POLICY FORUM

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AGRICULTURE AND ENVIRONMENT

The rotten apples of Brazil's agribusiness

Brazil's inability to tackle illegal deforestation puts the future of its agribusiness at risk

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In the increasingly polarized international political arena, it has become difficult to find common ground to solve Brazil's ongoing environmental crisis, which has global as well as local implications. International buyers of Brazil's agricultural commodities have raised concerns about products that are contaminated by deforestation (i.e., deforestation occurred during the process of producing the product) (text S12). European Union (EU) criticism of the Brazilian government bolsters demands to boycott Brazilian products and to withhold ratification of the trade agreement reached in 2019 between the EU and Mercosur, the South American trade bloc. Among the concerns is that increasing greenhouse gas (GHG) emissions from deforestation and forest fires in Brazil could cancel out EU climate change mitigation efforts. The Brazilian government and agribusiness contend that national laws ensure high conservation standards, and hence trading bans should not include legally authorized deforestation (*1*). Here, we address the interlinkage between illegal deforestation in the Amazon and Cerrado—the largest Brazilian biomes with the highest rates of deforestation—and EU imports of Brazil's soy and beef, the country's major agricultural commodities (table S9). Although most of Brazil's agricultural output is deforestation-free, we find that 2% of properties in the Amazon and Cerrado are responsible for 62% of all potentially illegal deforestation and that roughly 20% of soy exports and at least 17% of beef exports from both biomes to the EU may be contaminated with illegal deforestation. Raising awareness is important to press Brazil to conserve its environmental assets and to promote international political will for cutting telecoupled GHG emissions. This could be achieved, for example, through the environmental safeguards of the Mercosur-EU trade agreement, which require EU imports to comply with the export country's legislation.

Our study goes beyond previous assessments of soy and beef supply chain traceability and zero-deforestation commitments

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Cattle walk near an illegally burnt deforested area in the northern Brazilian state of Para. Beef exports contaminated by illegal deforestation are a key concern among some Brazilian trade partners.

(*2*–*5*), because we explicitly link illegal deforestation on individual rural properties to their agricultural production and exports to EU countries (text S12). To do so, we compiled a comprehensive set of land-use and deforestation maps for Brazil; information on 815 thousand rural properties' boundaries from the Cadastro Ambiental Rural (CAR), the country's online environmental registry (*6*); TRASE (Transparency for Sustainable Economies) data; and GTA documents (cattle transport permits) that are issued when animals are traded between properties and to slaughterhouses (table S1). We also developed software to deal with the geospatial data challenge of calculating the level of law compliance for each individual property, so as to differentiate between its potentially legal and illegal deforestation alongside its production of cattle and soy (texts S3 to S7 and figs. S4, S6, and S7).

ENVIRONMENTAL COMPLIANCE AND ILLEGALITY

Many countries have national or regional environmental regulation to protect riparian forests, in addition to local zoning laws that limit deforestation and the expansion of agricultural and urban areas. What makes Brazil stand apart is its property-level Forest Code (FC) and national CAR registry system, designed to monitor environmental compliance of its rural properties (*6*) (fig. S3). Brazil's FC regulates conservation on rural private properties (*1*), establishing areas of permanent protection (APPs) along water streams and on hilltops as well as legal reserves (native vegetation in a section of the property) (text S4). These legal reserves range from 20% of the property in most of the country (including parts of the Cerrado) to 80% in the Amazon rainforest, the latter in recognition of its environmental importance and economic potential for forest products (*7*).

Of our CAR sample, roughly 162 thousand of 362 thousand properties (45%) in the Amazon, and 217 thousand of 452 thousand properties (48%) in the Cerrado, are noncompliant with the FC for deforesting APPs or failing to conserve their minimum legal-reserve areas up until 2008—the deadline year for granting amnesty to eligible past deforesters (text S4 and figs. S8 to S13). Although these noncompliance figures do not yet equate to illegality, they do entail the obligation to start a program of environmental regularization by 2020, whereby landowners must submit and follow a self-designed plan to attain FC compliance over a period of 20 years (*8*).

A more pressing issue is illegal deforestation. Roughly 120 ± 26 thousand properties (15% of our sample) in both biomes were deforested after 2008 (*1*). About 36 thousand of these properties in the Amazon (84%) and 27 thousand in the Cerrado (35%) carried out this deforestation, in all likelihood illegally (figs. S12 and S13), because these properties had no forest surplus (i.e., vegetation above legal-reserve conservation requirements) to be eligible for a deforestation permit (see the figure) (text S5).

