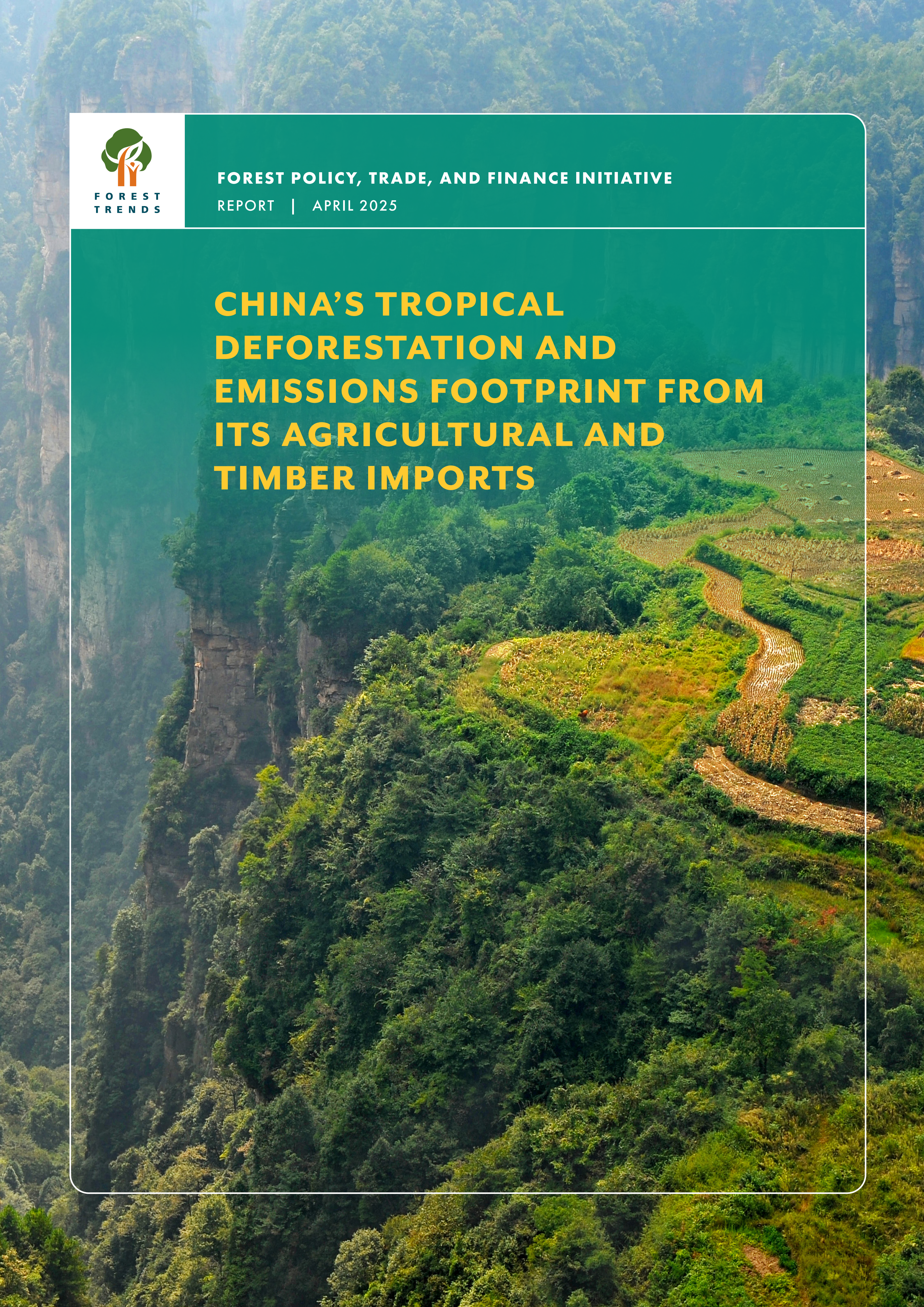

FOREST TRENDS

FOREST POLICY, TRADE, AND FINANCE INITIATIVE

REPORT | APRIL 2025

CHINA'S TROPICAL DEFORESTATION AND EMISSIONS FOOTPRINT FROM ITS AGRICULTURAL AND TIMBER IMPORTS

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Executive Summary

China's strong domestic forest conservation policies have ensured its national forests are making a major contribution to global afforestation and reforestation efforts, as well as internal climate goals. However, there has been no official mention of emissions and deforestation linked to China's timber and agricultural imports (known as "embedded emissions"). This is despite China being the world's primary or second main importer of the three main commodities (soy, beef, and palm oil) driving tropical deforestation, much of it illegal.

This report assesses China's embedded tropical deforestation and emissions footprint linked to its agricultural and plantation forestry imports. These calculations are based on a major global analysis and database of deforestation and carbon emission impacts of the international trade in agricultural and timber products (Pendrill et al. 2020; Singh et al. 2024), augmented by Forest Trends' (2021) analysis of the extent and nature of illegal tropical deforestation.

Key findings include:

1. China's tropical deforestation footprint due to agricultural and timber plantation imports accounted for between two and five percent of carbon emissions from tropical (including sub-tropical) deforestation between 2013 and 2022. When looking only at emissions from agricultural and timber plantation operations linked to international trade, this number rises to between six and seven percent of tropical deforestation emissions over the 2013-2022 period. In terms of land area, China's agricultural and timber imports have driven an annual loss of over 400,000 hectares (ha) of tropical forest (four million ha in total) over this period.

   China's "deforestation emissions footprint" (i.e., deforestation emissions embedded in its imports) amounted to almost 200 million tons (Mt) of carbon dioxide (CO_2) annually from 2013 to 2022, equivalent to 1.5-2 percent of China's total CO_2 emissions and 20-30 percent of its domestic agricultural sector emissions.

   These are conservative estimates since the methodology only captures land-use changes linked to agricultural and plantation timber imports, and it does not include deforestation and forest degradation due to natural forest timber (and other natural forest product) imports.

2. Nearly 70 percent of China's tropical deforestation footprint stemmed from illegal conversion of forests to commercial agriculture and timber plantations. China's imports of agricultural and timber products were linked to about 287,000 ha of illegal tropical forest clearance and 142 $MtCO_2$ emissions per year (over one percent of China's annual CO_2 emissions), or almost three million ha and one and a half thousand $MtCO_2$ emissions over a decade.

