绿色创新发展中心
Innovative Green Development Program

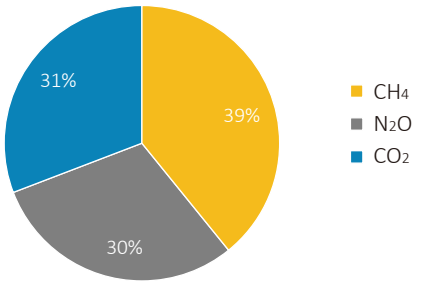
Progress and Prospects for Agricultural Non-CO_2 Greenhouse Gas Emissions

Status Quo

1. High share of non-CO_2 Greenhouse Gas (GHG) emissions in China's agricultural GHG emissions

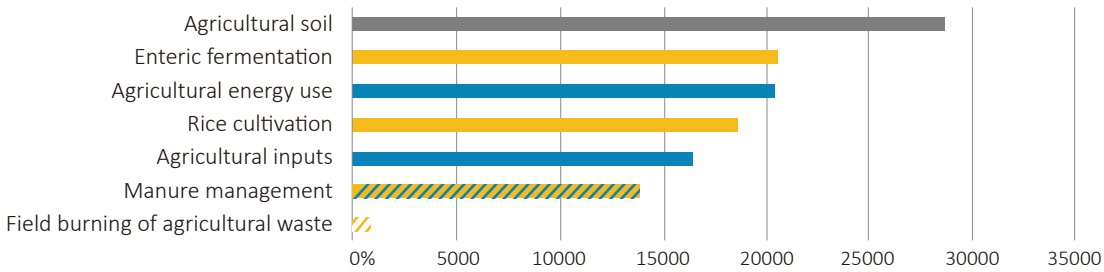
Estimates of the 2014 national GHG emissions inventory data in *Second Biennial Update on Climate Change in the People's Republic of China* submitted in 2018 show that China's GHG emissions from the agricultural sector were about 1,198 million tons of CO_2e, accounting for about 11% of national GHG emissions in the same year. Among them, non-CO_2 GHG reached 69% of total agricultural GHG emissions, with methane (CH_4) and nitrous oxide (N_2O) accounting for 39% and 30%, respectively.

Figure 1: Agricultural GHG emissions by gas in China (2014)



In terms of GHG sources, the highest emissions are from N_2O in agricultural soils, followed by methane from enteric fermentation.

Figure 2: The main sources and amounts of agricultural GHG emissions in China (2014, 10,000 tCO_2e)



Note: Labelled data for agricultural energy consumption and agricultural input are derived from calculations in the 2014 national GHG inventory[1]. Other data are calculated based on methane and nitrous oxide emissions data in the inventory multiplied by the corresponding GWP values.

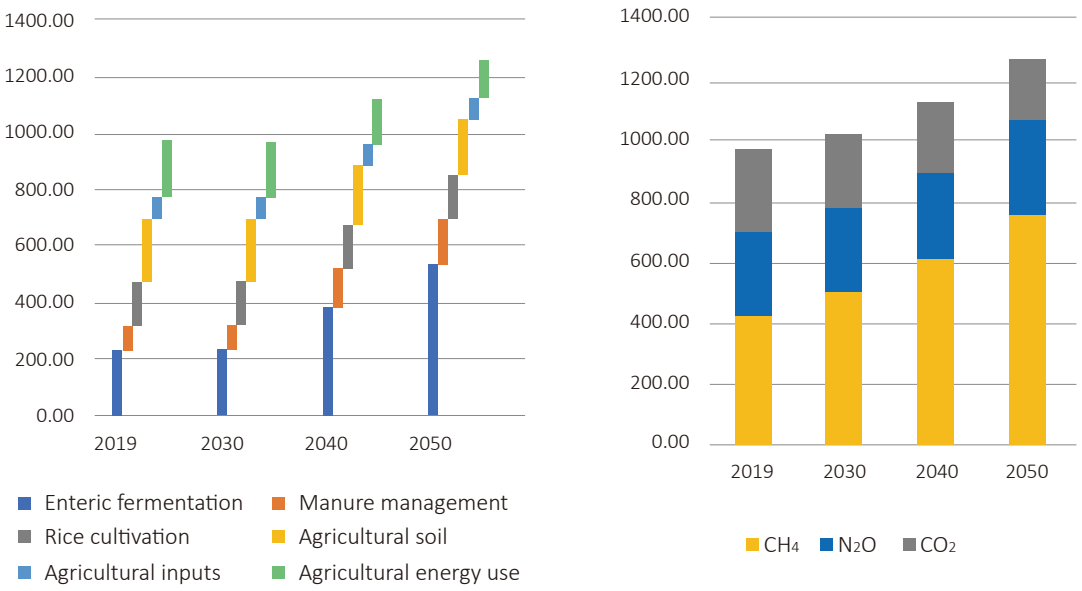
[1] Cheng, K, & Pan, G. (2021). How much more carbon can China's agriculture neutralize? *China Dialogue*. https://chinadialogue.net/zh/5/69745/