A substantial share of this potentially illegal deforestation is linked to agricultural export commodities. Of 53 thousand properties growing soy in both biomes, 20% were deforested after 2008, about half of them in a potentially illegal way (text S7, figs. S15 to S17, and table S6). In the Cerrado, we find 9.3 ± 1.2 thousand properties with deforestation after 2008 (43% with potentially illegal deforestation). In the Amazon, 1.5 ± 0.3 thousand properties were deforested since 2008, 91% of which were potentially illegal, despite the soy moratorium that prevents the trading of soy grown on deforested lands in this biome (*5*). Although only 1% of newly deforested areas are being cropped with soy in the Amazon biome, in contrast to 5% in the Cerrado (table S7), even farmers complying with the soy moratorium are clearing the forest for pasture or other crops within their holdings, and hence are still profiting from deforestation.

Despite uncertainties related to mapping and geospatial data modeling (texts S5 to S7 and S11), this represents an area of about 3.7 Mha of soy out of 17.2 Mha planted within the CAR properties during the 2016–2017 season (text S7 and figs. S14 and S15). This figure, tantamount to a harvest of 11.3 ± 1.1 million metric tons (text S7 and table S6), represents a very high level of soy potentially contaminated with illegal deforestation, including sizable volumes to the EU. Roughly 41% of EU's soy imports come from Brazil: 13.6 million metric tons per year, of which 69% come from this region (table S8). Although it is not possible to trace back soy imports to individual properties, we calculate by using municipality export shares that a total of 1.9 ± 0.2 million metric tons of soy grown on properties with illegal deforestation may have reached EU markets annually during the period of analysis (table S1), of which 0.5 million metric tons came from the Amazon (text S7, table S11, and fig. S21). In sum, 18 to 22% of all soy exported from the region to the EU is potentially contaminated. Yet the level of contamination may exceed the upper bound of 22%, given that our CAR sample covers only 80% of soy planted in the region (text S11).

With respect to beef, Brazil provides between 25% and 40% of EU beef imports (table S15). By matching GTAs issued in the states of Pará and Mato Grosso in 2017 with CAR data, we identify the origin of 4.1 million heads traded to slaughterhouses. Of this total, we estimate that 12 ± 2% (0.5 ± 0.1 million heads) come directly from properties with potentially illegal deforestation (table S13). In addition, 48 ± 10% of all slaughtered heads may be contaminated with potentially illegal deforestation from indirect suppliers, as the cattle pass from one property to another before being slaughtered (text S7, fig. S25, and table S13). Although beef exports from Pará are negligible, Mato Grosso state is the third largest Brazilian source of EU imports (fig. S30). By tracing cattle between properties and slaughterhouses, and tracing beef exports from the latter to EU countries, we estimate that of 17.7 ± 1.2 thousand metric tons of beef exported from Mato Grosso and Pará in 2017, about 46 ± 7% may have been contaminated with potentially illegal deforestation, including both direct and indirect suppliers (text S7 and figs. S24 to S26).

GHG EMISSIONS, AND A WAY FORWARD

China and the EU, Brazil's major agricultural product trade partners, acquired 29% and 19% of the country's agricultural exports,