3. China's tropical deforestation impact has been mainly driven by a few specific commodities and source countries, and in some cases, a few companies. Four commodities have accounted for most of China's deforestation footprint: palm oil, beef (including buffalo meat), soybeans, and plantation timber. Palm oil imports were linked to 26 percent of import-linked deforestation, followed by cattle and buffalo meat imports (23 percent), soybean imports (12 percent), and plantation timber imports (6 percent). Other significant products in China's deforestation footprint were natural rubber, maize, cocoa, cassava, and coffee.

The emissions were predominantly linked to imports from Indonesia (31 percent), Brazil (27 percent) and Malaysia (6 percent); other significant sources were Argentina, Bolivia, Paraguay, Côte d'Ivoire, and Ghana. In some source countries, the deforestation footprint was geographically highly concentrated. For example, three-quarters of deforestation linked to China's soy imports from Brazil were from just four states in northeast Brazil. In some hotspot areas, the supply chain involved a few major Brazilian companies.

4. Analysis reveals some prominent opportunities to reduce China's deforestation footprint with potential for high payoffs. A focus on greening the Brazil-China soy and Hong Kong supply chains could have a major impact given the scale of these trades and the above mentioned geographic, commodity, and company concentration. China's imports account for up to half of Brazil's beef-related deforestation and 60-70 percent of Brazil's soy exports. China has also made several policy statements on greening its agricultural and forest commodity supply chains.

   A notable development in the Brazil-China soybean trade was establishment of the Tropical Forest Alliance Taskforce on Green Value Chains for China in June 2023. This initiative brought together five market leaders (Bunge, Cargill, China Mengniu Dairy, L'Oréal, and Nestlé), who are responsible for almost 40 percent of China's international grain supplies. Subsequently, Mengniu Dairy Group was the first Chinese company under the Taskforce to commit to a zero-deforestation supply chain by 2030. This included a memorandum of understanding with COFCO International to deliver 50,000 tonnes of deforestation- and conversion-free (DCF) soybeans. The first Brazil-China soybean consignment was delivered in May 2024.

5. Meaningful change is only likely when China's trade partners implement and enforce import regulations. In the short term, addressing illegal deforestation through voluntary private sector initiatives, combined with supporting green supply chains, offers a politically more viable path than applying pressure for mandatory (but more effective) import regulations. Significant change is only likely when China's trade partners expand their demand for sustainable or legally verified commodities, and there are many more prosecutions under the US Lacey Act, the future EU Deforestation Regulation (EUDR), and UK regulations on illegal deforestation-linked imports. Meanwhile, China's policymakers face a strategic choice: either to proactively establish robust systems for ensuring and demonstrating sustainable sourcing that would position China as a leader in greening supply chains, while significantly contributing to global climate and biodiversity goals, or maintaining opaque supply chains with their growing risks for exports as consumer countries impose increasingly demanding, and more effectively implemented, import restrictions.

1 Introduction

No country is more important for climate change mitigation than China. It is easily the world's main emitter of greenhouse gases. In 2022, for example, China accounted for 29 percent of global greenhouse gas emissions (Crippa et al. 2023; Larsen et al. 2021). With its rapid economic growth, China's per capita emissions have tripled over the last two decades. On the other hand, China has a good record of achieving its international climate change commitments,[1] as well as being an undisputed world leader in renewable energy technology and implementation (Yang 2022).

China has made various international pronouncements on climate change mitigation and biodiversity goals, and President Xi has sometimes coined the phrase "ecological civilization." Its commitments include its Nationally Determined Contribution (NDC) under the Paris Agreement, the Glasgow Leaders' Declaration on Forests and Land Use, the US-China Joint Glasgow Declaration on Climate Action, and the 2023 Sunnylands Statement on Enhancing Cooperation to Address Climate Crisis,[2] as well as bilateral commitments such as the 2023 China-Brazil Joint Statement on Combatting Climate Change.[3]

Historically, the main emphasis of China's efforts at achieving its climate goals has been on adaptation and reducing emissions from domestic sources such as coal, non-renewable energy, transport, and the main industrial emission sources (cement, steel, and aluminium). The carbon sink contribution from China's ambitious national afforestation and reforestation (A/R) program is also emphasized in national climate change policy. In 2020, carbon sequestered through A/R offset an estimated 6-8 percent of China's industrial CO_2 emissions, or 13-17 percent when reduced emissions from improved forest management and lower deforestation and forest degradation are added (Jin et al. 2020).

There has, however, been little or no mention of the issue of emissions embedded in agricultural and timber imports. This is part of what is sometimes referred to as the "carbon loophole."[4] These embedded emissions are widely regarded as a major issue for efforts to decarbonize the global economy.[5] In aggregate terms, the carbon loophole is not an issue for China since it is a major net exporter of emissions from other sectors. China is, however, the world's biggest net importer of agricultural and forestry products, a large proportion of which are from tropical forest regions with poor governance records. It is therefore easily the most important player regarding the tropical forest "carbon loophole." Therefore, actions to reduce embedded trade emissions in its agricultural and timber imports are, or should be, critical to the credibility of China's claim to be a global leader of "ecological civilization" (Yang 2022).

[1] For example, China reportedly achieved its 2020 emissions reduction target three years in advance (Yang 2022).

[2] Refer to a report by TNI (2017(a)) for an overview on past and present peace initiatives and bilateral ceasefires with EAOs (in particular the tables found on page 8 and 33).

[3] The full text of the Brazil-China joint declaration on combating climate change can be found here: https://www.gov.br/mma/pt-br/assuntos/noticias/declaracao-conjunta-brasil-china-sobre-combate-as-mudancas- climaticas#:~:text=O%20Brasil%20e%20a%20China,sem%20deixar%20ningu%C3%A9m%20para%20tr%C3%A1s.

[4] The carbon loophole refers to greenhouse gas emissions associated with producing goods that are traded across countries, and which are then embedded in the imports of consuming countries (Moran et al. 2018).

[5] If there was an accounting system for consumption-based emissions, rather than production-based emissions, importing countries would be responsible for about a quarter of the world's CO_2 emissions (Moran et al. 2018).

