

Comparative Analysis of Agricultural Carbon Sequestration Policies in Different Countries

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Abstract

This article delves into the significance of agricultural carbon sequestration policies within the global climate change context, along with an examination of policy practices across multiple countries. Initially, the article introduces the concept of agricultural carbon sequestration, underscoring its pivotal role in attaining carbon neutrality, facilitating climate adaptation, and fostering sustainable development. Subsequently, through a comparative analysis of agricultural carbon sequestration policies in four representative nations—namely, the United States, the European Union, China, and Brazil—the article conducts an exhaustive exploration of each country's policy objectives, primary measures, effectiveness evaluation, and the challenges encountered. Furthermore, the article comprehensively scrutinizes the convergences and divergences among diverse countries' policies, offering several conclusions and insights, while accentuating the significance and potential of global collaboration.

Keywords

Carbon sink, Different countries, Policy direction, Future development.

1. INTRODUCTION

With the escalating global climate change, mitigating greenhouse gas emissions and enhancing carbon sequestration capacity have become crucial tasks for the entire world. Agricultural carbon sequestration, as a vital component, plays a key role in achieving carbon neutrality, promoting climate adaptation, and sustainable development. Agricultural carbon sequestration refers to the process of absorbing carbon dioxide from the atmosphere through agricultural activities and storing it in soil, plants, and living organisms, creating a stable carbon sink (Figure 1)[1, 2]. This not only helps reduce the concentration of greenhouse gases in the atmosphere but also enhances the adaptability and resilience of agricultural production.

Across the globe, different countries and regions have formulated their own strategies and measures for agricultural carbon sequestration policies. By comparing the similarities and differences, as well as the effectiveness of these policies, we can gain in-depth insights into the policy orientation and priority areas under various contexts, explore successful cases and lessons learned, and provide valuable references for other countries in policy formulation. This paper focuses on the agricultural carbon sequestration policies of four representative countries: the United States, the European Union, China, and Brazil. We conduct a comprehensive analysis of their policy objectives, main measures, effectiveness evaluation, and the challenges they face. The ultimate goal is to promote the collaborative development and cooperation of global agricultural carbon sequestration policies.

