CULTIVATING US AND CHINESE CLIMATE LEADERSHIP ON FOOD AND AGRICULTURE

A Roadmap for Collaboration

By Jennifer L. Turner,
Karen Mancl & Jennifer Nguyen

January 2024

Wilson Center | China Environment Forum

The Ohio State University
College of Food, Agricultural, and Environmental Sciences

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This publication is produced under the Wilson Center and Ohio State University joint project: **Cultivating US and Chinese Climate Leadership on Food and Agriculture**. The project was launched in September 2022, and today we succinctly call it the **Cool Agriculture Project**. While the United States and China are starting to decarbonize food production, it is not yet an area of significant bilateral collaboration or dialogue. Over the past year, we have engaged with US and Chinese agriculture, food system, and climate experts with two goals in mind to: (1) illustrate the complex climate footprint from US and Chinese agriculture and (2) highlight opportunities for bilateral cooperation on policies, projects, and strategies to reduce agriculture's climate footprint. The meeting videos, blogs, and podcasts we have produced are available on the Wilson Center's website at: Cool Agriculture: Climate and Food Challenges in the US and China.

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This publication would not have been possible without the assistance of our project partners. We drew considerable insights for this publication from the six Cool Agriculture podcasts Sustainable Asia produced for us. We also learned from the great research and writings on food and climate from the Institute for Global Decarbonization Progress (iGDP) and the Global Environmental Institute (GEI). China Dialogue produced three wonderful multimedia stories for the Wilson Center's *New Security Beat* blog on how US and Chinese farmers are coping with climate challenges, reminding us that it is the farmers who are on the frontlines of this crisis and key players in the solution.

We also are indebted to our advisory committee who gave us invaluable guidance on agrifood issues to focus on in our public meetings, publications and podcasts. They also were a great tough love crew in reviewing this publication. Any and all omissions and errors of course remain those of the authors.

Lastly, we salute the CEF research interns who gathered mountains of data for this report and generated rough drafts of the infographics. Our talented graphic designers Kerrin Cuison and Kathy Butterfield transformed those drafts into beautiful and sometimes humorous (burping cows and smiling rice bowls!) infographics to help us tell the agrifood-climate science and stories. Their creativity is unrivaled. We also want to give a shout out to Marty Zhu for his speedy work translating this report into Chinese—even conquering our corny food puns!

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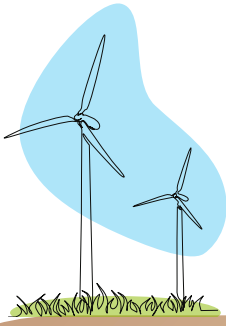
1979

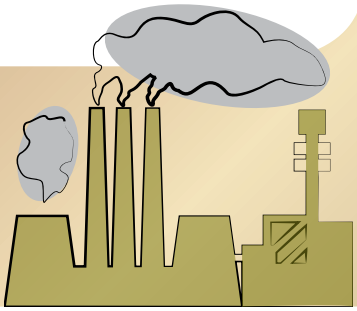
- Scientific and Technology Cooperative Agreement
- Atmosphere and Science and Technology Protocol
- MOU for 19 Bilateral Energy Agreements
- US-China Agricultural Exchanges start

1985

- Fossil Energy Protocol (Renewed in 2000 and 2005)
- Xi visits US as part of agricultural exchange



1994



- Annexes to the Fossil Energy Protocol

1995

- Energy Efficiency and Renewable Energy Protocol

1997

- 1st Meeting of US-China Forum on Environment & Development

1999

- 2nd Meeting of US-China Forum on Environment & Development
- US-China Bilateral Agreement on WTO (agriculture included)
- Agreement on US-China Agricultural Cooperation

2000

- US-China Advanced Biofuels Forum

2006

- First Meeting of the US-China Strategic Economic Dialogue (2nd Meeting 2009)

2007

- USDA and NDRC Sign MOU Biofuels

2008

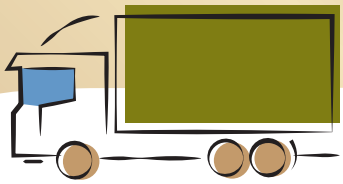
- Ten Year Energy & Environment Cooperation Framework

2016

- US-China Race to Zero Emissions Challenge
- Second US-China Joint Announcement on Climate Change

2017

- US withdrawal from Paris Climate Agreement
- Xi calls for a halt in US-China science and technology exchanges



2015

- COP21 Climate Negotiations Dig Into Soil Sequestration–4 per 1000 Initiative
- Paris Climate Agreement
- US-China Green Ports and Vessels Initiative
- US-China Clean Energy Research Centers Expand

2013

- Presidents Obama and Xi Agree to phase down HFCs under the Montreal Protocol
- US-China Climate Change Working Group Launched

2014

- Climate-Smart / Low-Carbon Cities Initiative launched
- First US-China Joint Announcement on Climate Change

2012

- Framework Plan for Ocean and Fishery Science and Technology Cooperation

2011

- US – China Cooperation on Climate Change, Clean Energy, and the Environment Statement
- US-China Agreement on Cooperation In Science and Technology Extended

2009

- Obama-Hu 9 New Clean Energy Agreements
- US-China Clean Energy Research Centers launched

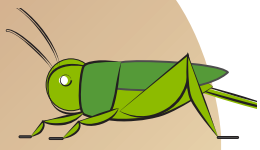
2010

- US-China Advanced Biofuels Forum
- US-China Energy Efficiency and Renewables Forums

2018

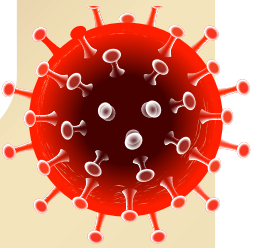
- US-China Trade War

2018–2019



- Silence in the bilateral climate relations.....

2020



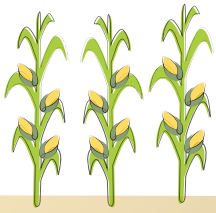
- US rejoins Paris Climate Agreement
- US-China relations worsened during COVID-19

2021

- President Biden announces US and China must cooperate on climate change at G20
- China halts climate talks after Speaker Pelosi's visit to Taiwan
- US ratifies Kigali Amendment to the Montreal Protocol

2022

- Global Methane Pledge launched at COP26
- US-China Glasgow Declaration at COP26
- China ratifies Kigali Amendment to phase down HFCs under Montreal Protocol
- Joint US-China statement on Climate mentions agriculture



2023

- US-China Sunnylands Statement on Enhancing Cooperation to Address the Climate Crisis

- At COP28 in Dubai, the US and China joined 150+ countries in signing the Declaration on Sustainable Agriculture, Resilient Food Systems and Climate Action

2024 & Beyond?

Potential Path for US-China Climate Cooperation

US-China Climate Cooperation Prioritized in the Sunnylands Statement

Set up a Working Group on Enhancing Climate Action in the 2020s

Restart the US-China Energy Efficiency Forum

Create a Technical Working Group on Methane

Recommence bilateral dialogues on energy policies and strategies

Phase down HFCs and **manage** nitrous oxide emissions

Hold a high-level event on subnational climate action

Advance 5 carbon capture and use sequestration projects in each country by 2030

Implement the 2021 US-China Joint Statement and US-China Glasgow Declaration goals, which includes **climate action on agriculture**

1 US-CHINA FOOD SUPERPOWERS AND THE GLOBAL CLIMATE FOOTPRINT OF FOOD

Coal and cars have long been the most prominent concerns for climate advocates. Yet experts are now raising the urgency of also lowering food's greenhouse gas (GHG) footprint—both to slow the climate crisis and to ensure global food security.

The agrifood sector—from production and processing to transport and disposal—accounts for 31% of global GHG emissions. Methane from livestock (cow burps and manure) and rice are major GHG emitters in food production. Nearly a quarter of agrifood emissions come from soil carbon released when land is converted to cropland. The increased use of fossil fuel-based fertilizers and plastic packaging along with the expansion of globalized food supply chains are also driving agrifood GHG emissions. As the world's food production and consumption superpowers, the United States and China are major contributors to agrifood GHGs.