In this report, China's embedded tropical forest footprint, in terms of deforestation and CO_2 emissions from its agricultural and plantation forestry imports, are estimated from a major global database of the deforestation and emission impacts of international trade (Singh et al. 2024, building on Pendrill et al. 2019 and 2020). This database uses a land-balance model to attribute deforestation to the expansion of cropland, pastures, and forest plantations (and the commodities produced from this land), and traces these commodities to consumption by importing countries using physical and monetary trade models. For a fuller explanation of the methodology, see Annex 1. The illegal deforestation and emissions estimates in this paper draw from Forest Trends' (2021) analysis of illegality in forest-risk commodity (FRC) production associated with illegal forest clearance.[6]

[6] Forest Trends (2021) estimated specific risks of illegal deforestation for several key commodities, but not for all agricultural commodities. For these commodities, a flat rate of 50 percent was applied. This was below the estimated overall illegality level (69 percent) of global tropical deforestation. For more detail, see Annex 2.

2 China's Tropical Deforestation Footprint Embedded in its Agricultural and Timber Imports

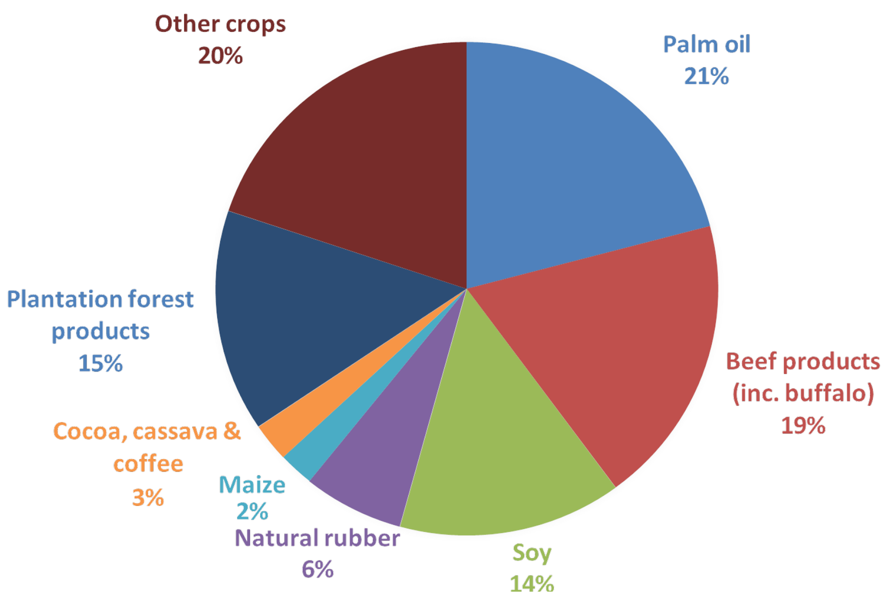
Based on Forest Trends' analysis of the global embedded deforestation and emissions database (Singh et al. 2024), China's agricultural and plantation forest imports were linked to average annual tropical deforestation of 416,000 hectares (ha) between 2013 and 2022. The associated annual carbon dioxide emissions were 195 million tons ($MtCO_2$). Of these totals, 286,00 ha of tropical forests were illegally deforested per year—almost 3 million ha over ten years. The associated emissions were 142 $MtCO_2$ per year (almost one and a half thousand $MtCO_2$ over the decade).

According to these estimates, China's agricultural and timber imports[7] were responsible for about 6-7 percent of tropical deforestation emissions linked to the international agricultural and timber trade, and 2-5 percent of all tropical and subtropical deforestation emissions, including due to domestic (i.e., within producer countries) consumption of the products. It was also found that most of China's embedded deforestation and emissions footprint (from agricultural and forestry imports) were from palm oil, beef products, soy, and plantation timber imports (Table 1, Figure 1A). These four product groups accounted for 69 percent of the deforestation risk area and 67 percent of emissions (Figure 1B). Other significant forest-risk commodities were natural rubber, maize, cocoa, cassava, and coffee.

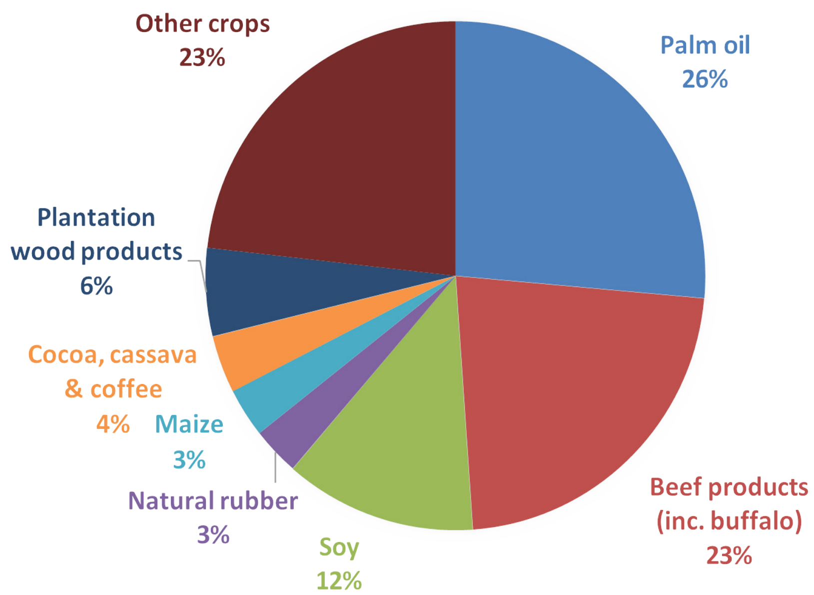
A 2024 analysis by Transparency for Sustainable Economies (Trase) of the Singh et al. (2024) database indicates that in recent years, beef imports have become much more important than palm oil imports in China's deforestation footprint. Looking only at the 2019-2021 period, Trase (2024) found that over half (53 percent) of China's deforestation footprint was attributed to cattle products, followed in importance by soy (20 percent), palm oil (10 percent), plantation wood products, rubber, and cocoa.