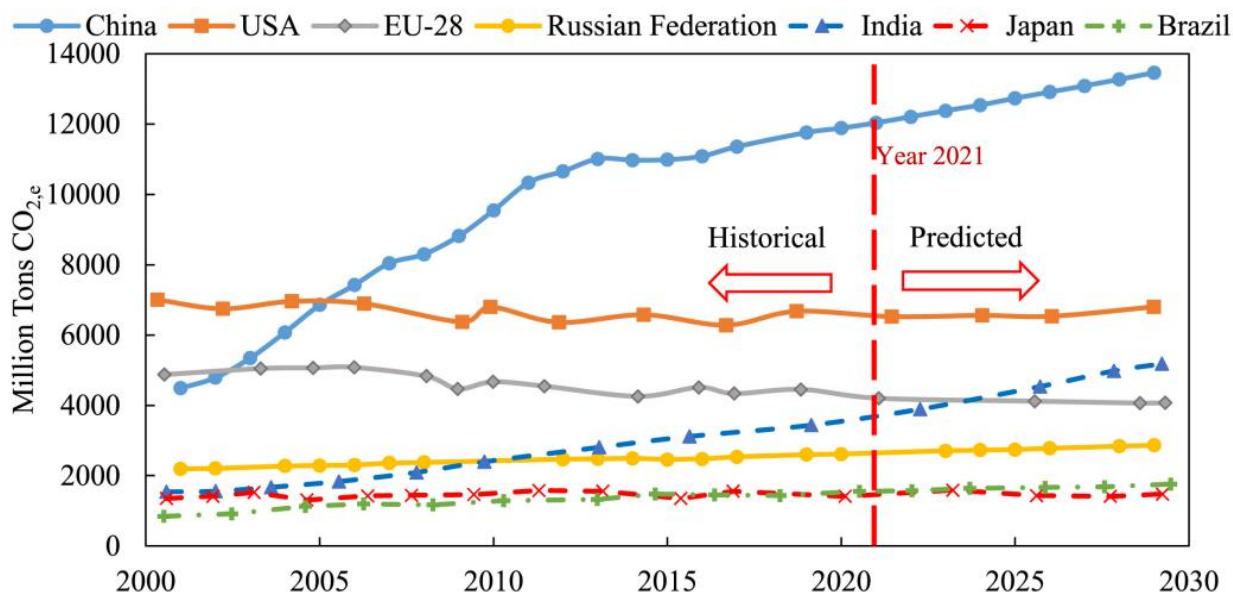


Figure 1. Carbon emission in major countries and regions [2]

2. DIFFERENCES IN AGRICULTURAL CARBON SEQUESTRATION POLICIES AMONG COUNTRIES

2.1. China

2.1.1 Promoting Organic Farming and Straw Returning Measures

The Chinese government actively promotes organic farming and straw returning measures in its agricultural carbon sequestration policy. Organic farming is an agricultural production model based on ecological cycles and natural regulation, which reduces the use of chemical fertilizers and pesticides, promotes the accumulation of organic matter in the soil, and enhances soil carbon storage capacity. At the same time, straw returning involves returning crop residues to the soil after harvesting, which helps increase soil organic carbon content, improve soil quality, and thus enhance agricultural carbon sequestration[3]. The promotion of these measures not only contributes to climate change mitigation but also improves the ecological environment of farmland and enhances the quality and safety of agricultural products[4].

2.1.2 Construction of Agricultural Water Conservancy Facilities and Crop Rotation

The construction of agricultural water conservancy facilities and the implementation of crop rotation are also important components of China's agricultural carbon sequestration policy[5]. The development of agricultural water conservancy facilities helps regulate irrigation and drainage in farmland, maintain soil moisture, improve the absorption efficiency of CO₂ by crops, and increase carbon sequestration in agricultural ecosystems[6]. Furthermore, crop rotation is an effective agricultural management measure that enhances the efficient use of soil nutrients, reduces soil erosion and nutrient loss, and facilitates the stable accumulation of soil organic carbon.

2.1.3 Establishment of Carbon Trading Market and Economic Incentives for Farmers

The Chinese government is committed to establishing a carbon trading market, facilitating carbon emission rights trading and carbon sequestration trading to encourage farmer participation in carbon sequestration projects and provision of carbon sequestration services. After implementing agricultural carbon sequestration measures, farmers can obtain carbon emission rights or carbon sequestration certifications, enabling them to participate in carbon trading and increase their economic benefits. These economic incentives encourage farmers to

actively engage in agricultural carbon sequestration projects, promoting the implementation and dissemination of agricultural carbon sequestration policies[6].

2.2. United States

2.2.1 Incentive and Subsidy Measures to Encourage Farmer Participation in Carbon Sequestration Projects

The United States government encourages farmer participation in agricultural carbon sequestration projects through incentive and subsidy measures, aiming to increase soil carbon storage and reduce greenhouse gas emissions. For instance, the United States Department of Agriculture (USDA) has launched various incentive programs such as carbon capture initiatives and land conservation programs, providing financial and technical support to farmers to implement soil improvement, vegetation restoration, and farmland conservation measures to enhance agricultural carbon sequestration. Furthermore, the U.S. government offers opportunities for participating farmers in the carbon market, allowing them to trade their implemented carbon storage projects as carbon credits and gain economic returns.