With a population of 1.4 billion, food security concerns have long driven China's agricultural policy. For the past 20 years China has been gradually losing the ability to be food independent. China's food security index was 93.6% in 2000, meaning the country grew enough food to feed most of its population. In 2020, that number had fallen to 65.8%. This shift is driven in part by the changing diets of China's growing, increasingly urban, middle class. Food safety concerns have also increased consumer demand for some food imports.

To fill the food security gap, China became the world's leading agricultural importer with the United States as its biggest supplier of soybeans and grains. China is also increasingly dependent on US meat and animal exports This interlinked trade has defined the bilateral agricultural relationship. (See Interlinked Trade Infographic).

The food system is now the second largest source of GHGs in the United States, accounting for 9 to 11% of total domestic emissions. In China, farming and animal husbandry contribute 8.2% of the country's total GHG emissions, with over 50% stemming from agricultural methane and nitrous oxide.

Extreme weather driven by climate change is also threatening food security around the world. But climate-smart agricultural practices can help combat the climate crisis and meet the food demands of a growing global population.

Zeroing in on climate action surrounding food production and consumption can help the United States and China reach their net zero goals. Encouragingly, both countries are starting to take steps independently to decarbonize food production.

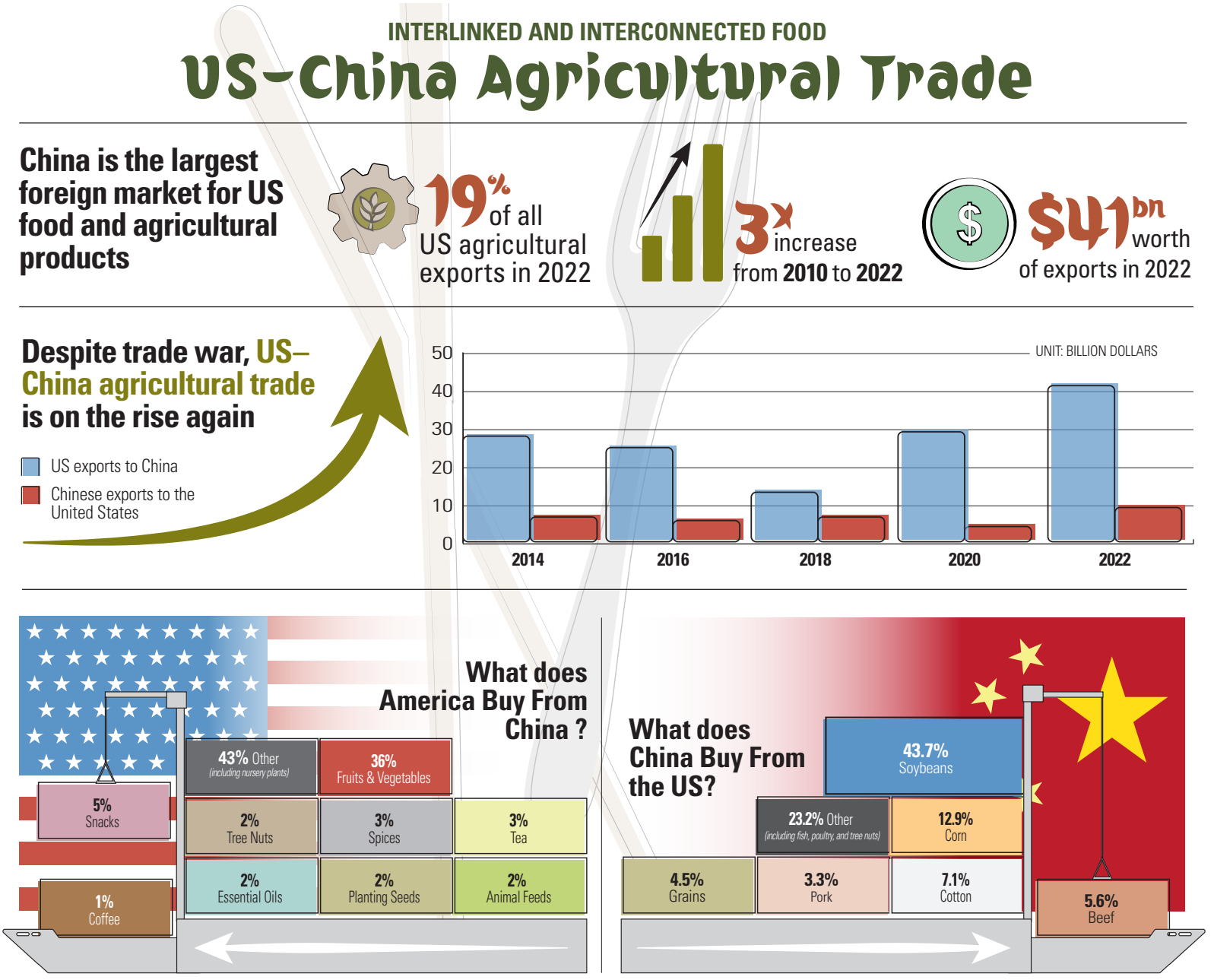
The Biden administration has recognized this in massive funding for climate-smart agriculture to support farmers and offer incentives to adopt conservation agriculture and other practices. To reach China's 2030 peak carbon and 2060 carbon neutrality goals, the Xi Jinping administration is starting to focus on agrifood emissions, emphasizing emission reductions from fertilizer use and agricultural waste. Chinese policymakers are also exploring policies to create incentives for improving soil quality to sequester carbon—and to measure progress towards that goal.

An Opening for US-China Agrifood Climate Action

Climate collaboration has been a near-constant feature in US-China diplomacy for 40+ years. The climate cooperation that grew over the past decades has centered on coal, the clean energy sector, vehicles, and buildings—but not agriculture. (See Timeline). Agricultural collaboration has been on a parallel track. Strikingly, agriculture was the first area of scientific exchange

between the two countries, beginning even before they signed the Science and Technology Agreement in 1979. Agricultural exchanges and joint projects on food security, animal health, agricultural technology, and biofuels have quietly strengthened the foundation of Sino-American relations over the decades. (See Food Superpowers Infographic).

It was not until 2021 that the diplomatic door for US-China agriculture and climate cooperation opened. The April 2021 *US-China Climate Crisis Statement* and the *US-China Glasgow Declaration* both highlighted "green and climate resilient agriculture" as an area for joint work.



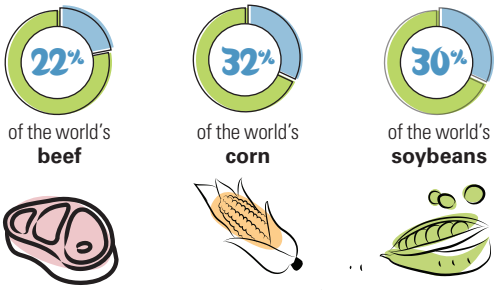
*The percentages represent the monetary value of agricultural commodities each country imports from the other. For example, soybeans are 43.7% of the total value of Chinese agricultural imports from the United States.

Sources: *AgEcon Search, FERN, Minnesota Department of Agriculture, Reuters, Statista, USDA, World Bank. Research by Zhiyuan Zhou and graphic design by Kerrin Cuison.*

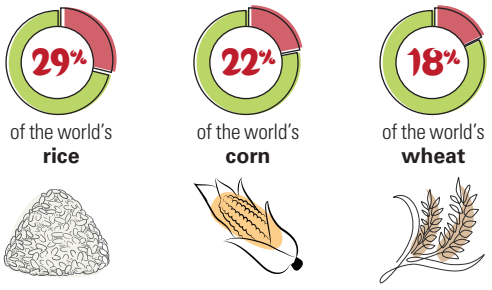
The US and China are Food Superpowers

China's growing appetite means greater potential for US-China food businesses and joint climate action

THE US PRODUCES:



CHINA PRODUCES:



18% of the world's population	957m² cropland per capita	3000–4000 years of agriculture	1.6 acres of average farm size	177 million farmers
4% of the world's population	4,865m² cropland per capita	200–300 years of agriculture	444 acres of average farm size	3.4 million farmers

China has to feed 4x more people than the US on less land

Sources: *AgEcon Search, AgWeb, FERN, Minnesota Department of Agriculture, Reuters, Statista, USDA, World Bank, Worldometer. Research by Zhiyuan Zhou and Karen Mancl and graphic design by Kerrin Cuison.*

After the Glasgow climate talks, the United States and China planned meetings to flesh out the details in the declaration. However, the climate dialogues were halted in 2022 in the midst of skyrocketing political tensions over Taiwan, espionage accusations, and broader geopolitical competition. Another challenge facing the relaunch of climate cooperation is the growing US concern over China's dominance in the mining and refining of the critical minerals necessary for renewable energy and battery technologies that will make the clean energy transition possible.