[7] This includes imports by Hong Kong and Macao, included under China in the Singh et al. (2024) study.

Figures 1A and 1B | China's Imports: Distribution of Tropical Deforestation Risk Area and Emissions by Commodity Mapping



1A. Tropical Deforestation Risk Area



1B. Tropical Deforestation Emissions

Source: Singh et al. 2024.

Table 1. Tropical Deforestation Risk Area and Emissions Attributable to China's Agricultural and Timber Imports (2013-2022 Average)[8]

			Illegal deforestation estimate*		
Commodity	**Deforestation risk area (000 ha/year)**	**Deforestation emissions ($MtCO_2$)**	**Illegality risk %***	**Deforestation risk area (000 ha/year)**	**Deforestation emissions $MtCO_2$**
Palm oil (fruits)	86.91	51.61	73%	63.86	40.25
Cattle/buffalo meat and associated co-products	79.04	43.97	89%	70.22	40.39
Soya beans	59.80	24.23	92%	55.10	22.35
Rubber (natural)	26.97	6.00	42%	11.40	2.83
Maize (corn)	9.46	6.15	52%	4.96	3.15
Cocoa beans	5.12	3.56	64%	3.27	1.99
Cassava (fresh)	3.26	2.78	50%	1.63	1.39
Coffee (green)	2.06	0.81	44%	0.92	0.37
Plantation timber†	60.56	10.93	56%	34.10	6.87
Other crops	82.66	45.42	50%	41.33	22.71
Total	**415.85**	**195.45**	--	**286.78**	**142.31**

Notes:

* The illegality risk percentages are from a Forest Trends (2021) analysis of illegally produced agricultural commodities (See Annex 2).

† Plantation wood products were not included in the Singh et al. (2024) dataset; they are based on 2013-2018 data in Pendrill et al. (2019). The illegality risk for plantation timber was based on a periodically updated analysis of legality and governance risks in timber source countries published on Forest Trends' Illegal Deforestation and Trade (IDAT) Risk Dashboard.

[8] The illegality parameters in the fourth column of Table 1 reflect the country mix of sources for China's imports of each commodity and so are slightly different to the overall illegality parameters for each product.

These calculations can be considered as conservative regarding China's deforestation and carbon footprint since:

- The attribution method of Pendrill et al. (2020) and Singh et al. (2024) is based on land-use expansion and does not capture the deforestation area and emissions where forest is cleared for timber (imported by China) without subsequent establishment of cropland, pasture, or plantations.
- The calculations exclude forest degradation emissions associated with natural forest wood and non-timber forest products imported by China. Based on emission factors from field research by Pearson et al. (2017) on forest degradation emissions from natural forest logging in Asia, embedded forest degradation emissions in China's 2018 tropical (natural forest) timber imports were almost 11 $MtCO_2$.

As regards the relative scale of China's embedded emissions footprint, it can be noted that in 2022, China emitted about 12,100 $MtCO_2$ (IEA 2023), and in 2019, domestic food production emissions were 1,200 $MtCO_2$ (i.e., about 10 percent of total national emissions) (Liu et al. 2023). Thus, embedded trade emissions in China's agricultural and timber imports accounted (in 2022) for about 2-3 percent of China's total CO_2 emissions, and 15-17 percent of national food production emissions. Box 1 shows how China's embedded deforestation footprint compares to other countries and regions.

The data also reveal that agricultural and plantation timber imports from Brazil and Indonesia were responsible for over half of the deforestation area and emissions from 2013 to 2022 (Figures 2A and 2B). Production in Brazil, mainly of beef and soy, accounted for 30 percent of the deforestation risk area and 27 percent of emissions, whereas Indonesia (mainly palm oil) was responsible for 23 percent of the area and 30 percent of emissions (the relatively higher emissions from palm oil being due to peat forest clearance). The next main sources were Malaysia (palm oil and plantation timber), Chile (plantation timber), and three other Latin American beef and soy producers: Argentina, Bolivia, and Paraguay.

