

On the Realization of Double Carbon Goal from the Perspective of Cultivated Land Quality Protection

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Abstract: Since the revolution, the greenhouse gases produced by human activities have gradually increased, and the greenhouse effect has gradually strengthened, resulting in a series of environmental problems such as climate warming, glacier melting and sea level rise. China's peak carbon dioxide emissions and carbon neutral strategy is not only a major demand for global climate control, protecting the earth's homeland and building Community of Shared Future for Mankind, but also an inherent demand for China's high-quality development, ecological civilization construction and comprehensive management of ecological environment. The two fundamental ways to realize the carbon-neutral strategy of China are "reducing emissions" and "increasing exchange".

Keywords: Cultivated land quality, Double carbon, Reduce carbon emissions, Increase soil carbon sink.

1. Introduction

Agriculture is the main source of non-carbon dioxide greenhouse gases (mainly methane and nitrous oxide, whose greenhouse effect is 25 times and 298 times that of carbon dioxide, respectively), accounting for 10% ~ 12% of the global total greenhouse gas emissions from human sources [1]. Agriculture is both a carbon source and a carbon sink. According to IPCC Guidelines for National Greenhouse Gas Inventory, agricultural carbon emissions mainly come from farming, irrigation, fertilization, pesticide application, use of agricultural film, use of agricultural machinery, straw treatment, livestock and poultry breeding and manure management. Soil is the foundation of agricultural production and the largest carbon pool in terrestrial ecosystem. Its carbon storage is about 3 times of atmospheric carbon pool [2] and 2.5 times of terrestrial vegetation carbon pool. Among all carbon neutral and negative technologies in the world, soil carbon sequestration is recognized as the most potential, lowest cost, easiest to operate and realize. It is estimated that the annual carbon sequestration of farmland soil in the world can offset the carbon emissions of 0.4~1.2 Pg, which is equivalent to 2.8% ~ 8.3% of the global greenhouse gas emissions in 2015. China is a country with poor soil carbon and cultivated land.

China is a country with poor soil carbon, and the average organic carbon content of cultivated soil is 1/3 lower than that of European and American countries. In the vast agricultural areas of China, the soil is shallow, the fertility of the land is low, coupled with intensive cultivation, excessive application of chemical fertilizers and soil erosion, which makes the content of soil organic carbon in cultivated land low, and its carbon sequestration potential is huge. China has an area of more than 1.95 billion mu of cultivated land, and a 1% increase in soil organic carbon in cultivated land can increase foreign exchange by 1.8 billion tons. Therefore, reducing agricultural carbon emissions and enhancing the carbon

sequestration capacity of cultivated soil are the powerful starting points for China to achieve carbon neutrality.

In October 2021, the State Council issued the "peak carbon dioxide emissions Action Plan to 2030", which calls for promoting emission reduction and carbon sequestration in agriculture and rural areas. It is necessary to reasonably control the amount of chemical fertilizers, pesticides and plastic film, implement the substitution plan of chemical fertilizers and pesticides, and strengthen the comprehensive utilization of crop straws and the resource utilization of livestock and poultry manure; It is necessary to carry out actions to improve the quality of cultivated land, implement the national black land protection project, and improve the storage of soil organic carbon. From 2000 to 2019, the top three agricultural emissions in Jiangsu Province were rice planting, chemical fertilizer and livestock and poultry manure management, contributing 14.01%, 10.73% and 10.26% respectively [3]. Therefore, from the perspective of cultivated land quality protection, on the one hand, we should reduce the use of chemical fertilizers, pesticides, agricultural films and other inputs, and make rational use of agricultural wastes such as straw and livestock manure to reduce carbon emissions; On the other hand, we should vigorously promote the improvement of cultivated land quality, increase soil carbon sink, and jointly promote emission reduction and carbon sequestration, so as to promote the protection of cultivated land quality and achieve the "double carbon" goal.

2. Continue to Reduce Chemical Fertilizers and Increase Efficiency, And Reduce Carbon Emissions

Among agricultural inputs, the contribution rate of chemical fertilizer to greenhouse effect is the highest, accounting for about 65% [4]. The greenhouse effect of chemical fertilizer mainly comes from the production and application of nitrogen fertilizer. On the one hand, greenhouse

gases will be produced during the production of chemical nitrogen fertilizer, and about 6 tons of carbon dioxide will be produced when 1 ton of chemical nitrogen fertilizer is produced [4]; On the other hand, chemical nitrogen fertilizer enters the soil for nitrification and denitrification, which will produce nitrous oxide. It is estimated that 1% of nitrogen fertilizer will enter the atmosphere in the form of nitrous oxide [5]. At present, there are widespread problems in farmland in China, such as excessive application of nitrogen fertilizer and low utilization rate of nitrogen fertilizer. The utilization rate of chemical nitrogen fertilizer is 30% ~ 40%, which is lower than that of developed countries. Therefore, it is necessary to continuously promote the action of reducing and increasing the efficiency of chemical fertilizers, improve the utilization rate of chemical fertilizers, especially nitrogen fertilizers, reduce the production and application of chemical fertilizers, and reduce carbon emissions.