2. China's agricultural non-CO_2 GHG emissions still have room to rise

Agricultural GHG emissions will continue to rise as people's living standards improve and food consumption increases. According to FAO, China's per capita intake of animal protein is around 40.3 grams per day, which remains lower than major developed countries, and there is still room for future growth.

In addition, according to iGDP's analysis, CH_4 and N_2O emissions from enteric fermentation and manure management in the agricultural sector will continue to rise as animal food intake increases, and CH_4 and N_2O emissions will still predominate among GHGs in agriculture by 2050.

Figure 3: China's agricultural GHG emissions trends by sector and by gas 2019-2050 (MMT CO_2e)



Data source: iGDP estimates

Key Challenges

1. Non-CO_2 GHG emissions reduction is not a priority in China's current agricultural policy

Due to China's long-standing emphasis on food security, agricultural development policies focus on food security and sustainable development of the agricultural environment. Although policies based on food security and environmental pollution management provide co-benefits for agricultural GHG emissions reduction, the latter is not a priority in the list of agricultural policies.

For example, in the 18th Central Government Document No. 1 released in 2021, green agricultural development was mentioned as one of the key elements of promoting agricultural modernization[2]. The document emphasized the necessity of guarding the government red line of 120,000 km^2 of arable land, adopting measures to promote conservation tillage, reduce the amount of and improve the efficiency of

[2] *Opinions of the CPC Central Committee and The State Council on Comprehensively Promoting Rural Revitalization and Accelerating Agricultural and Rural Modernization*

chemical fertilizers and pesticides, increase the utilization of livestock and poultry manure, and strengthen the supervision of agricultural quality and food safety[3]. The implementation of these measures can reduce agricultural GHG emissions while protecting agricultural resources, mitigating agricultural pollution and improving the quality of agricultural products. However, GHG emissions reduction is not yet a straightforward policy objective.

Table 1: Policy measures related to emissions reduction in agriculture

Main policies	GHG emissions reduction measures
National Plan for Sustainable Agricultural Development (2015-2030)	• Increase the resource utilization of livestock and poultry manure, reaching the target of an 80% utilization rate of livestock and poultry manure in 2025. • Promote the reduction of volume and efficiency increase of chemical fertilizers and pesticides, as well as organic fertilizer substitution; build a long-term mechanism to replace chemical fertilizers with organic fertilizers for fruits, vegetables and tea. • Promote the recycling of agricultural films and the wide-use of environmental friendly biodegradable mulch: increase the recycling rate of used agricultural films to 85% in 2025, and establish a pilot agricultural film recycling subsidy system. • Promote green agricultural machinery application and integrate agricultural green development machinery and intelligent equipment under the scope of agricultural machinery purchase subsidies. • Promote informatization and smart transformation in planting, animal husbandry and fishery. • A framework integrated by agricultural and rural emissions reduction and carbon sequestration with food security, rural revitalization and agricultural and rural modernization by 2025.
The 14th Five-Year Plan for the National Green Development of Agriculture	
Plan for Improving and Protecting Arable Land Quality	
Opinions on Comprehensively Promoting Rural Revitalization and Accelerating Agricultural and Rural Modernization	
Digital Agriculture and Rural Development Plan (2019-2025)	
Implementation Plan for Emissions Reduction and Carbon Sequestration in Agriculture and Rural Areas	