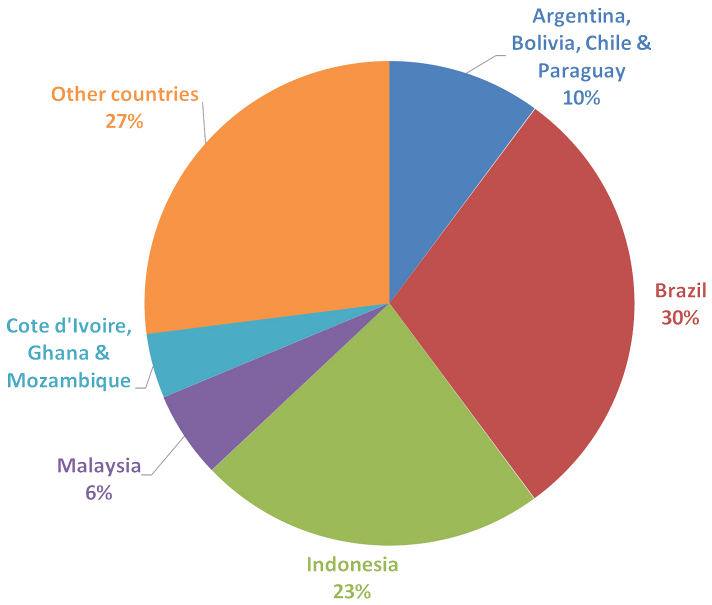
BOX 1

Country and Regional Comparisons of Embedded Deforestation Footprints

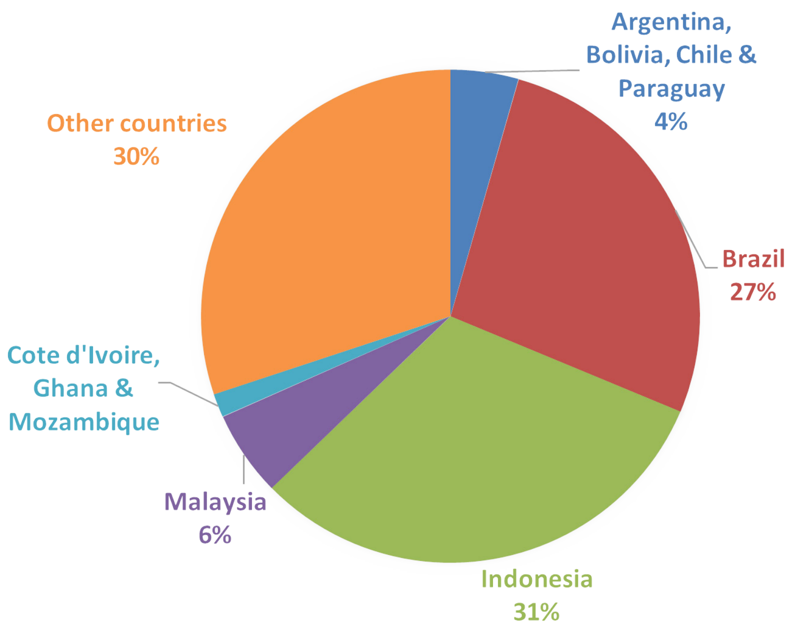
Based on analysis of the Pendrill et al. (2020) data, WWF (2021) found that in 2017, China's imports of agricultural and plantation wood products were linked to 24 percent of global deforestation, putting China ahead of the EU (16 percent), India (9 percent), US (7 percent), and Japan (5 percent). It was also noted that the EU had a bigger deforestation footprint until 2014 when China overtook it.

Another analysis by Trase (2024), based on the Singh et al. (2024) database, estimated that over the 2019-2021 period, China's deforestation footprint from agricultural and timber imports was about double that of the EU, and four times that of the US.

Figures 2A and 2B | Tropical Deforestation Risk (ha) and Emissions ($MtCO_2$) Due to China's Agricultural Imports by Producer Country (2013-2022)



2A. Tropical Deforestation Risk Area



2B. Tropical Deforestation Emissions

Source: Forest Trends analysis of data in Singh et al. 2024.

3 Other Studies of China's Agricultural and Timber Import Footprint

Various other studies have assessed the embedded deforestation or ecological footprint of China's agricultural, timber, or other biomass imports using various methods and metrics. First, a study by Hoang and Kanemoto (2021) used a broadly similar approach to that of Singh et al. (2024) and also drew on the Pendrill et al. (2020) dataset, but claimed that it expanded the scope of land-use changes through spatial analysis of deforestation drivers.[9] This study found that in 2015, China's net imports of "deforestation-related commodities" resulted in 395,000 ha of embedded tropical and sub-tropical deforestation. This figure is close to the average annual tropical deforestation estimate presented above (416,000 ha) for the 2013-2022 period. It therefore provides a degree of triangulation; since it refers to net deforestation-related commodity imports, the implication is that the gross import-based estimates from Singh et al. (2024) and Pendrill et al. (2020) are underestimates of the deforestation and emissions' impacts. Hoang and Kanemoto (2021) also revealed a dramatic increase in China's deforestation footprint since the millennium: total deforestation (i.e., of all types of forest) from China's net imports of deforestation-related commodities in 2015 (623,600 ha) was over six times that of 2001.

A second paper (Zhao et al. 2021) took a different approach[10] to assessing China's agricultural import footprint: it focused on the resource use (mainly land) and emissions impacts, including deforestation emissions (but not deforestation per se), of China's future demand for food. This study projected that from 2010 to 2050, the share of imports in China's food supply will rise from seven percent to 20 percent for "ruminant meat," from 12 percent to 20 percent for dairy products, and from 45 percent to 70 percent for oil crops, resulting in annual (embedded) global deforestation emissions of 23 $MtCO_2e$ (million tons of carbon dioxide equivalent) by 2050. This would be about four percent of net[11] domestic greenhouse gas emissions from China's AFOLU sector in 2050.

This study also found that 43 percent of deforestation caused by soyabean cultivation in Brazil in 2017 was due to China's soy imports. Another projection was that the latter will account for 46 percent of the global soybean trade in 2050, with 53 percent of soy imports coming from Brazil and 37 percent from the US. According to the projections, China will account for about two-fifths (16 million ha) of Brazil's soy production.

The third and most recent study (Wang et al. 2024) focused on China's footprint from its biomass imports and consumption over the 2004-2017 period. The main metric used as an indicator of China's ecological footprint was "Human Appropriation of Net Primary Productivity" (HANPP).[12] A definition of HANPP according to Cherlot et al. (2018) is "the proportion of terrestrial net primary production consumed directly and indirectly through human land use. Hence, HANPP can serve as an integrated measure of the socioecological impact of human land-use change."

[9] The main difference in the Hoang and Kanemoto (2021) analysis was a different approach to the spatial classification of deforestation drivers based on a study by Curtis et al. (2018) and use of a global supply chain model (Lenzen et al. 2012). The study also used FAOSTAT and OECD-FAO data for agricultural production projections. In addition to the emission projections, the study estimated impacts on the use of nitrogenous fertilizers and irrigation water.

[10] This involved using a Global Biosphere Management Model (GLOBIOM), an agricultural and forest sector model used for environmental sustainability analysis in land-based sectors, and adopting a range of development and demand scenarios to estimate China's food imports needed to supplement national production.

[11] I.e., after taking out the carbon sink effect of afforestation and reforestation.

[12] HANPP quantifies the extent to which human activities alter the availability of biomass by measuring the difference between potential natural vegetation NPP (i.e., the theoretical amount of biomass production in the absence of human intervention) and the NPP remaining in the ecosystem after human occupation. This study included analysis of HANPP embedded in China's international trade and the use of "structural decomposition analysis" to evaluate the impact of change drivers on HANPP (Wang et al. 2024).

This study found that China was the largestt net importer of HANPP in 2017. China's HANPP imports were about twice the size of the US, the second largest importer, and three times those of Japan. Over the 2004-2017 period, China switched from being a net exporter to a net importer of HANPP. In 2004, it had a net HANPP outflow of 0.06 Pg C/yr (pentagrams of carbon per year), and in 2017, a net inflow of 0.57 PgC/yr.