Reducing fertilizer efficiency mainly depends on soil testing, formula fertilization, side deep fertilization of rice, simultaneous sowing of wheat seed and fertilizer, combined application of organic and inorganic fertilizers, application of slow and controlled release fertilizers and other measures. Based on the rational application of organic fertilizer, soil formula fertilization is to put forward the appropriate dosage and proportion of nitrogen, phosphorus, potassium and trace elements, as well as the corresponding fertilization technology, so that crops can eat the "nutrition package". Soil testing and formula fertilization can reduce the loss of four kinds of active nitrogen (ammonia volatilization, nitrous oxide emission, nitrogen leaching and runoff) by 27.6% ~ 35.3% [6]. Jiangsu Province has implemented the subsidy project of soil testing and formula fertilization since 2005. Over the past ten years, farmers' fertilization methods have gradually changed, and the utilization rate of chemical fertilizers has gradually increased. By 2020, the utilization rate of chemical fertilizers of main crops in the province will increase to 40.7%. Side-deep fertilization is the simultaneous application of formula fertilizer or slow-release fertilizer near the root of rice seedlings during rice transplanting, which can reduce the total amount and times of fertilization and improve the utilization rate of fertilizer. Wheat seed and fertilizer sowing technology is to deeply apply seeds and high-efficiency slow-release fertilizer to the ground at one time by using a seeder during wheat sowing period, which can simplify cultivation methods and improve fertilizer utilization rate. Combined application of inorganic fertilizer can reduce the amount of chemical fertilizer and improve the yield and quality of crops. Slow-release fertilizer can slowly release nutrients according to the needs of different growth stages of crops, supply fertilizer as needed, and reduce fertilizer loss. Reasonable use of nitrification inhibitor is an important measure to reduce nitrogen loss and improve nitrogen utilization rate [6]. Compared with conventional surface application, nitrogen reduction surface application with urease inhibitor can reduce emissions by 75.9% ~ 81.7% [7]. Wu et al. [8] found that nitrification inhibitors can reduce nitrous oxide emissions by 8.75% ~ 25.28% under different nitrogen fertilizer levels in vegetable fields.

3. Rational Utilization of Livestock and Poultry Manure Resources to Reduce Carbon Emissions

During the storage, transportation and use of livestock and

poultry manure, methane and nitrous oxide will be produced. Although the resource utilization of livestock and poultry manure will inevitably produce greenhouse gases, it is of great significance in protecting human settlements, reducing the amount of chemical fertilizer, fertilizing cultivated land and improving soil organic matter. From the project of replacing chemical fertilizer with fruit, vegetable and tea organic fertilizer in 2020, the total amount of chemical fertilizer applied in the project area of Jiangsu Province decreased by 17.55% compared with the previous year, and the total amount of organic fertilizer applied increased by 24.53% compared with the previous year; The quality of agricultural products is 100% in line with national food safety standards or industrial standards for agricultural product quality and safety; Soil pH, plough layer thickness, organic matter and salinization tend to improve.

In order to meet the demand of "double carbon" target, we should further explore a more reasonable resource utilization mode of livestock and poultry manure. Pyrolysis of livestock and poultry manure to prepare biochar is a treatment method that can quickly realize its harmlessness, reduction and resource utilization [9]. In 2015, the amount of carbon sequestration of livestock and poultry manure biochar in China reached 350 million t, equivalent to about 17.2% of the annual carbon emissions [10], which has great potential for carbon sequestration and emission reduction. The biogas produced by anaerobic fermentation of livestock and poultry manure can be used to generate electricity (1 m³ biogas can replace 0.6 m³ natural gas and 0.714 kg coal) [11], and the biogas residue and biogas slurry produced can be used to produce organic fertilizer, forming an organic ecological recycling industry. For example, Hai 'an, Rugao and other counties in Jiangsu Province rely on the pilot project of green cultivation and recycling agriculture to promote the implementation of biogas slurry returning to fields.

