

Guest editorial: Agricultural and rural development under the goal of carbon neutrality

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Under the Paris Agreement bringing all parties together to limit the global average temperature by mid-century, more than 130 countries have announced a carbon neutrality goal so far. In 2020, China pledged to reach carbon peak emissions by 2030 and achieve an ambitious goal of carbon neutrality by 2060. However, numerous challenges exist, such as imbalanced economic development and pandemics, for countries to form a true global community to implement carbon-neutral strategies. As a developing country, China has even more challenges in transitioning to sustainable and high-quality development from the current stage of large energy consumption and coal-based energy structure under the tight schedule.

The last four decades have witnessed remarkable success in poverty eradication and modernization in rural China. However, the ever-growing demand for agricultural products has placed considerable pressure on the coordination between agricultural as well as rural development and environmental sustainability. In particular, the traditional lifestyles and agricultural production adopted in rural China induce high greenhouse gas (GHG) emissions. According to the latest national population census in 2020, over 500 million people live in the rural area in China, and 31% of the households in rural China rely on traditional solid fuels such as coal and firewood for cooking and heating. In addition, agricultural sector is the primary anthropogenic source of methane and nitrous oxide. Moreover, despite a large potential in restoring carbon sinks in farmland and fishery, there are few relevant projects in agriculture. Therefore, the agricultural and rural area plays a critical role in tackling climate change by decreasing emissions and increasing sink capacity in China.

In light of China's carbon-neutral goal before 2060, agricultural and rural development faces enormous challenges and opportunities. Some key questions need to be answered to resolve the conflict between agricultural and rural development and China's carbon-neutral goal in an effective and efficient manner: What is the role of the agricultural and food sector in achieving the national carbon-neutral goal? How to coordinate growth in the agricultural sector and decarbonization progress? Which policies are available to promote the adoption of clean technologies in agricultural production? What are the fundamental forces to shape a low-carbon rural life? How to align rural revitalization with the carbon-neutral goal?

This special issue is hosted by the Center for Energy and Environmental Policy Research (CEEP) at Beijing Institute of Technology (BIT). The CEEP, together with *China Agricultural Economic Review (CAER)*, had the honor to open a discussion of exploring appropriate pathways for China's agricultural and rural development to achieve the goal of carbon neutrality.

Under a double-blinded review process, 8 out of 26 manuscripts were included in the special issue from four broadly defined research questions, with two papers for each.

The first group of studies directly explores agricultural development under China's carbon-neutral goal. On the one hand, the goal may impose a constraint on production. [Wei et](#)

al.(2022) simulate the impacts of the “dual carbon” goals (i.e. carbon peak before 2030 and carbon neutrality before 2060) on China's agriculture sector under various scenarios. It finds that attaining the carbon neutrality goal by 2060 will reduce agricultural production by 0.49–8.94%. Such production losses can be fully offset by a 1% increase in agricultural productivity, indicating the effectiveness of technology progress in agriculture on buffering the adverse impact of the decarbonization schemes and promoting agricultural development. On the other hand, government policies can potentially facilitate the carbon-neutral goal while securing food production. *Kong et al. (2022)* comprehensively evaluate current mitigation strategies for agricultural GHG emissions to achieve the goals of both decarbonization and food security. It indicates that improving nitrogen use efficiency is the most effective strategy, while livestock dietary manipulation is the least effective one. Moreover, this research also forecasts to what extent the goals can be achieved by a mixed strategy.

The special issue includes two papers on technology progress which is essential to resolve the conflict between decarbonization and agricultural development. *Liu et al. (2022)* use a novel index to measure the total factor agricultural carbon productivity. It is then applied to test the inverted U-shaped relationship between agricultural production agglomeration and agricultural carbon productivity theoretically and empirically. This research advises on agricultural layout optimization, and hence building a modern agricultural industrial system and achieving the carbon peaking and neutrality goals. *Zhang et al. (2022)* take a close look at grain trade and planting technology. It shows that the carbon footprint can be reduced by 3.29 million tons by adjusting the grain import structure. Combined with domestic grain production, the total reduction will amount to 4.51 million tons. Overall, this paper sheds light on the role of planting technology and trade structure to reduce emissions.

Facing various conditions across the country, policymakers should appropriately consider regional disparities against a uniform carbon policy. *Tang and Ma (2022)* empirically analyze the cost-effectiveness of China's GHG reduction under diverse carbon policies. They find that a moderate improvement has been achieved during 2008–2017. It further estimates the provincial reduction potential based on marginal abatement costs. The results suggest that western provinces generally have a larger reduction potential compared to eastern ones. The findings support the idea to include the agricultural sector into the national carbon market. Exploring regionally differentiated governance pathways is of great significance for promoting coordinated urban–rural development and achieving the goals of carbon peak and carbon neutrality. Taking the Beijing-Tianjin-Hebei urban agglomeration as the empirical research area, *Fu et al. (2022)* analyze its spatio-temporal evolution characteristics of carbon balance over the past two decades and simulate the land use pattern under the scenario of low-carbon emission in 2030. It suggests different governance of increasing carbon sinks, promoting collaborative emissions reduction efforts, optimizing industrial and energy structures and implementing the sustainable agricultural transition in different regions.

Understanding the micro-level behaviors of the rural population is critical to better designing and implementing policies in rural China toward the carbon-neutral goal. On the production side, *Wang et al. (2022)* empirically examine the impact of farmers' actual adaptations on rice yields in the upland areas of Yunnan province of China. With a carefully designed survey for farmers, this paper identifies only a 2% of rice yield increase due to farmers' adaptative practices. The findings highlight the need to encourage climate change adaptation further and deliver training in technical efficiency improvement, especially in upland areas. On the consumption side, *Sun et al. (2022)* rely on a unique household energy survey to examine the role of off-farm work in the rural residential energy transition in China. The article reveals that

off-work can affect rural household energy use through three mechanisms: income, labor availability and working environment. It provides recommendations to accelerate energy transition in rural China by offering more off-farm working opportunities for rural laborers.

We sincerely appreciate the referees who greatly facilitated the review process. It is expected that the publications included in the special issue will be essential references for years to come. As they have paved a clear path to high-quality agricultural and rural development, we hope that the special issue can make an immediate impact on encouraging more far-reaching studies related to agriculture and carbon neutrality. We are also grateful to *CAER* and the editorial team for providing us with this opportunity and guidelines to co-organize this special issue and Dr. You Zhou for his high quality assistance. We look forward to more collaborations in the near future. The special issue is just the beginning. It is our aim to attract audiences from diverse backgrounds to the discussion of agricultural and rural development under the goal of carbon neutrality. Tackling climate change is challenging, and it calls for strong cooperation between all communities.

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