2. Smallholder-based agricultural production poses challenges for the scaling of emissions reduction

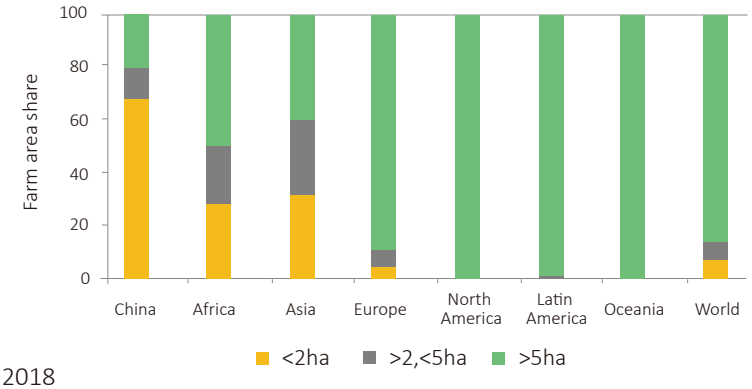
In contrast to developed countries, Chinese croplands are still dominated by smallholder farms. At such a small scale of farmland, it is difficult to scale GHG emissions reduction technologies and to improve agricultural productivity. In addition, scaling these technologies and practices also faces challenges from the aging farming population, as well as a generally low rural education level.

As shown in Figure 4, nearly 70% of China's farmlands are under 2 hectares. In contrast, the majority of the world's regions farms at a scale of 5 hectares or more. Estimates based on 2017 statistics show that there are

[3] http://www.gov.cn/zhengce/2021-02/21/content_5588098.htm

220 million smallholder farmers in China with an average farm size of only 0.5 hectares, and even considering transferred land, the average farm size is only 0.7 hectares[4]. In addition, data from "*Comprehensive Survey and Research Report of China Rural Revitalization in 2021*" show that the proportion of China's rural population aged 60 and above is over 20%, and the working-age population aged 15-64 is dominated by those whose highest educational level is junior high school.

Figure 4: Farm size share in China and other regions[5]



Data source: Wu et al, 2018

Mitigation Potential Analysis

iGDP's analysis found that taking additional actions could reduce agricultural emissions in China. In particular, non-CO_2 GHG emissions reduction shows the greatest potential, and the top three mitigation actions are enteric fermentation, livestock and poultry manure management, and rice cultivation in 2050.

Based on existing both international and domestic agricultural emissions reduction technologies and practices, iGDP developed seenario analysis to estimate the emissions reduction potential of China's agricultural sector. With these mitigation actions (see Table 2), iGDP found that, by 2050, China's agricultural GHG emissions could be reduced by **53%** compared to 2019 and 60% from the 2050 baseline level.

CH_4 accounts for the largest emissions reduction potential at 65% of the total reductions by 2050, followed by N_2O at 22%. Compared to the baseline scenario, non-CO_2 GHG reductions in the agricultural sector amount to 660 million tons in 2050.

In terms of emissions sources, the largest reduction potential by 2050 comes from enteric fermentation, which produces 378 million fewer tons of CO_2e compared to the 2050 baseline scenario, with the main reduction actions including dietary shift and the use of feed additives. The second is livestock manure management, with a reduction of 119 million tons of CO_2e compared to the baseline scenario, with reduction actions including resource utilization of livestock manure. Rice cultivation follows closely behind, with a reduction of 77.34 million tons of CO_2e through irrigation adjustments and the adoption of dry direct-seeded rice.

[4] Du, Y. (2018). Smallholder production and agricultural modernization. *Chinise Rural Economy, 10,* 2–6.

[5] Wu, Y., Xi, X., Tang, X., Luo, D., Gu, B., Lam, S. K., Vitousek, P. M., & Chen, D. (2018). Policy distortions, farm size, and the overuse of agricultural chemicals in China. *Proceedings of the National Academy of Sciences, 115*(27), 7010–7015.