Climate envoys John Kerry and Xie Zhenhua met in November 2023 and the two countries issued the Sunnylands Statement on Enhancing Cooperation to Address the Climate Crisis. The two sides committed to talks in 2024 and are notably prioritizing methane emissions and subnational climate cooperation. This renewed climate détente was timely. Food was on the climate negotiation table at COP28 where the United States and China joined 157 countries signing the Declaration on Sustainable Agriculture and Resilient Food systems. It commits countries to integrate food into their climate action plans.

A Path Forward

Most scientific research between US and Chinese agricultural and climate scientists was frozen after the Trump administration withdrew from the Paris Climate Agreement and halted all climate and environmental dialogues with China. In our Cool Agriculture research and convenings over the past year, we uncovered some quiet US-China climate research projects on perennial rice, biofuels, and EV tractors. The two countries could greatly expand and elevate climate action in the agri-food sector.

This report outlines some of the possible paths forward, especially in three areas of agriculture: soil sequestration, reining in GHG emissions from rice,

and reducing food waste methane. These pathways forward on agrifood and climate collaboration offer big mitigation potential and do not trigger politically sensitive tripwires.

This report is meant to be a catalyst for new conversations as the two countries restart climate meetings. The 2014 US-China Climate Agreement helped pave the way for the Paris Climate Agreement. Similarly, action by these two food superpowers to address agrifood GHG emissions could help set the world on a path to climate-smart food production.

Why the Climate Change–Agrifood Nexus Matters

Climate Change Threats to Agriculture and Food Security

Extreme weather events reduce crop yields
Changing weather patterns shift planting and harvest time
Range of invasive species expands
Seasonality shifts hurt pollinators and animal breeding
Shifting cold hardiness zones require new kinds of crops

Agricultural Practices that Generate Greenhouse Gas (GHG) Emissions

Land use change (clearing forests for livestock or crops) is 18%+ of global food GHG emissions
Livestock emits 66% of global agricultural methane
Food loss and waste are responsible for 8-10% of global methane emissions
Rice emits 11% of global agricultural nitrous oxide emissions
Full lifecycle of fertilizers produces 5% of the global GHG emissions
Fossil fuels for farm equipment, grain drying, and irrigation were 2% of global GHG emissions in 2020

Agricultural Practices to Sequester Carbon / Reduce GHG Emissions

No-till and retaining crop residue	Carbon credits and emission trading markets
Cover crops	Crops integrated with trees and livestock
Perennial crops	Agroforestry
Organic fertilizer	Integrated soil fertility

Sources: Our World in Data, WRI, WWF, Greenhouse Gases: Science and Technology, University of Cambridge News, Environmental Research Letters

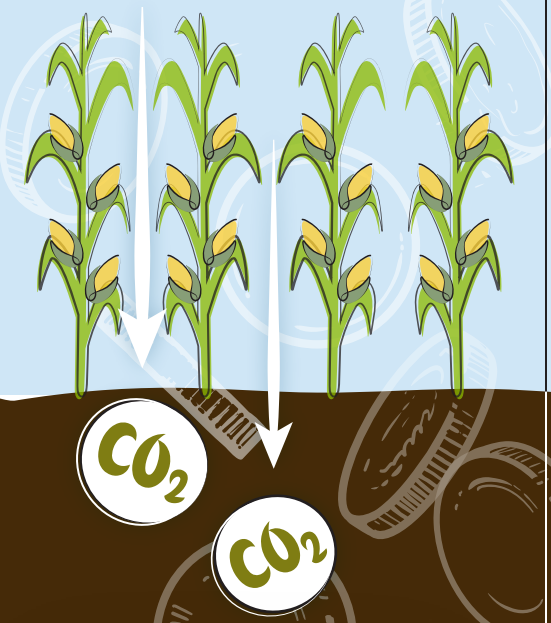
2 THREE PROMISING AREAS FOR US-CHINA AGRIFOOD AND CLIMATE COLLABORATION

Soil is a Carbon Bank Account

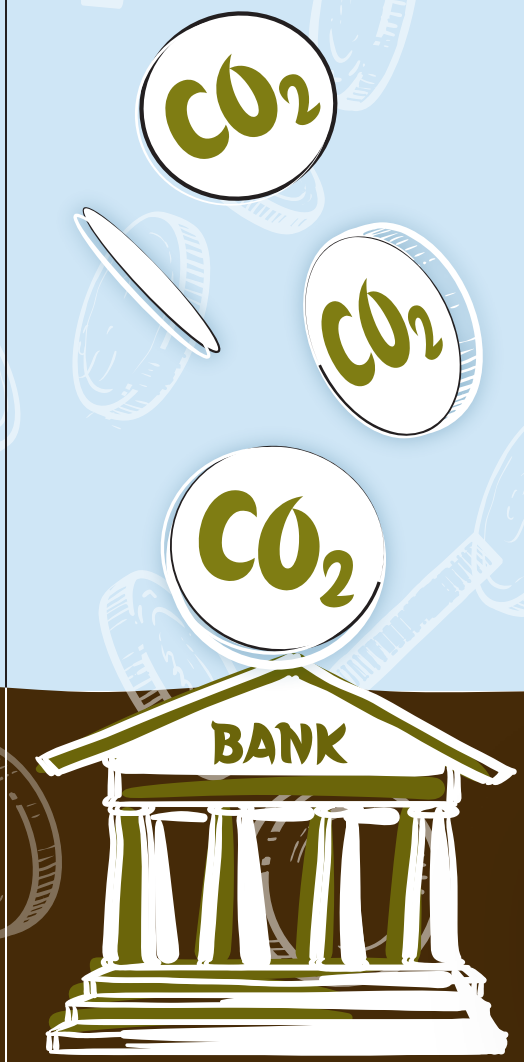
The Two-Step Carbon Deposit

First, plants absorb carbon dioxide from the air during photosynthesis (~30% of what humans emit every year)

Second, bacteria and fungi break down carbon-based plants and animals and store that carbon in the soil

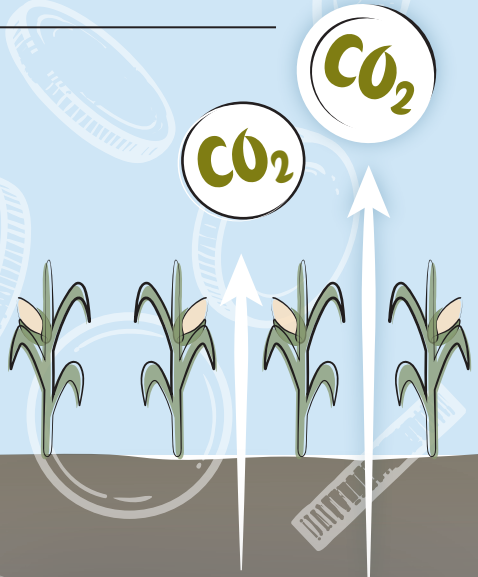


Soil is the largest reservoir of carbon, 3x the amount stored in living plants



Conservation Agriculture Practices to Fill the Soil Carbon Account

- No-till
- Cover crops & crop rotation
- Integrating crops with livestock and trees
- Managed grazing



Soil Impoverishing Agricultural Practices

Tilling, monocrops, removing crop residue, overgrazing and excessive fertilizers release soil carbon BACK into the atmosphere

Sources: Climate Central, Columbia University, Nature, Science Direct, World Bank. Research and concept by Ann Williams and Jennifer Turner and graphic design by Kerrin Cuison.