Over 60 percent of China's HANPP's imports in 2017 were in oilseed products, mainly from Brazil, the US, Australia, Canada, and Argentina. Brazil was the biggest overall supplier of China's HANPP consumption, having increased almost fourfold over the period. In 2017, China consumed about a quarter of the world's oilseed sector HANPP. It was also noted that the East Asia and Pacific region, especially Australia, New Zealand, and Vietnam, was a primary source of China's HANPP imports across various agricultural sectors. The future tropical deforestation pressure is also indicated by the projected fourfold increase from 2017 to 2050 in China's biomass imports from "lower-middle-income" and "low-income" countries (Wang et al. 2024).

4 China's Illegal Tropical Deforestation and Emissions Footprint

Forest Trends (2021) estimated that from 2013 to 2019, about 60 percent (or 6.6 million ha per year) of tropical deforestation was caused by the expansion of commercial agriculture ("agro-conversion" for short), including cattle pasture, and that at least 69 percent (or 3.5 million ha per year) of this agro-conversion violated national laws and regulations (e.g., obtaining land illegally, forest clearance in excess of permits, human rights abuses, breaches of environmental law, and "fraud and corruption").

It was further estimated that illegal agro-conversion of tropical forests resulted in over 2.7 gigatons of CO_2 emissions per year, or at least 42 percent of total tropical deforestation emissions. Forest Trends considered these illegality estimates to be very conservative, noting that actual rates were likely higher but obscured by inadequate monitoring and reporting by governments, civil society, or researchers, as well as weak enforcement.

As presented in Table 1 on page nine, China's total illegal tropical deforestation footprint from agricultural and timber imports amounted to at least 287,000 ha and 142 $MtCO_2$, which is over one percent of China's total CO_2 emissions, and over ten percent of domestic food production emissions. This indicates China's emissions reductions potential if it were able to eliminate imports of timber and agricultural commodities produced on illegally cleared lands (not to mention the potential positive impact on other life-supporting ecosystem services and externalities).

5 Deforestation Hotspots and Trades, and Related Intervention Opportunities

Recent research, particularly studies using the Trase tool,[13] provides some more detailed insights into China's tropical deforestation footprint. By tracking soy and beef exports from Latin America to specific production locations and stakeholders, Trase reveals cost-effective intervention opportunities for China. These trades are concentrated in geographical hotspots and amoung a few large companies, making targeted support and outreach more focused and cost-effective than those addressing numerous small and medium sized enterprises (although these smaller operations often exist within larger companies' supply chains).

5.1 The Brazil-China Soybean Trade

China's imports of soybeans from Latin America have risen sharply over the last decade. For example, between 2010 and 2017, they rose by 170 percent (Trase/CDP 2019). China is the main export market for Brazilian soybeans, accounting for 70 percent of Brazilian soy exports in 2018, up from 59 percent in 2013. Although the Matopiba region of Brazil (comprised of Maranhao, Tocantins, Piaui, and Bahia States) supplied only nine percent of China's Brazilian soy imports in 2018, it accounted for 77 percent of the deforestation linked to the Brazil-China soy trade. Matopiba's disproportionate impact stems from two factors: the Cerrado frontier region's carbon emissions per ton of soy exports were six times the national average in 2018 (Vasconcelos 2022), and its weaker governance led to about 90 percent of deforestation being probably illegal due to the lack of deforestation permits (Valdiones et al. 2021).

It was also revealed that five Brazilian traders accounted for 70 percent of Matopiba's soybean exports: Cargill, Bunge, Amaggi/LD Commodities, ADM, and Agrex. The concentration of trade within just a small number of suppliers, combined with the geographical concentration of deforestation, creates opportunities for targeted cost-effective collaboration between Chinese soy buyers, Brazilian traders, and the Matopiba State governments. Vasconcelos (2022) suggests a sustainable soybean trade agreement between the Brazil Association of Vegetable Oil Industries (ABIOVE) and the China Soybean Industry Association, potentially using the Round Table for Responsible Soy (RTRS) certification framework. China's potential for leadership in greening this trade is particularly relevant given that the five companies control 80 percent of China's overall soybean supplies (Chunquan 2023).

[13] The TRASE tool draws on publicly available production, trade, and customs data, and on modelling, to trace commodity flows back to the specific production locations and stakeholders involved along the chain (https://www.trase.earth/).

5.2 The Brazil-China Beef Trade

China's imports of Brazilian beef have also grown dramatically, rising from zero in 2013 to 44 percent by 2019 (Vasconcelos 2022). The deforestation impact of China's beef imports was notably higher than other areas. At 59 hectares per thousand tons of beef imports, it was more than double that of EU beef imports (Trase 2020). China accounted for about half of Brazil's deforestation emissions linked to beef exports in 2017 (Pendrill et al. 2020).

The deforestation impact was again highly concentrated, with over half occurring in just two percent of cattle-producing municipalities (Vasconcelos 2022). The trade was similarly concentrated, with five companies (JBS, Marfrig Global Foods, Minerva, Mataboi Alimentos, and Irmaos Goncal) handling 73 percent of beef exports to China in 2017 (Vasconcelos 2022). The two largest companies, JBS and Marfrig, which account for over half of China's beef imports from Brazil, have invested heavily in traceability systems (Trase 2021). Both companies had commitments to zero deforestation and 100 percent supply chain traceability, including all their indirect farm-level supply (CCICED 2021). In 2021, JBS launched an open-access beef cattle traceability system, the "Transparent Livestock Farming Platform." Using blockchain technology,[14] this aimed to monitor beef supply chains for deforestation, labor violations, and invasion of indigenous lands (Ferrer 2021). Marfrig established the "Marfrig Club" to provide support (financial and technical assistance) to collaborating suppliers (CCICED 2021).

In 2020, Trase (2020) found that 25 municipalities accounted for about half of the emissions linked to China's 2017 beef imports. Another Trase study (zu Ermgassen et al. 2020) reported that in 2019, China licensed an additional 20 slaughterhouses in Brazil, and that the deforestation footprint of these slaughterhouses was double that of previously licensed Brazilian slaughterhouses supplying China.

5.3 The Indonesia-China Palm Oil Trade: Demand-side Challenges

Despite the Indonesia-China palm oil trade's significant impact on China's emissions footprint, even more so than the Brazil-China beef and soy trades,[15] efforts to green this trade have seen limited success. Initial promising steps have included the 2013 memorandum of understanding between the Roundtable on Sustainable Palm Oil (RSPO), an international palm oil certification body; efforts of China's Chamber of Commerce for Foodstuffs to promote sustainable palm oil imports (Yifan 2021); and the China Sustainable Palm Oil Alliance, which was formed in 2018 between the RSPO, WWF, multinational companies, retailers and processors, and banks.