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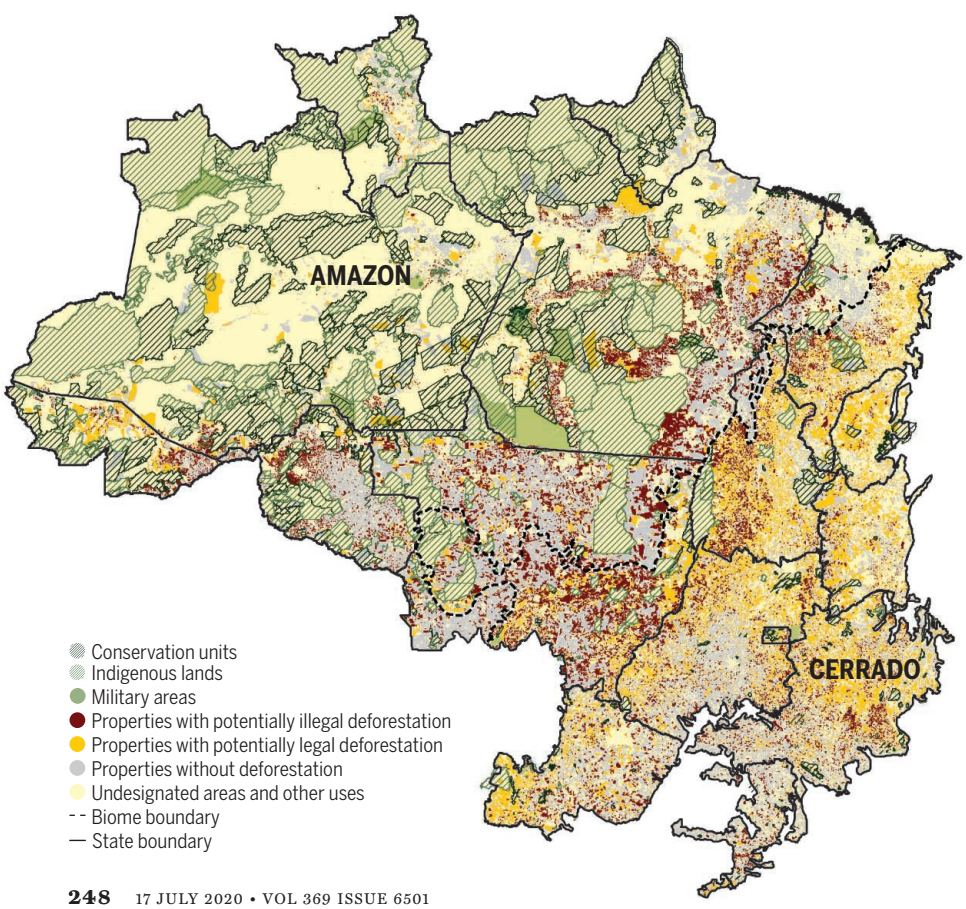
respectively, over the past 5 years (fig. S2) (*9*). All economic partners of Brazil should share the blame for indirectly promoting deforestation and GHG emissions by not barring imports and consuming agricultural products contaminated with deforestation, illegal or not. We calculate by superimposing a biomass map on deforestation maps (text S8) that EU soy imports alone could be responsible for the indirect emission of 58.3 ± 11.7 million metric tons of CO_2 equivalent ($MtCO_2e$) from both legal and illegal deforestation in the major Brazilian biomes between 2009 and 2017 (table S16), taking into account municipalities' export shares. Yet the EU share is likely to increase as a result of the Mercosur-EU and U.S.-China trade agreements. If implemented, these agreements will increase EU demand for Brazilian products (text S2) because of lower tariffs and to fill in the gap as U.S. exports to the EU could be redirected to China.

Most of Brazil's agricultural properties are deforestation-free. Of our CAR sample, 15% of properties were deforested after 2008, half of them potentially illegally. However, only 2% (17,557) of all properties in both biomes are responsible for 62% of all potentially illegal deforestation (text S10 and table S18). This small but very destructive portion of the sector poses a threat to the economic prospects of Brazil's agribusiness, in addition to causing regional and global environmental consequences. It is not enough to claim to be the world's most sustainable agriculture while a share of the sector fails to comply with the country's own environmental laws and supports the government's undoing of past environmental achievements (text S1). Instead, the government and agribusiness should take concrete steps to achieve countrywide environmental compliance. This is economically viable, given that about 4.1 Mha of legal-reserve debts in soy farms could be compensated by purchasing forest certificates from landowners with FC surplus (*10*). Additionally, the required restoration of 0.6 Mha of all riparian APPs together with 4.3 Mha of legal reserves on low-yield pasturelands in both biomes would remove 1.4 ± 0.3 $GtCO_2e$ (text S9, fig. S28, and table S17). This will greatly benefit agribusiness because its productivity depends on the rainfall regulated by the vast forests and other native vegetation (*7*) that still cover 60% of the Brazilian territory (*1*).

In the EU, public and private initiatives are building up to ensure agricultural imports free of tropical deforestation (*11*), and soon Chinese companies may follow suit (*12*). Yet so far there is a strong emphasis on private certification schemes that are costly, lack transparency, and encompass only specific farms and hence a small part of the sector. Here, we demonstrate that thanks to Brazil's already existing CAR registry (*6*), mapping and monitoring programs (*13*), and animal tracking system (GTA), it is possible to implement a national and public monitoring system that enforces environmental compliance at the property level to substantially reduce deforestation in the country's major agricultural supply chains. Brazil certainly has all the elements to feed the world with a responsible agricultural sector that tackles climate change and protects some of the world's most biodiverse regions. But to achieve this goal, the country and its international partners must acknowledge their shared environmental responsibilities as a main step to seek common solutions. ■

Linking rural property deforestation to agriculture and exports

Though most of Brazil's agricultural output is deforestation-free, 2% of properties are responsible for 62% of all potentially illegal deforestation. Roughly 20% of soy and at least 17% of beef exports from both biomes to the EU may be contaminated with illegal deforestation.



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