Soil: The Silent Climate Fighter

In the 1930s, overfarming, over-tilling, and overgrazing soil in the Great Plains of the United States resulted in the infamous Dust Bowl, which decimated 100 million acres and forced 400,000 people to flee their farms. In response to this catastrophe, officials and farm experts launched conservation agricultural practices to rebuild soil health and lessen dust storms. Today about 30% of US farms have adopted no-till and other healthy soil practices.

Yet catastrophic dust storms continue to impact the water-rich Corn Belt. Drivers in central Illinois had near-zero visibility when 55-mph winds blew dust from newly tilled fields in May 2023, causing a 90-car pileup. Four top soil scientists explained in an op-ed that over-tillage on two to three crops per year had eroded and degraded soil by reducing organic matter and carbon.

China can tell a similar story. Chinese scientists estimate current farming practices could completely erode the black soil in Heilongjiang Province (known as the granary of China) in 113 years. One Heilongjiang farmer lamented how much of his soil is washed away with heavy summer rains. If China's soil erosion continues at the current rate, an area as large as Puerto Rico will disappear in 50 years, resulting in a 40% drop in food production.

Healthy Soil Healthy Climate

Soil is the foundation of food production and nature's perfect creation to act as a medium for seeds to sprout and grow. Healthy soil has the ideal balance of minerals, organic matter, and air, allowing for the movement of water and the penetration of roots.

Soil is an oft-overlooked carbon sink. Soil conservation practices are critical climate actions that bolster both soil health and food security. Indeed, the COP 21 global climate talks—held in 2015—was the first to include soil in a climate proposal, the "4 per 1000" initiative. This proposal encourages voluntary adoption of conservation agricultural practices to increase the amount of carbon stored in the surface layer of soil by 0.4% per year (that is 4 parts per 1000). Merely hitting this target could offset 10% of annual global anthropogenic emissions. Meanwhile, in China, the 4 per 1000 approach could offset 25% of the country's annual fossil fuel emissions.

As the Soil is a Bank Account infographic shows, conservation agricultural practices restore soil and ecosystem health through reduced soil erosion and compaction, enhanced soil fertility, water quality protection, and improved wildlife habitats. Farmers also benefit from reduced labor and fuel costs with the elimination of plowing.

Incentivizing Conservation Agriculture for Soil and Climate Health

The combination of aggressive tilling, poor farming techniques, and drought have catalyzed catastrophic erosion in the United States and China, spurring both into action. US and Chinese scientists and policymakers are promoting conservation agriculture as beneficial for both soil health and climate change mitigation. This shared goal creates an area for both countries to dig into together.

United States: After the 1930s, the government's conservation agriculture push faced the challenge of convincing farmers to give up tilling the soil. The US Congress thus created the USDA Soil Conservation Service to support extension educators from Land Grant Universities to promote conservation agriculture at state and county levels. Starting in 1996, the Farm Bill created the EQiP program with incentives for adopting conservation tillage practices and planting cover crops.

In the early 2000s, the USDA went a step further. It established **GRACEnet** (Greenhouse Gas Reduction through Agricultural Carbon Enhancement Network)

to monitor GHG emissions under traditional management practices and to identify improved management processes. The USDA went on to develop **COMET-Farm**, an online carbon emission accounting tool for farms and ranches.

Since 2022, the **USDA Climate-Smart Agriculture Partnership grant program** has supported farming and policy practices that increase soil health. Many environmental groups—such as The Nature Conservancy and the Environmental Defense Fund—have also worked with farmers to incentivize no-till and other climate-smart soil practices.

China: Low crop yields resulting from degraded soils and water shortages sparked the introduction of conservation agriculture in China in the 1990s. The immediate challenge posed by this change was the lack of no-till planting equipment capable of cutting through crop residue left on the soil surface. Since that time, Chinese agricultural universities and research academies have been developing appropriate machinery, as well as setting up long-term demonstration sites. The government has supplied some farmers with this newly developed no-till planting equipment.

The Action Plan for Conservation Agriculture of Black Soil in Northeast China (2020 – 2025) promotes climate-smart practices in a major Chinese grainbelt. In 2022, China's Ministry of Agriculture and Rural Affairs also issued an **Implementation Plan for Emission Reduction and Carbon Sequestration in Agriculture and Rural Areas**. In this plan, one of the ten major action areas included improving carbon sinks in farmland. These plans could promote the greater adoption of conservation agriculture, which currently is practiced on less than 5% of Chinese farmland.

In northern China, excessive irrigation and over-fertilization are being tackled with "fertigation," a drip irrigation system that precisely delivers fertilizer and water to each plant. While often used in the United States for high-value fruit and vegetable crops, China is expanding this system to grains and field crops to conserve water and lessen fertilizer use. A co-benefit of this practice is lower GHG emissions.

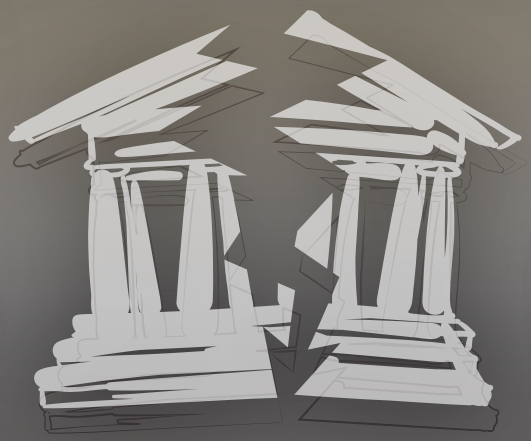
Bankrupting Our Soil's Health and Carbon

THE EARTH HAS LOST 1/3 OF ITS ARABLE LAND BETWEEN 1975-2015 TO EROSION AND POLLUTION

Degraded Land

Erosion, organic matter decline, biodiversity loss, compaction, heavy metal pollution, and salination have degraded **60%** of arable land in the US and **58%** in China

More than **1/4** of China's arable land is becoming desert due to drought, inappropriate farming practices, overgrazing, and climate change



Total Farmland (in million hectares)

China	US
135	166

Disappearing Farmland

The US lost **12.5 million** hectares of farmland (the size of Mississippi) to development between 1992 and 2013

Between 2001 and 2013, China's rapid urbanization consumed **33 million** hectares of agricultural land (about three Mississippis)

Sources: *American Farmland Trust US Congress, The White House, World Bank, ScienceDirect, Reuters, Farmland Info Center, Wilson Center, Chinese State Council, Chinese Ministry of Ecology and Environment, China Daily, PNA, HUD Exchange, the Guardian, Union of Concerned Scientists*

Soil Health and Carbon Sequestration

United States and China Can Dig into Dirt Together

With their history of collaboration, Chinese and US agricultural and climate scientists are well positioned to develop the models and remote sensing technologies necessary to monitor and incentivize these soil and carbon-friendly agricultural practices. Together, the two countries can also tackle the challenges of **carbon measurement, monitoring, and verification** in soil conservation practices. (These are tricky to measure because of the variability among land types and farming practices.)

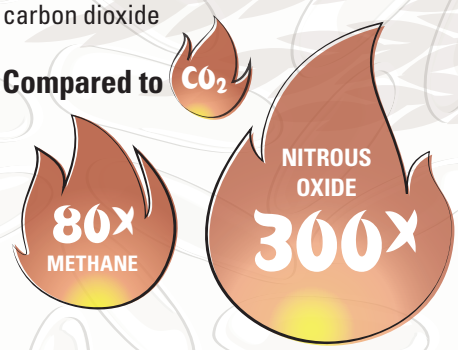
Thus far, neither country has a common platform to make soil carbon data accessible for analysis. Filling these data and monitoring gaps is critical for estimating and verifying the benefits of climate-smart agricultural practices. Another untapped area of promising partnership around soil includes **strengthening education, training, and technical assistance for conservation agriculture**.