[14] Blockchain technology involves a "decentralized, distributed ledger that records the provenance of a digital asset" (Whitfield 2022). Its key advantage is that data in a blockchain cannot be modified, which should therefore reduce corruption. The importance of blockchain technology is also noted by CCICED (2021).

[15] Due to the drainage of peat forests for palm oil plantations.

However, these initiatives fell well short of their targets, with RSPO-certified palm oil reaching only two percent of Chinese sales by 2021 (versus the 10 percent target) (Yifan 2021). The disappointing progress has been due to several linked challenges (Yifan 2021), but dominantly due to demand-side challenges:

- Abundant RSPO-certified supply of palm oil, but minimal consumer or retail demand.
- Low or non-existent visibility for RSPO palm oil. Palm oil is usually one of many ingredients, and often a minor one, in thousands of supermarket products. In China, it is also only rarely listed as a separate ingredient, usually being labelled as "vegetable oil."
- Difficulty in charging a premium price.
- Limited participation by Chinese companies (most of the Palm Oil Alliance members were multinational).
- Weak coordination between government, industry, and consumers.

Given the unique demand-side challenges to a green supply chain for palm oil, it may be that only a legislative approach obliging due diligence by importers, as proposed by the EU, would have much additional impact to efforts already underway on the supply side (documented by CICCED 2021, among others).

6 Progress and Challenges in Greening China's Soft Commodity Supply Chains

The most important response to addressing deforestation in supply chains has been the establishment of the Tropical Forest Alliance Taskforce on Green Value Chains for China in June 2023. The Taskforce brought together five market leaders: Bunge, Cargill, China Mengniu Dairy, L'Oréal, and Nestlé. These companies collectively account for almost 40 percent of China's international grain supplies, and generate annual revenue of nearly 240 billion CNY (approximately US$32 billion) in the Chinese market (TFA 2023).

The aims of the Taskforce are stated as:

- Improve information-sharing and fostering a common understanding across supply chains.
- Engage with the public sector to create an enabling policy environment.
- Empower consumers to make sustainable purchases through increased public awareness.
- Encourage partnerships with producer countries.

Early progress has included:

- The Mengniu Dairy Group became the first Chinese company under the Taskforce to commit to zero deforestation in its supply chain by 2030.
- In November 2023, Mengniu signed a memorandum of understanding with China Oil and Foodstuffs Corporation (COFCO) International to deliver 50,000 tonnes of deforestation- and conversion-free (DCF) soybeans to China (Chunquan 2023).
- The first Brazil-China soybean consignment arrived in Tianjin in May 2024 (COFCO 2024a). This also forms part of COFCO's goal of a deforestation-free soy supply chain by 2025 (op. cit.).

Some of the initiatives to green Brazil's soy and beef supply chains to China have been supported by innovative financing arrangements, but two prominent examples reveal some of the challenges they face. The first example concerns a proposed loan of US$200 million from the Inter-American Development Bank (IDB) to Marfrig, Brazil's second largest food processing company, to develop a "deforestation-free" beef supply chain (CCICED 2021). The loan for Marfrig's Plano Verde included interest rate reductions tied to achieving traceability ahead of target dates, and a "sustainable transition bond" linked to proving the cattle are not from recently deforested or protected areas, or areas subject to indigenous land rights.

However, the IDB loan to Marfrig never happened. It was dropped in late 2021 following a campaign against it by over 200 NGOs (Business & Human Rights Resource Centre 2021). The campaign included allegations that the loan would have exposed huge areas of threatened forest ecosystems to the threat of illegal logging, the lack of an effective tracking system for the entire supply chain and other loopholes, and Marfrig's poor environmental and social track record. However, another $30 million loan to Marfrig from the &Green Fund[16] initiative with similar aims was disbursed in 2021 (&Green 2022b).

[16] The goal of &Green, founded by IDH in the Netherlands, "is to finance the delinking of major commodity supply chains from deforestation in a way that is commercially viable and replicable. The Fund focuses on the tropical forests and peatlands most in need of protection and invests in the commodity sectors most active in those valuable ecosystems, i.e., beef (livestock), palm oil, soy, and forestry (including rubber)" (&Green 2022a).

The second example is a US$2.3 billion sustainability-linked loan to COFCO from a consortium of 20 banks, including some based in China, with the aim of sourcing sustainable soy from Brazil (Wragg 2019). This included interest deductions linked to achieving environmental, social, and governance targets. The loan's implementation has been criticized by Global Witness (2023) for its weak due diligence systems, limited oversight of indirect suppliers, and failure to spell out its obligations in the case of non-compliance, although COFCO (2024b) claims it is on course to achieve its objectives.

While these initial steps through the Tropical Forest Alliance Taskforce demonstrate promising momentum, particularly in the soy sector, they will need to be significantly scaled up to meaningfully reduce China's tropical deforestation footprint. The combination of China's political commitment to climate action, growing international pressure around deforestation-free supply chains, and increasing corporate awareness of reputational risks creates an opportunity for transformative change. However, converting these opportunities into concrete reductions in forest loss will require expanded participation from Chinese companies, stronger policy frameworks to support supply chain transparency, and innovative financing mechanisms that reward sustainable practices.

As major markets like the EU implement strict import regulations and enhance their prosecution capabilities through improved data analytics and AI, Chinese industries and policymakers may find it increasingly advantageous to proactively establish robust systems for ensuring and demonstrating sustainable sourcing. Success in this transition could position China as a leader in green commodity supply chains while significantly contributing to global climate and biodiversity goals.

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Annexes

Annex 1 Methodological Basis of Deforestation and Emissions' Estimates

The papers by Pendrill et al. (2019 and 2020) and Singh et al. (2024) quantified deforestation attributable to the international agricultural and forestry trade based on a land-balance model to attribute deforestation to the expansion of cropland, pastures, and forest plantations and the commodities produced on this land, and tracing these commodities to consumption by importing countries using physical and monetary trade models. More specifically, the analysis by Singh et al. (2024) used the "Deforestation Driver and Carbon Emission" (DeDuCE) model, which combined remote sensing data, agricultural statistics, and an extensive literature review of datasets on land use and land-use change.