Figure 5: Emissions reduction potential in China's agriculture by gas in deep mitigation actions, 2050 (MMT CO_2e)

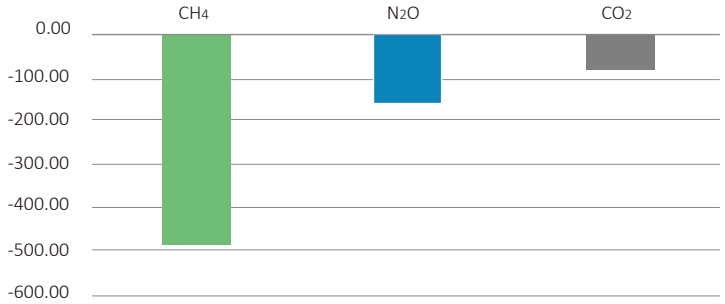
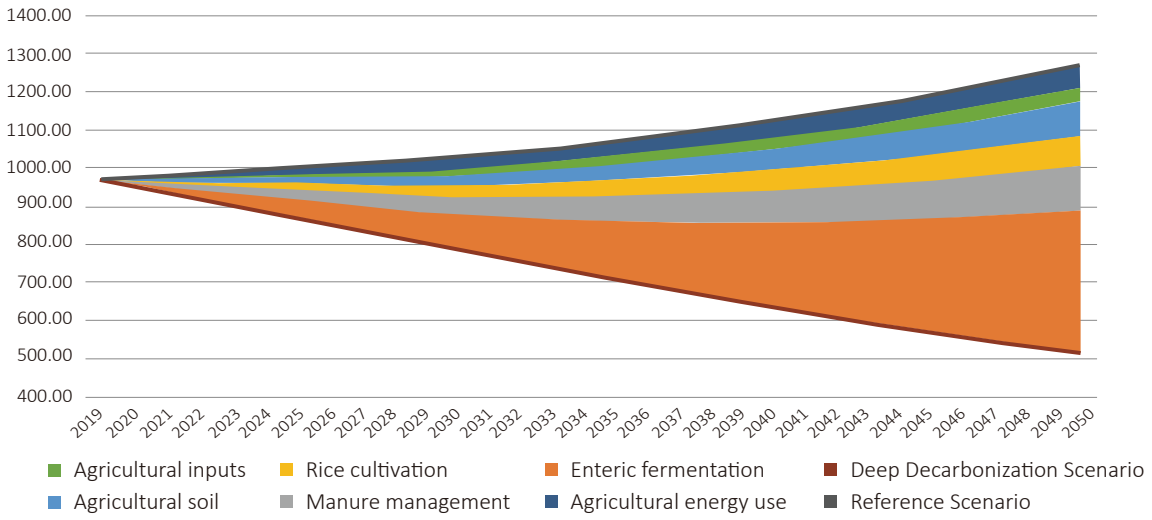


Figure 6: Emissions reduction potential in China's agriculture by source in deep mitigation actions (MMT CO_2e)



Data source: calculated by iGDP

Table 1: Policy measures related to emission reduction in agriculture

Main sources	Deep mitigation actions	Emissions reduction potential
Enteric fermentation	Dietary shift, feed additives	378MMT CO_2e
Manure management	Methane production from livestock and poultry manure and scale farming of livestock and poultry	119MMT CO_2e
Rice cultivation	Irrigation adjustment and promotion of dry direct seeding	77.34MMT CO_2e
Agricultural soil	Knowledge-based N management, promotion of slow-release fertilizers and nitrogen fertilizer enhancers	87.31MMT CO_2e
Agricultural inputs	Promotion of biodegradable agricultural films, reduction of pesticide and nitrogen fertilizer inputs	32.31MMT CO_2e
Agricultural energy use	Energy efficiency improvements and electrification of agricultural machinery	65MMT CO_2e

Policy Suggestions

The realization of deep mitigation potential requires strengthening existing mitigation policies, an policy, technical and financial support to implement mitigation technologies and practices through pilot demonstrations.

1. Due to the high cost of existing mitigation technologies, such as the adoption of feed additives, slow-release fertilizers and fully biodegradable agricultural films mentioned in Table 2, more private capital participation is needed to promote the large-scale application of technologies, while mitigation technologies and practices that have been commercialized also require multi-channel financing approaches to support technology implementation given the high upfront costs.

