission have attracted increasing attention from society. Given that China proposed to reduce carbon emission per unit of GDP annually, low carbon will become an important label for China's future economic development. In achieving the desired objectives, reducing the carbon emissions caused by agricultural land use will be the best choice for China's agricultural development in the new era. Awareness is the precursor of action; hence, to make the low-carbon concept become deeply rooted in people's minds, low-carbon agricultural land use should quickly become a reality. We must strengthen the implementation and publicity of efforts to reduce carbon emissions through agricultural land use, establish low-carbon awareness, provide better guidance for actual production, and achieve the ultimate goal of reducing agricultural land carbon emissions.

Strengthening financial support to reduce agricultural land carbon emission, increase carbon sink and build diversified funding channels: Low-carbon agricultural land is a revolution in the development of agriculture. To transform traditional agricultural land use to low-carbon utilization, we should strengthen low-carbon technology innovation and promotion for agricultural land use, and provide considerable financial support to transform traditional agricultural land use to low-carbon utilization. These steps will gradually improve the investment system of low-carbon agricultural land use. Funds are usually collected for emission reduction from government departments and the community by tax, credit, price, investment, and other economic tools, as well as information, technology and services to achieve low-carbon agricultural land use. China should vigorously provide fiscal support for agriculture, adjust national financial allocation structure, include low-carbon agriculture land use in the financial budget, and increase the amount annually. China should also use national financial resources to establish policy-oriented agricultural insurance companies, establish agricultural risk fund, effectively avoid the risks and losses in low-carbon agricultural development, and improve the motivation of the main concerned bodies in developing low-carbon agriculture.

CONCLUSION

Considerable reduction of the carbon emissions that arise from agricultural land use is an important step to achieving China's emission reduction targets, and such reduction is the basic premise to promote China's agricultural land use and sustainable agricultural development. The optimization of agricultural land resources and environment is an important guarantee to achieve sustainable social and economic development. The paper explore the factors of carbon emissions from Chinese agricultural land resources, reveals the microscopic mechanisms of carbon emissions caused by agricultural land use, and proposes specific emission reduction measures. Based on the important theories on farmer's behaviours and environmental externalities, the paper measures the amount of carbon emissions caused by agricultural land use in China from 2002 to 2013. The paper also uses Kaya identical equation to analyse the driving factors of carbon emissions arising from agricultural land use from the national and provincial levels, and proposes scientific countermeasures to promote carbon emission reduction. These results have important theoretical and practical reference values for the formulation and implementation of China's carbon emission reduction policy for agricultural land. Recommendations include calculating the output efficiency of carbon emission caused by Chinese agricultural land use, dividing regions to analyse the overall efficiency of agricultural land resource utilization, and using space panel data model to analyse whether the geographical association can exert significant impact on carbon emissions and other topics.

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