Both countries have been piloting **projects on carbon credits for soil conservation** to encourage the adoption of conservation agriculture. The California Emissions Trading System and a number of voluntary carbon credit markets have been spreading around the United States, which offer lessons for the voluntary emission trading scheme China launched in the summer of 2023.

The Climate Price of Rice

Climate super pollutants, like methane and nitrous oxide, **heat** the earth faster than carbon dioxide

Compared to CO_2

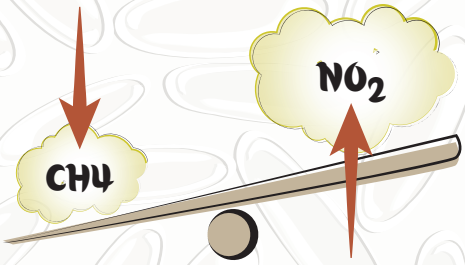


12% of global methane emissions are from rice production

Globally, rice fields generate **11%** of agricultural nitrous oxide emissions

Sticky Climate Challenge

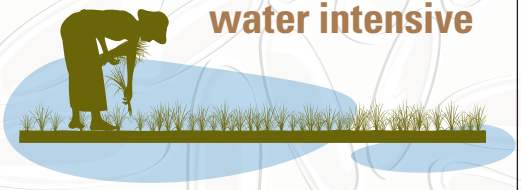
Efforts to reduce methane almost always lead to greater nitrous oxide emissions



Rice feeds half the world's population daily

but is a major greenhouse gas emitter

Rice production is also water intensive



4000 to 5000

liters of water are consumed per kilo of rice produced

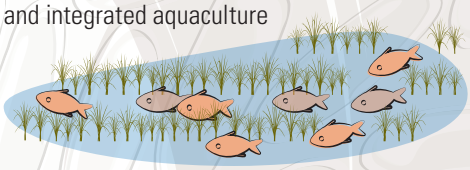
Climate-Smart Actions for Rice and Other Crops

USDA invested **$300M** as part of the Inflation Reduction Act to improve measurement and reporting of agricultural emissions

To save water and emit less methane and nitrous oxide, **China** piloting practice to cover newly planted rice fields with plastic films

New Innovations and Solutions

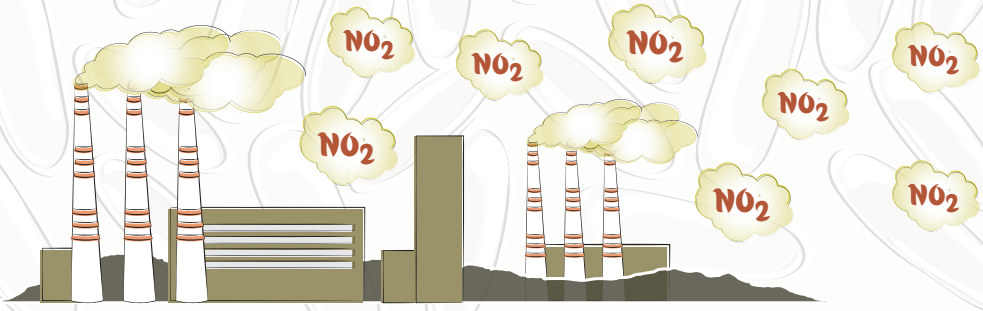
Alternate wetting and drying, plastic mulch, and integrated aquaculture

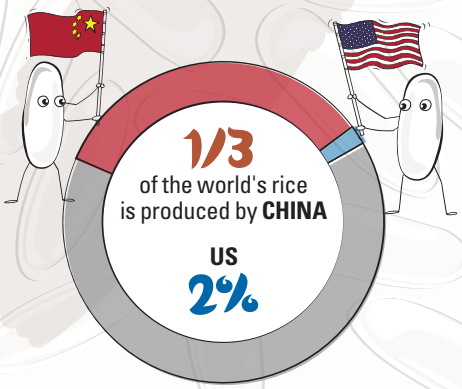


New varieties of rice with higher yields and lower methane

No-till agriculture and integrated nitrogen management

The amount of unaccounted-for **nitrous oxide global emissions from rice** may be as high as the annual **GHG emissions from 200 coal power plants**





Sources: *Associated Press, USDA ERS, China Dialogue, Karen Mancl, V Vinod Goud, IRRI, Josh Gabbatiss, Ei Phyu Win and Kyaw Kyaw Win, Sonoko D. Belilngrath-Kimura, Aung Zaw Oo, Mohammad Saiful Alam, Mariam Khanam, Md. Mizanur Rahman, WWF. Research and concept by Jennifer Nguyen and graphic design by Kerrin Cuison.*

Rice: A Sticky Climate Challenge

Rice feeds half the world. Yet this major staple crop requires a lot of water to germinate and grow. The customary method is twofold: flooded paddies provide the thirsty rice with water, and nitrogen is applied to maximize yields.

However, this recipe for growth also produces two super climate pollutants: methane (CH-4) and nitrous oxide (N_2O). As a major GHG-emitting crop, rice contributes 12% of total global methane emissions and 48% of total methane emissions in global croplands. Nitrous oxide, which is emitted from both the soil and the plant itself, is a long-lived GHG that is 300 times more potent than CO_2.

Tricky Tradeoffs

Though rice produces less global methane emissions when compared to those created by cattle, it remains a major challenge to China's mitigation efforts. In China, rice farming is responsible for 15.6% of the country's total methane emissions.

The United States produces only 2% of the world's rice, but it is a major exporter, accounting for 5% of the global rice trade. The USDA is playing an expanding role in climate-smart rice research and investment, but meeting the challenge also needs US farmers' support to incentivize pilots.

Methane emissions from rice can be eliminated when farmers flood a rice field and then allow the water to evaporate and expose the soil in mid-season, before flooding the fields again. This practice is called alternate wetting and drying (AWD). One problem, however, is that AWD increases nitrous oxide emissions by 20% on average, with high variability due to environmental conditions and management practices.

Chinese farmers receive incentives to adopt a variety of practices to decrease methane emissions from rice production, including using agricultural plastic films, dryland rice production, and experimentation with new rice crop varieties. Unfortunately, some of these climate actions can lower crop yields. Such trade-offs make methane-mitigation practices more difficult to adopt, especially given China's need to increase food security.

Cooking Up New Climate-Smart Recipes

Both the United States and China have the agricultural research capacity to perfect a recipe to grow climate-smart rice. Working together, the two countries could help to solve this immense challenge. Methane was a major focus of the 2021 *US-China Glasgow Climate Declaration*. Rice is an ideal area for joint research and learning, since it does not trigger economic or geostrategic landmines. For years, US and Chinese agriculturalists have been collaborating on new strains of perennial rice that sustain high yields with lower methane emissions. Scientists and farmers in both countries have independently piloted new ways of growing rice to mitigate methane and/or nitrous oxides—sharing such lessons could accelerate solutions.

Integrated rice field aquaculture in China. Self-sufficiency in food and rural poverty alleviation are driving China's agricultural policies. Even as Chinese policymakers look to curb agricultural GHG emissions, strategies that might lower yields are not acceptable. Therefore, some Chinese scientists are looking to ancient rice-growing techniques to mitigate rice emissions.

Farmers have historically raised ducks, fish, and rice together in flooded rice paddies. The animals eat insects, and their waste breaks down to fertilize the rice. Now called integrated rice field aquaculture, these practices gained national policy support in China in the 1980s. Compared to other rice-growing practices, integrated rice field aquaculture releases more methane but 20% lower nitrous oxide emissions.

Ground cover rice production systems in China. In China, the ground cover rice production system provides a new way to save water, especially when growing rice in the country's northern regions. In this process, rice paddy soils are covered with agricultural plastic films at the beginning of the growing season. Early research is promising, showing this approach uses 64% less water and emits 54% less methane and nitrous oxide than regular flooded paddy practices.

New US rice growing practices. Growing rice in rows rather than in paddies is a new practice in the United States. Row rice has the advantages of employing less labor and using less water, but it also requires 25% more nitrogen fertilizer. In studying emissions from row rice fields, USDA researchers found a 93% reduction in methane emission in row rice, yet this impact was canceled out by a 98% increase in nitrous oxide emissions.