This allowed calculation of the attribution of the embedded deforestation area (in ha/year) and associated net emissions from losses in above-ground, below-ground, and soil (including peat drainage) carbon (in tCO_2/year), by country of production, year, and commodity. It is important to note that this excluded forest loss that was not attributable to expanding pastures, cropland, or forest plantations (for example, deforestation and emissions where forest was cleared for timber without subsequent land-use expansion). Forest degradation emissions from logging in natural forests were also not included. The net carbon emission calculations factored in carbon sequestered by replacement land uses. Instances of net-negative deforestation emissions reflected situations where the carbon stock of the replacing land use (e.g., tree crops and plantation timber) exceeded gross carbon loss from forest clearing.

Calculation of the embedded emissions in agricultural and forest product imports by consumer countries used a multi-regional input-output (MRIO) framework called IOTA (Croft et al. 2018). This involved using national-level production and trade data from FAO and UN COMTRADE, and a global economic MRIO (EXIOBASE developed by Stadler et al. 2018) to link production and associated impacts to localized final consumption.

The model included not only the direct trade of deforestation-linked commodities, but also trade and consumption of products and services using these commodities as inputs. This allowed estimates of the consumption-based deforestation and carbon footprint of different countries.

Annex 2 Illegality Risk Levels of Agricultural Commodities

The following table presents estimated illegal deforestation risk levels in the production of commercial agricultural commodities in 2019, including by country of origin. It is reproduced from: Forest Trends. 2021. Illicit Harvest, Complicit Goods: The State of Illegal Deforestation for Agriculture. Washington, D.C.: Forest Trends. https://www.forest-trends.org/publications/illicit- harvest-complicit-goods/.

Commodity / Country	Exports (t) VARIABLE F (volume)	Percent Displacing Forest VARIABLE G	Exports Displacing Forest (t) VARIABLE F (volume) x VARIABLE G	Value of Exports (USS) VARIABLE F (value)	Value of Exports Displacing Forests (US$) VARIABLE F (value) x VARIABLE G	Risk of Illegality (%)
SOY						
Brazil	86,257,817	49%	42,266,330	$34,143,807,081	$16,730,465,470	95%
Argentina	36,406,078	9%	3,276,547	$15,399,779,750	$1,385,980,178	65%
Paraguay	6,846,205	57%	3,902,337	$2,517,960,954	$1,435,237,744	100%
Bolivia	2,096,546	52%	1,090,204	$906,761,607	$471,516,036	74%
Total			**50,535,418**		**$20,023,199,427**	
BEEF						
Brazil	1,466,721	36%	528,020	$6,829,752,742	$2,458,710,987	95%
Argentina	696,654	14%	97,532	$3,182,591,774	$445,562,848	65%
Paraguay	298,197	45%	134,189	$1,081,656,371	$486,745,367	24%
Mexico	269,805	38%	102,526	$1,504,715,721	$5,571,791,974	97%
Total			**862,266**		**$3,962,811,176**	
LEATHER						
Brazil	458,024	36%	164,889	$1,379,585,563	$496,650,803	95%
Argentina	130,302	14%	18,242	$701,997,552	$98,279,657	65%
Paraguay	38,443	45%	17,299	$68,405,882	$30,782,647	24%
Mexico	59,374	38%	22,562	$577,048,923	$219,278,591	97%
Total			**222,992**		**$844,991,698**	

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COCOA						
Ghana	880,684	13%	114,489	$2,400,471,201	$312,061,256	45%
Côte d'Ivoire	2,075,738	40%	830,295	$5,539,897,778	$2,215,959,111	100%
Total			**944,780**		**$2,528,020,367**	
PALM OIL						
Indonesia	31,949,015	38%	12,140,626	$16,235,334,628	$6,169,427,159	81%
Malaysia	17,289,965	68%	11,752,416	$9,547,187,841	$6,492,087,732	37%
Peru	84,700	44%	37,268	$53,917,344	$23,723,631	51%
Total			**23,930,310**			
PULP						
Indonesia	5,609,279	100%	5,609,279	$3,474,161,516	$3,474,161,516	68%
Malaysia	41,739	14%	5,843	$70,665,651	$9,893,191	37%
Total			**5,615,122**		**$3,484,054,707**	
PAPER						
Indonesia	5,459,420	100%	5,459,420	$4,799,339,658	$4,799,339,658	68%
Total			**5,459,420**		**$4,799,339,658**	
RUBBER						
Cambodia	171,814	100%	171,814	$204,463,624	$204,463,624	16%
Laos	273,109	17%	46,429	$382,922,271	$65,096,786	49%
Vietnam	754	63%	474,939	$1,072,663,372	$675,777,924	37%
Malaysia	721,114	66%	475,935	$1,100,039,911	$726,026,341	37%
Indonesia	2,547,109	26%	662,248	$4,055,599,339	$1,054,455,828	47%
DRC	1,458	15%	219	$1,879,879	$281,982	99%
Total	**4,468,475**		**1,831,584**		**$2,726,102,486**	
COFFEE						
Côte d'Ivoire	45,465	13%	5,910	$73,811,041	$9,595,435	26%
Vietnam	14,220,377	15%	213,357	$2,456,928,976	$368,539,346	37%
Honduras	368,957	29%	106,998	$1,031,639,781	$299,175,536	74%

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Total			**326,265**		**$677,310,318**	
			MAIZE			
Argentina	29,335,760	52%	15,254,595	$6,128,813,587	$3,186,983,065	65%
Total			**15,254,595**		**$3,186,983,065**	
GRAND TOTAL			**104,982,756**		**$54,918,051,424**	

FOREST TRENDS

Forest Trends works to conserve forests and other ecosystems through the creation and wide adoption of a broad range of environmental finance, markets and other payment and incentive mechanisms. This report was released by Forest Trends' Forest Policy, Trade, and Finance program, which seeks to create markets for legal forest products while supporting parallel transformations away from timber and other commodities sourced illegally and unsustainably from forest areas.

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