2.2.2 The Role of Scientific Research and Innovation in Agricultural Carbon Sequestration

The United States places great emphasis on the role of scientific research and innovation in agricultural carbon sequestration[7]. Government agencies, agricultural institutions, and academia collaborate extensively in conducting research to explore new carbon storage technologies and management methods. By leveraging cutting-edge technologies and scientific knowledge, farmers can more effectively increase soil organic carbon content, enhance crop carbon uptake capacity, and lower greenhouse gas emissions. The U.S. government actively encourages collaboration between the agricultural and scientific communities to foster technological innovation and practical application of agricultural carbon sequestration methods.

2.3. Brazil

2.3.1 Promoting Sustainable Agricultural Practices and Rainforest Conservation

As a country with vast agricultural land and unique ecosystems, Brazil places great emphasis on advancing agricultural carbon sequestration policies. The Brazilian government is committed to promoting sustainable agricultural practices by popularizing organic and eco-friendly agricultural technologies. This approach aims to improve agricultural productivity while minimizing greenhouse gas emissions. Additionally, the Brazilian government attaches high importance to the preservation of rainforest resources, recognizing the rainforest as a massive carbon sink with significant implications for global climate balance. Therefore, Brazil actively takes measures to prevent deforestation and illegal land clearing, aiming to protect and enhance the rainforest's carbon absorption capacity.

2.3.2 Reforestation and Collaboration with International Institutions for Carbon Offset Certification

To further enhance agricultural carbon sequestration capacity, the Brazilian government focuses on reforestation projects. Through large-scale afforestation, particularly restoring vegetation on degraded lands, Brazil aims to increase forest cover and carbon storage capacity to boost agricultural carbon sequestration. Furthermore, Brazil collaborates with international institutions to seek carbon offset certification[8]. By selling certified carbon offsets in the international carbon market, Brazil can gain economic benefits, further incentivizing farmer participation in agricultural carbon sequestration projects.

2.4. European Union

2.4.1 Subsidies and Incentives to Promote Low-Carbon Agricultural Practices

As a key economic entity committed to addressing climate change, the European Union (EU) has implemented a series of agricultural carbon sequestration policies to promote low-carbon agricultural practices. Providing subsidies and incentives to farmers is an integral part of the EU's policy. By offering financial subsidies and rewards, farmers are encouraged to adopt more environmentally friendly and low-carbon agricultural production methods, such as promoting organic agriculture, reducing the use of fertilizers and pesticides, and implementing nitrogen management measures[9, 10]. This not only helps reduce agricultural carbon emissions but also enhances the carbon storage capacity of farmland, leading to an increase in agricultural carbon sequestration.

2.4.2 Ecological Compensation Measures to Encourage Wetland Conservation and Restoration

The EU's agricultural carbon sequestration policy also emphasizes wetland conservation and restoration. Wetlands are essential carbon sinks that play a crucial role in mitigating climate change and protecting ecosystems. Through the implementation of ecological compensation measures, the EU provides economic support and incentives to farmers actively engaged in wetland conservation and restoration efforts. This approach encourages farmers to participate in wetland protection, contributing to improved ecological functionality and carbon storage capacity in wetland areas, thereby promoting an increase in agricultural carbon sequestration.

3. COMPARATIVE ANALYSIS OF AGRICULTURAL CARBON SEQUESTRATION POLICIES IN DIFFERENT COUNTRIES

3.1. Policy Emphasis and Measures Variations

Different countries exhibit certain variations in the formulation of agricultural carbon sequestration policies, primarily in terms of policy emphasis and the measures adopted. China, the United States, Brazil, and the European Union, being countries with significant agricultural industries, focus on slightly different aspects (Figure 2).

In terms of policy emphasis, the Chinese government emphasizes the promotion of organic agriculture and straw returning practices to increase agricultural carbon sequestration by reducing agricultural emissions and enhancing soil carbon storage. The US government, on the other hand, encourages farmers' participation in carbon storage projects through rewards and subsidies, while also emphasizing the promotion of agricultural science research and innovation. The Brazilian government emphasizes the promotion of sustainable agricultural practices and rainforest conservation, giving priority to reforestation and collaborating with international organizations to obtain carbon emission reduction certifications. The European Union focuses on promoting low-carbon practices in the agricultural sector through subsidies and incentives to encourage farmers to adopt environmentally friendly and sustainable agricultural production methods, while also emphasizing wetland conservation and restoration.