Carbon and other markets to promote climate-smart rice. In 2017 the USDA invested $22.6 million in Conservation Innovation Grants to support seven rice farmers in selling carbon credits for methane-reduction conservation practices. Microsoft was the first company to buy carbon credits from these cutting-edge rice projects. In 2022, the USDA announced the $2.8 billion Climate-Smart Commodities Program to create market opportunities for farmers investing to reduce GHG emissions. Seventy projects were funded in September 2022, including a $7.5 million for rice project. Expanding climate branding and carbon markets for agriculture could be a fruitful area for US and Chinese exchange. The US voluntary market for agricultural carbon trading is expanding, and in 2023 the Chinese government relaunched its voluntary emission trading for methane mitigation, renewables, and forestry protection.

Rice Farmer Training and Capacity Building. Another area for US-China collaboration in rice methane mitigation is to look into tailored training programs and incentives to encourage farmers to adopt such practices. As is true in all areas of climate-smart agriculture, measuring, verifying, and reporting methane emissions produced by rice fields before and after climate interventions is yet another potential topic for US-China partnership.

Food Waste: A Low-Hanging Fruit for Methane Reductions

Today, a third of food grown around the world is wasted. As this food decomposes, it emits methane that accounts for 8 to 10% of global GHG emissions. This has significant implications for both China and the United States. These two nations may be food superpowers in production and trade but they also lead the world in food loss and waste—ranking first and third, respectively.

From 2014 to 2018, 27% of China's food was lost or wasted, emitting an average of 464 million tons of CO_2e. The United States wastes and loses 40% of the food it produces each year. The resulting GHG emissions are 170 million metric tons, which is equivalent to those of 42 coal-fired power plants.

Reducing food waste in China and the United States could be a climate solution with a big punch. Both countries have taken some national action, but regional and local governments, businesses, and NGOs are particularly active in this space, pushing it both within these nations and at global climate talks.

In 2022, the Global Alliance for the Future of Food assessed the food and climate actions of 14 countries on their National Determined Contributions (NDCs)—the national climate initiatives at the heart of the Paris Agreement. Neither the United States nor China had NDCs with comprehensive efforts to mitigate food loss and waste. Food waste is a low-hanging fruit for the two countries to share lessons on policies and best practices.

From Farm to Fork to Landfill

If food waste were a country it would be the **world's third largest source of greenhouse gas emissions**

China is #1 and **US #3** in Food Waste Globally

TOTAL US
91 Mt

TOTAL CHINA
348 Mt

Annual Per Capita Food Waste

US

China

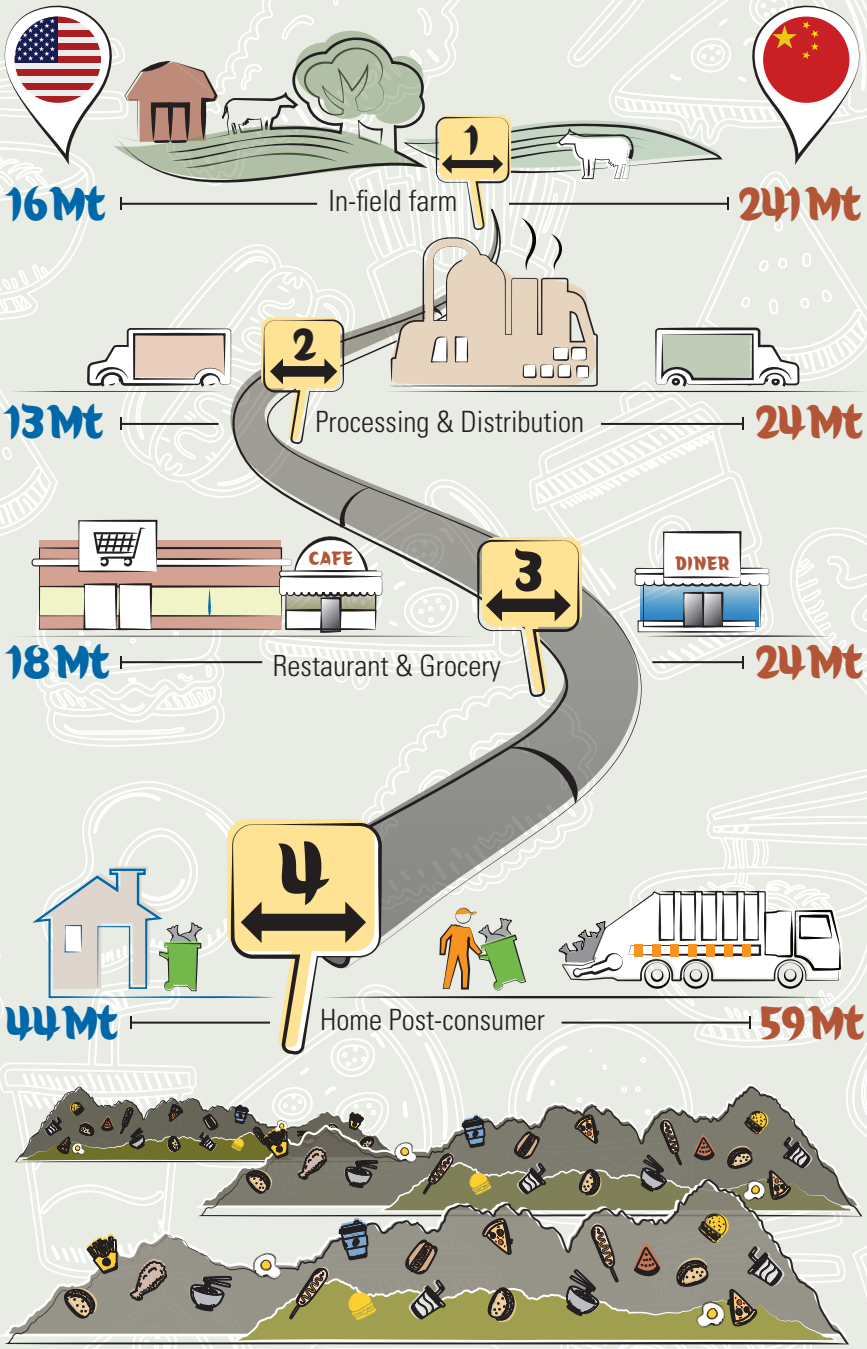
Food Waste Methane Emissions

US
146–295 MMT
CO_2e GHG

China
153–465 MMT
CO_2e GHG

CO_2e = CO_2 equivalent

Annual Food Waste Pipeline in US & China
Million Tons (Mt)



Sources: Carbon Brief, FAO, Forbes, iGDP, EDF, Nature, ReFed, Science Direct, USDA, and, UN. Research & concept by Yiming Zhong and graphic design by Kerrin Cuison.

Trends in US Food Waste Action

One of the earliest US national actions on food waste began in 2011, when the Environmental Protection Agency (EPA) launched its "Food Recovery Challenge." Over the next ten years, 600+ companies, restaurants, and universities diverted over 5.5 million tons of food away from landfills and incinerators. The US Department of Agriculture (USDA) and EPA created the US Food Loss and Waste 2030 Champions in 2016 to prod US businesses to make public commitments to reduce food loss and waste in their own operations by 50 percent by 2030.

The Biden-Harris administration's Inflation Reduction Act (IRA) includes $5 billion in grant funding for Greenhouse Gas Planning that communities can use for food waste reduction programs. The IRA also allocates significant funding to USDA conservation programs to support and incentivize organic waste reduction, composting programs, and infrastructure on farms.

At the state level, more than 33 bills addressing food waste were introduced in 12 states in 2017. Ten of these states and the District of Columbia offered a tax incentive for food donations to food banks. In 2012, the Vermont legislature unanimously passed the Universal Recycling Law, becoming a full ban on disposing food waste in landfills in 2020. (Food donations in Vermont have grown by 40 percent.) Now other states are also moving to adopt similar bans.