4. Improve the Quality of Cultivated Land, Reduce Emissions and Increase Foreign Exchange

The global farmland covers an area of 20.55 billion mu, and its organic carbon storage is about 170 billion t, which exceeds 10% of the global land organic carbon storage [12]. And it is of great significance to reduce emissions and increase efficiency.

4.1. Manage rice planting accurately, protect and improve the quality of paddy fields.

Soil organic matter content in paddy field is high (according to the results of investigation and evaluation of cultivated land quality grade, the organic matter content in paddy field in Jiangsu Province is about 25% higher than that in dry land on average), soil biological activity is high, and soil carbon sequestration capacity is higher than that in dry land. According to the research in Taihu Lake area, the net carbon sink produced by rice field ecosystem in one season is 2 ~ 3 times of that under dry farming [13]. Rice is the largest food crop in Jiangsu Province, with an annual planting area of more than 30 million mu. Therefore, rational planting and increasing organic matter in rice fields is one of the important measures to reduce emissions and fix carbon. First, do a good job in water management. Under the condition of rice flooding, the decomposition of active organic substances in the soil will produce methane, and when it dries, it will

produce nitrous oxide, which is a trade-off relationship. Compared with long-term flooding, multiple drainage during rice growth can reduce methane emissions by about one and a half times, and shallow water-saving irrigation (5 ~ 25 cm) can reduce methane emissions by about 40% compared with deep irrigation (30 ~ 50 cm) [14-15]. It is suggested that shallow irrigation and repeated drainage should be carried out during rice growth period, and organic materials should not be put before irrigation. Second, it is necessary to fertilize accurately. Excessive application of chemical fertilizer, especially nitrogen fertilizer, will not only produce more nitrous oxide, but also lead to deterioration of soil properties. Therefore, the emphasis is on reducing the nitrogen input in paddy fields and improving the utilization rate of nitrogen fertilizer. It is suggested to use three technical modes: one-time fertilization, one base and one topdressing and one base and two topdressing, that is, one-time basal application of urea+slow and controlled release fertilizer in high fertility soil. Apply urea+slow and controlled release fertilizer (or formula fertilizer) to medium fertility soil base, and apply urea or nitrogen and potassium fertilizer once; Apply urea+slow-controlled release fertilizer (or formula fertilizer) to soil with leaking fertilizer and sandy texture, and apply urea or nitrogen and potassium fertilizer twice.

4.2. Straw resource utilization and returning to field

In recent years, with the continuous improvement of crop yield, the straw yield has gradually increased. The average annual straw resource in Jiangsu Province is over 30 million tons, and the most important utilization way is directly returning to the field and using it as fuel [16]. As an organic material, straw returning directly to the field can increase soil organic matter and improve soil structure, but it will significantly increase methane emission. Converting crop straw into biomass charcoal can not only achieve the effect of returning straw to fields to fertilize soil, but also reduce greenhouse gas emissions [17-18]. Jiang Kaiyang et al. [16] analyzed the biogas potential and carbon footprint of straw in Jiangsu Province from 2008 to 2017, and found that the annual carbon emission of straw used for direct combustion in Jiangsu Province was 7,315,400 tons. If all straw used for direct combustion was biogas, the annual carbon emission could be reduced by 3,591,000 tons. Therefore, it is an important measure to protect and improve the quality of cultivated land, reduce emissions and increase foreign exchange by further changing the utilization mode of straw directly returning to the field and shifting to green and efficient ecological utilization such as biochar and biogas.

4.3. Conservation tillage

Reasonable farming methods are of great significance to improving cultivated land quality and reducing greenhouse gas emissions. Conservation tillage refers to an advanced agricultural farming technology that adopts no-tillage and less tillage on farmland, combines crop straw and stubble mulching, green manure rotation and pesticide pest control. Tillage will accelerate the decomposition of organic matter and increase greenhouse gas emissions. Compared with tillage measures such as tillage, rotary tillage and deep tillage, no-tillage and less tillage can reduce soil carbon dioxide and nitrous oxide emissions [19-21]. Conservation tillage can also improve soil structure, increase the thickness of plough layer and improve soil fertility. It is suggested that the frequency of

plowing should be reduced, and green manure in fertile fields or economic green manure with both fertilizer and vegetables and fertilizer and feeding should be actively planted in the first-class protected areas of Taihu Lake, newly reclaimed beaches, orchards and tea gardens, and hilly areas, so as to protect and improve the quality of cultivated land, reduce emissions and increase foreign exchange.

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