Regarding specific measures, different countries also exhibit certain variations. China employs policy regulations and economic incentives to promote organic agriculture and straw returning practices, improving agricultural production and land use, and reducing the use of fertilizers and pesticides. The US government offers economic rewards to encourage farmers' participation in carbon storage projects, such as carbon sequestering forests and soil carbon storage initiatives[12, 13]. The Brazilian government takes measures to protect rainforests, enhance agricultural sustainability, and increase forest carbon storage through initiatives like reforestation. The European Union uses subsidies and incentives to encourage farmers to adopt low-carbon agricultural practices while promoting wetland conservation and restoration to increase wetland carbon storage.



Figure 2. National bioeconomy strategies and related policy instruments [11].

3.2. Impact of Policies on Agricultural Carbon Sequestration

The agricultural carbon sequestration policies of different countries have varying degrees of impact on agricultural carbon sequestration[14]. China's organic agriculture and straw returning practices have contributed to an increase in agricultural carbon sequestration to some extent, but they still face challenges related to technology dissemination and management. The US carbon storage projects have actively encouraged farmer participation in carbon sequestration activities, but they need to balance economic and ecological benefits. Brazil's rainforest conservation and reforestation measures have significantly impacted agricultural carbon sequestration and forest carbon storage, but they also need to address the balance between forest conservation and agricultural development. The European Union's low-carbon agricultural practices and wetland conservation measures have contributed to increased agricultural carbon sequestration, but policy fairness and effectiveness need to be ensured to encourage active farmer participation[11].

4. CONCLUSION

4.1. Effectiveness and Challenges of Agricultural Carbon Sequestration Policies in Different Countries

Through the comparative analysis of different countries' agricultural carbon sequestration policies, it is evident that various countries have taken proactive and effective measures to increase agricultural carbon sequestration and address climate change[15]. China's promotion of organic agriculture and straw returning practices has led to a certain increase in agricultural carbon sequestration, but challenges such as technology dissemination and management need to be addressed. The US carbon storage projects encourage farmer participation in carbon sequestration activities but require balancing economic and ecological benefits. Brazil's rainforest conservation and reforestation measures have increased agricultural carbon sequestration, but they also need to address conflicts between forest conservation and agricultural development. The European Union's low-carbon agricultural practices and wetland

conservation measures have increased agricultural carbon sequestration, but policy fairness and effectiveness need to be ensured.

4.2. Learnings and Inspirations

The comparative analysis of agricultural carbon sequestration policies from different countries provides valuable experiences and insights. Firstly, governments should establish clear policy objectives and measures to encourage farmer participation in carbon sequestration activities and promote sustainable agricultural development. Secondly, policy formulation should comprehensively consider economic, social, and environmental benefits to ensure policy balance and sustainability. Thirdly, a cooperative mechanism needs to be established between governments and farmers to jointly promote increased agricultural carbon sequestration and address the challenges of climate change. Finally, policy implementation should be customized according to the characteristics of different regions and agricultural types to ensure policy applicability and effectiveness.

4.3. The Importance and Prospects of Promoting Global Agricultural Carbon Sequestration Cooperation

Global climate change is a global challenge, and all countries should work together to promote cooperation and exchange in agricultural carbon sequestration. By sharing successful experiences and technologies, countries can learn from each other and improve the efficiency and scale of agricultural carbon sequestration. At the same time, strengthening international cooperation can promote the development of carbon trading and carbon markets, encouraging more farmers to participate in carbon sequestration activities. Through global agricultural carbon sequestration cooperation, larger-scale carbon emission reductions can be achieved, making a positive contribution to global efforts in combating climate change.

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