NGOs and businesses have also joined the effort. The Natural Resources Defense Council developed the Save the Food campaign to educate consumers and policymakers on how to waste less food at home. The WWF is working with businesses and governments on a Food Waste Commitment to halve food waste on the US West Coast by 2030. In another effort, Feeding America partnered with food manufacturers, grocery stores, and restaurants to rescue 3.6 billion pounds of groceries in 2022. Food companies including Danone, Starbucks, and others have joined the Farm Powered Food Alliance to accelerate the use of aerobic digestion of food waste to generate renewable energy.

Trends in Chinese Food Waste Policies, Plans and Programs

China is one of the few countries in the world to implement a law on food waste. The April 2021 *PRC Law Against Food Waste* created heavy fines targeting restaurants—which are China's biggest food waste culprits. The law also sets requirements for food producers, food and beverage service operators, industry associations, and the public. The Anti-Food Waste Law has allowed China to transition away from campaigns and voluntary food waste actions to a more regulatory approach with teeth.

China's initial push on food waste began in 2013 with the government's Clean Your Plate Campaign—which encouraged officials at extravagant feasts and receptions (and the Chinese public) to eliminate food waste. A 2020 "2.0" version of this campaign issued guidelines urging restaurants to use smaller dishes and remove minimum order charges. Many buffet restaurants even started charging customers a "clean plate" deposit. The 2020 *Solid Waste Law Amendments* banned excessive food waste in restaurants, codifying the Clean Your Plate campaign into law.

The Chinese government's 2017 mandate for cities to collect and sort waste led many of them to build compost and anaerobic digesters to safely dispose of the food waste and capture methane emissions to generate electricity. The mandate also sparked a community composting movement to turn urban household kitchen waste into valuable soil amendments. Farms have also been brought into these efforts, as both the 2020 14th Five-Year Plan on agriculture and the 2021 regulation on grain circularity target reductions in grain loss. Both measures also included provisions for better storage and transportation systems for grain.

Businesses have also innovated to reduce food waste. The Chinese discount grocery store Hotmaxx sold more than 300 million near-expired food items in 2021, reducing more than 70,000 tons of food waste and preventing 140,000 tons of carbon emissions. The

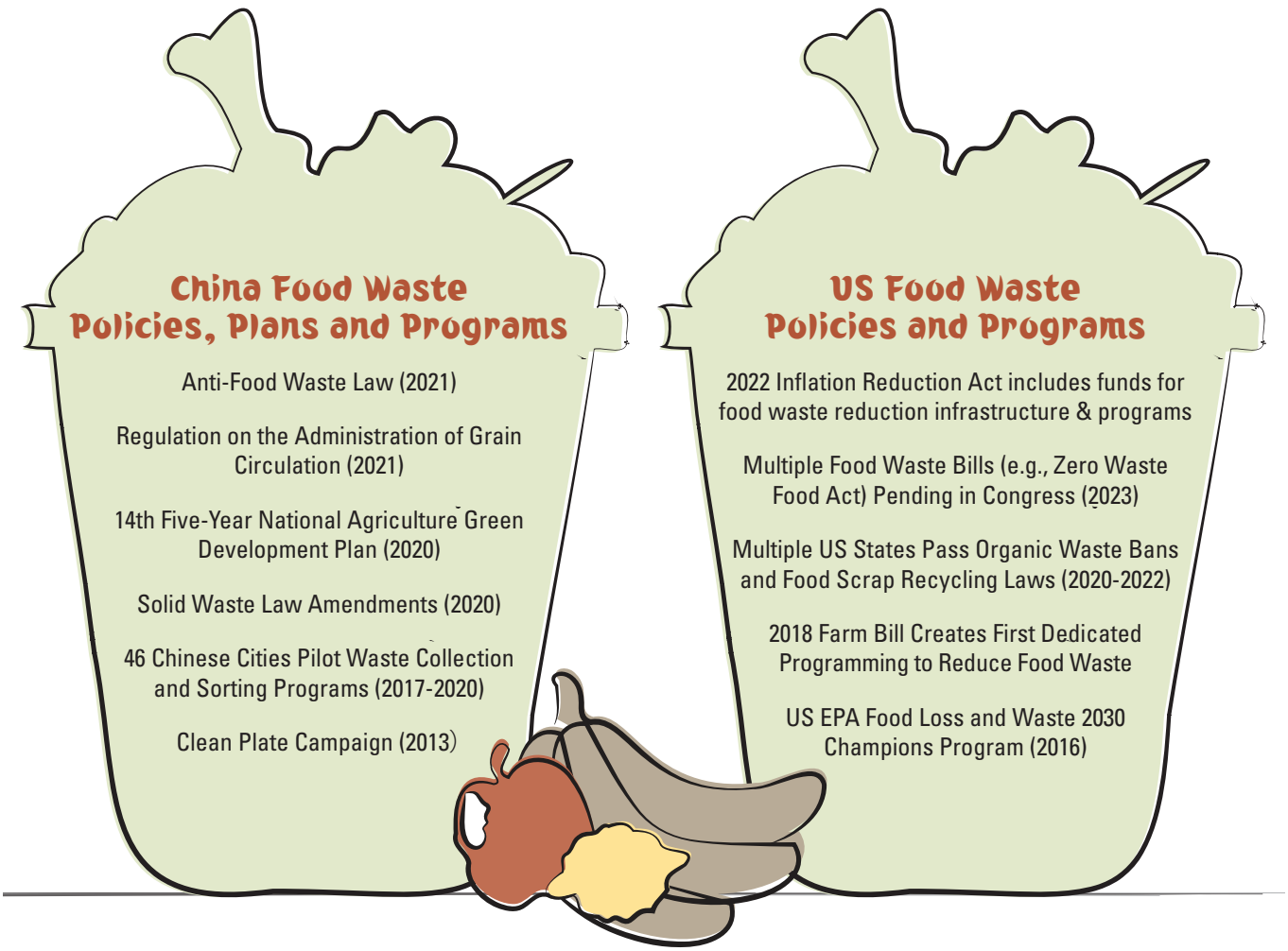
city of Shenzhen mobilized 45 enterprises to donate surplus food to local food banks—which was distributed to people in need through an app. The result was a savings of 43 tons of food and 86 tons of GHG emissions in 2023. Large retail stores (including Walmart China) partnered with the China Food Bank network in 2021 to establish food safety standards and models of surplus food donation and distribution.

Chinese and international NGOs are taking innovative approaches to curb food waste. Since 2020, a social enterprise RARE and WWF-Beijing have collaborated with small and medium-sized restaurants to change manager and kitchen employee behaviors through zero-waste recipe contests, educational board games, and an app the staff uses to measure and track kitchen waste.

Farm to Fork to Landfill: A Journey Ripe for Joint Learning

Besides embracing policies and actions focused on urban food waste, the United States and China can also share practices and regulations to help safely turn food waste into animal feed. It is an established practice that has stalled due to animal disease concerns, but holds great promise as a method to use food waste productively.

US and Chinese Food Waste Policies



3 A CORNUCOPIA OF UNTAPPED AREAS FOR US-CHINA FOOD AND CLIMATE COOPERATION

This short roadmap only scratches the surface of the numerous common challenges the United States and China face in reducing GHGs from their agrifood systems. Throughout this paper, we have outlined soil, rice, and food waste as potential impactful mitigation areas where new joint climate conversations can begin.

These conversations will be restarting soon following the November 2023 *US-China Sunnylands Statement on Enhancing Cooperation to Address the Climate Crisis*. The statement notably includes support for climate cooperation among states, provinces, and cities, building on previous successful subnational climate partnerships that flourished during the Obama administration. The emphasis in the Sunnylands statement on subnational channels and managing methane and nitrous oxide emissions could open up opportunities to build climate exchanges and mutual learning on food and agriculture.

Below, we briefly outline other areas ripe for joint climate mitigation and adaptation in the agrifood space. As with soil, rice, and food waste, these are also non-competitive areas that could be ideal for policy and scientific collaboration. Specifically, we highlight livestock methane, greening transport in agriculture, adaptation in agriculture, and strategies for financing low-carbon agriculture.