2. Driving consumer behavior change is critical. As mentioned earlier, animal enteric fermentation has the greatest mitigation potential with dietary shift as the key. Therefore, the regularly released and updated *Chinese Dietary Guidelines* calls for more efforts to popularize said changes. In addition, referring to domestic and foreign strategies in behavioral intervention will also promote dietary shift.

3. The scale farming of livestock and poultry and methane production from livestock and poultry manure show significant potential. China's existing policies already include quantitative policy targets for resource utilization of livestock and poultry manure and large-scale livestock and poultry farming, so the continuation and strengthening of existing policies and the promotion of policy implementation will help reduce emissions.

4. With a high proportion of smallholder farmers in China, existing practice shows that technical training and management programs for farmers can enhance emissions reductions. For example, from 2005-2015, a training program to improve agricultural management and technology involving more than 20 million farmers in China not only reduced fertilizer use and increased yields, but also reduced GHG emissions[6] through developing farmland improvement plans tailored to local conditions.

5. The potential for reducing emissions from rice cultivation in China is considerable, and setting up pilot projects to promote low-emissions rice varieties will not only help China to reduce its own emissions, but also provide a positive example for rice emissions reduction in other regions worldwide.

[6] Cui, Z., Zhang, H., Chen, X., Zhang, C., Ma, W., Huang, C., Zhang, W., Mi, G., Miao, Y., & Li, X. (2018). Pursuing sustainable productivity with millions of smallholder farmers. *Nature*, 555(7696), 363–366.

Case study 1: Zero-Carbon Rice Pilot

The Organic Food Development Center of the Ministry of Ecology and Environment will build the first provincial organic rice carbon sequestration and emissions reduction demonstration base in Hemujian Village, Dongba Street, Gaochun District, Nanjing City, Jiangsu Province, applying no chemical fertilizers or pesticides, and growing zero carbon rice in an ecological way.

Hemujian Village, where this project was implemented, is located in the hilly mountains with convenient transportation and a beautiful environment, showing regional and resource advantages. After 11 years of continuous development, it now has an organic rice production base of 173 hectares, and is suitable as a model village for regional agricultural emissions reduction. By implementing a set of key planting technologies for carbon sequestration and emissions reduction by organic rice, establishing GHG emissions and soil carbon sequestration measurement models, and building a 33-hectare demonstration base, the project is exploring methods for carbon sequestration and emissions reduction by organic rice planting in the province.

The case is excerpted from:
https://jsnews.jschina.com.cn/nj/a/202208/t20220801_3046608.shtml

Case study 2: Agricultural Carbon Neutral Account: Green Loan for Agriculture

The pig breeding industry has long been troubled with high carbon emissions. It therefore actively promotes the construction of modern zero carbon pasture to boost the national goal of carbon peaking and carbon neutrality, and to accelerate the green transformation, using intelligent breeding models, automatic environmental control systems, automatic feeding, automatic manure removal and other advanced technologies to transform output waste into organic fertilizer, electricity and other reusable green materials through a process of harmless treatment. Once "Zero Carbon Pasture" is completed and put into operation, it is expected to reduce the average annual carbon emissions 4166 tons of CO_2e. To support zero carbon pasture construction, Jiangshan Rural Commercial Bank launched agricultural carbon financing products, crediting the enterprise with 20 million CNY. It also issued a project loan of 5 million CNY on the same day, offering an interest rate of 5%, 100 BP lower than the original implementation rate, providing an effective solution to the enterprise's financial problems in pasture construction.

The case is excerpted from:
http://www.greenfinance.org.cn/displaynews.php?id=3467

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About iGDP:

innovative Green Development Program is a non-profit consultancy that focuses on green and low-carbon development. It works to strengthen China's low-carbon environmental policy design and implementation through interdisciplinary, systematic and empirical research. We work with all stakeholders to promote a zero-emissions future and tell the story of China's green and low-carbon development. iGDP's research, consulting and communications focus on the following areas:

- Energy Transition
- Green Economics
- Climate Strategies
- Sustainable Cities
- Strategic Communication

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