Agricultural Methane: Moooving into Cows and Other Livestock Emissions

Methane is a short-lived climate super pollutant with 80 times the warming power of CO_2. The 2021 UN Global Methane Report highlighted agriculture as the largest source of anthropogenic methane, followed closely by methane from coal, oil, and gas. Agricultural practices account for approximately 40% of the total methane emissions produced in the United States and China—mostly from livestock (66%) and rice production (20%).

In animal agriculture, methane comes from animal feed, animal manure, and the animals themselves via enteric fermentation. The latter is particularly damaging. Cow and other animal burps account for 40% of global agricultural methane emissions. An analysis of cow methane emissions reveals 97% come from burps, with the remaining 3% from manure. The methane in the latter category is emitted as the manure decomposes, a process that also emits nitrous oxide. Methane from pig and chicken manure is also a growing source as demand for pork, chicken, and eggs increases. However, the major methane culprit among livestock animals is cows, which are responsible for 86% of all US livestock methane emissions. China is the world's largest emitter of agricultural methane with 43% coming from cattle.

While not in partnership, US and Chinese scientists have been conducting research into feed, breeding, and vaccines to reduce cow methane emissions. Such strategies could potentially achieve 60% of targeted reductions in global agricultural methane.

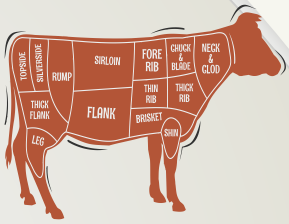
The Methane Hoofprint of Cows

14.5% of greenhouse gas emissions come from livestock

Livestock, mainly cattle, burps and farts make up **40%** of global methane emissions

#1 Source of **agricultural greenhouse gas emissions** worldwide is **cattle**

1.5 billion cattle are raised for meat production worldwide



Cow manure emits methane and nitrous oxide

Every year, one cow belches **220** pounds of methane

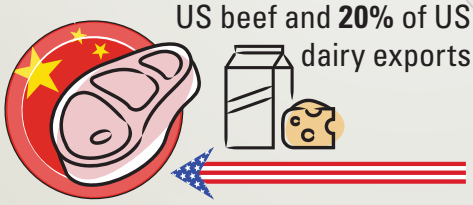
Cow enteric methane is **97%** from burps and **3%** farts.

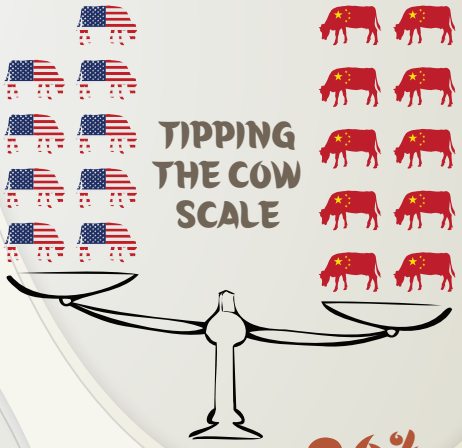
Burp

43.4% of **China's** agricultural **methane emissions** come from **cattle**

86.2% of all **US** agricultural **methane emissions** come from **cattle**

China is the **3rd largest importer** of US beef and **20%** of US dairy exports

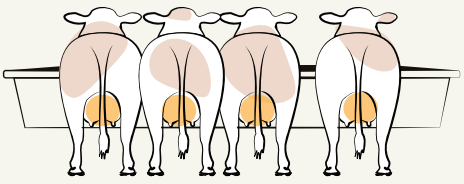




US and China account for **20%** of the world's **cattle population**

Methane emissions from cows can vary depending on:

1. **Food intake**
2. **Changes to stomach bacteria**
3. **Type of food**



Innovative Solutions

- **Creating feed and feed additives for lower methane burps**
- **Breeding of climate-friendly cows**
- **Capturing manure methane for energy usage**

Mooovement on Mitigation

- **US** signed **Global Methane Pledge** to cut emissions by 30% by 2020
- In 2023, **USDA** supported **9 climate-smart dairy project**
- **US-China Glasgow Declaration** prioritizes cutting methane emissions
- **China's National Methane Action Plan** announced at **COP27**
- **Chinese** 2016 guidelines **to reduce meat consumption 50%** by 2030

Sources: CBS News, China Dairy Industry Association, Christopher Gambino, FAS/USDA, Food Unfolded, Global Citizen, Journal of Animal Science, Journal of Cleaner Production US EPA, Reuters, UC Davis, Undeniably Dairy, University of Nebraska-Lincoln Institute of Agriculture and Natural Resources. Research & concept by Jennifer Nguyen and graphic design by Kerrin Cuison.

Areas Ripe for Bilateral Science and Policy Dialogues

Green Transport in Agriculture. The United States is the world's top emitter of CO_2 from transportation and China is second. Fully 28% of total US GHG emissions came from transportation in 2021, with 10% of those stemming from agriculture. Transportation is 12.42% of China's total CO_2 emissions. Data for agrifood transport emissions (farm equipment and cold chain) are elusive, but Nature estimates on-farm vehicles account for 5.4% of total agricultural GHG emissions. Yet in both countries, agriculture is an overlooked target for greening transport. Decarbonizing farm equipment and HFC (a short-lived climate pollutant) in food cold chain transport are untapped opportunities for both countries to reduce GHG emissions.

Policies and Science for Agricultural Adaptation in a Changing Climate. The United States and China face common threats to their agriculture from climate change. Extreme weather patterns are intensifying the floods and droughts that decimate crops and soil quality. Thus, both countries are experimenting with agricultural practices for climate-resilient agriculture, offering many areas for joint scientific learning.

One often overlooked climate threat to agriculture is increasing nighttime temperatures (70F to 80F), which are shifting the ranges of food crops, lowering crop yields, and endangering animal health. Under heat stress, animals eat less, grow slower, produce less milk, and have lower reproduction success. Hot and humid conditions can even kill dairy cows, poultry, and hogs. In the United States, the estimated annual cost of livestock heat stress is about $2 billion.

US and Chinese researchers could jointly work on adaptation of livestock production to a warmer climate, which will require breeding and animal genetics to improve heat tolerance. Policies will need to change to support this crucial adaptation research and infrastructure.

Strategies for Financing Low-Carbon Agriculture. While the United States and China both have significant potential to mitigate and adapt to climate change in the agrifood sector, funding for climate-smart agriculture needs to be strengthened.

China is the world's largest investor in renewables and emerging clean technologies such as EVs and energy storage batteries. The country has adopted a top-down approach to green financing with Beijing promoting a profusion of green finance tools—green bonds, a national carbon market, special green finance zones. Since 2019, the Agricultural Bank of China and the Climate Bond Initiative have worked together on creating criteria and pilot projects for green agriculture bonds.

By contrast, the US government has taken a more bottom-up approach to green financing by investing to catalyze markets to develop clean energy and other environmental protection industries and technologies. In 2022, the Biden administration launched an unprecedented infusion of investment into climate-smart agriculture. The USDA announced it would invest $3.1 billion to expand markets for Partnerships for Climate-Smart Commodities and the Inflation Reduction Act provided an additional $19.5 billion over five years for climate-smart agriculture.

Source: AgWeb, Business Wire, California-China Climate Initiative, China Dialogue, China Newsweek, Climate and Clean Air Coalition, Climate Change Research (China), Council on Foreign Relations, Earth.org, Environmental Defense Fund, European Commission, Feeding America, Food and Agriculture Organization, Global Alliance for the Future of Food, Global Times, Greenhouse Gases: Science and Technology, International Energy Agency, IOPScience, Journal of Geographical Research: Biosciences, Library of Congress, Nanjing University Lishui Institute of Ecological Environment, National Public Radio, Natural Resources Defense Council, Nature, Our World in Data, Project Drawdown, Rare, SaveTheFood, ScienceDirect, Sciendo, Springer, Sznews, The International "4 per 1000" Initiative, The Land Institute, The Poultry Site, The World, Time Magazine, UNEP, University of Cambridge, US Department of Agriculture, US Department of State, US Environmental Protection Agency, Wilson Center's New Security Beat, World Resources Institute, World Wildlife Fund, Xinhuanet

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