

COMMENT

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MARZILDA CRUPPE/GREENPEACE



Fields of soya beans (left) sit alongside untouched natural forest in the Cerrado ecoregion of Brazil.

US–China trade war imperils Amazon rainforest

An analysis of global soya-bean production forecasts massive deforestation in Brazil — stakeholders must act fast to prevent it, warn **Richard Fuchs** and colleagues.

Last year, the United States introduced tariffs of up to 25% on Chinese imported goods worth US\$250 billion. In retaliation, the Chinese government imposed tariffs of 25% on \$110-billion worth of US goods — including soya beans, a crop mainly used for animal feed. As a result, exports of US soya

beans to China dropped by 50% in 2018, even though the trade war began only midway through the year.

We forecast that a surge of tropical deforestation could occur as a result of the fresh demand being placed on China's other major suppliers to provide up to 37.6 million tonnes of the crop (that is how much

China imported from the United States in 2016). Already, two decades of growth in the global market for soya has led to large-scale deforestation in the Amazon rainforest¹.

As of 2016, Brazil supplied almost half of China's soya-bean imports, and it has the infrastructure and land area to rapidly ▶

► increase production. We estimate that the area dedicated to soya-bean production in Brazil could increase by up to 39%, to 13 million hectares, extrapolating from the most recent (2016) data from the Food and Agriculture Organization of the United Nations (FAO). For comparison, almost 3 million hectares of rainforest were cleared in 1995 and in 2004, the country's two peak deforestation years (see go.nature.com/2xtkkrd).

We urge the United States and China to adjust their trading arrangements immediately to avoid this catastrophe. We also lay out some of the broader changes needed — globally and within nations — to shield tropical forests from shifting trade patterns.

BEAN COUNTING

China depends heavily on soya-bean imports from three trading partners. Brazil is the largest, followed by the United States and Argentina². Ninety-four other countries, including China itself, together produce little more soya than Brazil alone (see 'Soya swings', panel B; and Supplementary Information).

To cope with the current shortfall in US exports, China could reduce its use of soya bean. This seems unlikely given the nation's growing demand for meat. Just a 2% reduction in soya as animal feed would result in the country producing 10 million tonnes less meat each year³.

China could increase its own production of soya beans. But it would have to triple it to make up the shortfall. That would require around 13 million hectares of land — an area the size of Greece. This also seems unlikely given the limited fertile land now available for crops.

Some reconfiguration of trade flows might absorb some of the shortfall, as could efforts to substitute other crops into animal feed, such as rapeseed and maize (corn). Last year, Argentina and the European Union started buying soya from the United States for livestock feed and biofuel⁴. This could make soya beans produced by Argentina, or rapeseed produced by the European Union, available for export to China.

But it is unclear whether China will engage in trade deals that would ultimately benefit the United States. Also, globally, soya is the preferred choice for animal feed: it contains both protein and fat, and the crop fixes nitrogen, reducing the need for fertilizer (see 'Uses of Brazilian soya'). Lastly, the contributions made by small producers are tiny compared with what's needed — even accounting for possible increases in production. Russia's plan to boost its production by 20% over the next few years³, for instance, would result in future exports of only 0.7 million tonnes.

In our view, the most likely scenario is that Brazil will ramp up its production substantially, and a few other major producers will supply whatever else is needed.

Political, legal and trade-system interventions that have prevented the expansion of soya-bean production in the Amazon⁵ are now being weakened¹. For instance, Brazil's newly elected president, Jair Bolsonaro, limited the land rights of Indigenous people this January (see go.nature.com/2y9rjvn). Indeed, deforestation increased by 29% between 2015 and 2016 (see go.nature.com/2xtkkrd), and jumped by 50% between August and October 2018, during the Brazilian presidential election campaign (see go.nature.com/2uyrjpt).

Also, trade wars have resulted in hikes in soya-bean production in Brazil in the past. Following a 1980 US embargo on soya-bean exports to the Soviet Union, the amount of land devoted to its production in Brazil more than doubled between 1990 and 2010, to 24.2 million hectares. This pushed cattle farming from the southern Cerrado savannah into the Amazon, and caused nearly one-quarter of the total annual deforestation of the Amazon in some years¹.

“Trade wars have resulted in hikes in soya-bean production in Brazil in the past.”

SOYA SCENARIOS

To get a rough estimate of how global soya-bean production might change under different trade scenarios, we analysed the 2016 data from the FAO database FAOSTAT. This includes 94 nations' total land area dedicated to soya, each country's yield rates and their overall production for the year (see Supplementary Information for methods). It also includes trade data — who exported to China, how much, and so on.

Assuming there is no change in total global demand, an extra 22.6 million to 37.6 million tonnes of soya-bean production

in Brazil would satisfy China's needs (see 'Soya swings', panel A).

If all 94 countries help to make up the shortfall, with their percentage contributions staying at current levels, Brazil would need to supply as much as 16.7 million extra tonnes of soya beans. This would require up to 5.7 million hectares more land (a 17.3% increase). Under this scenario, Argentina would then supply an additional 6.1 million to 10.2 million tonnes (requiring 2.0 million to 3.3 million hectares of land at current yields), with all the other producers (excluding China) together producing around the same amount as Argentina.

These figures do not account for the potential cultivation of soya beans on land that is now used for other protein and oil crops, such as maize, palm oil and rapeseed. But the substitution of one crop for another has technical and political limits. In Brazil, for example, soya beans, sugar cane and maize represent around 85% of total crop production, and all three are crucial to the nation's economy. (Sugar cane is used to produce the biofuel ethanol, which gives Brazil independence from the global oil market, and maize is used as livestock fodder.) It is possible to import palm oil from Malaysia or Indonesia, say, but this would cause deforestation in those countries.

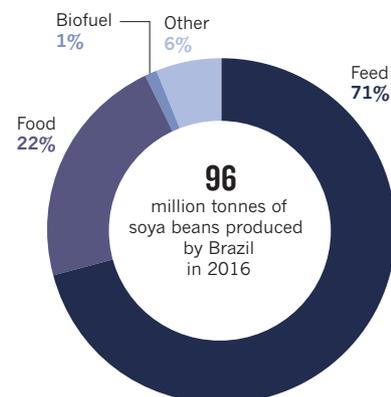
The requirements for land could be reduced a little if producers were to increase their yields. The leading soya-bean producers (Brazil, Argentina, Canada and Russia) currently achieve average yields of 1.5–3 tonnes of soya bean per hectare, compared with a US yield of 3.5 tonnes. The United States adds around 62 kilograms of fertilizer per hectare, Canada 60 kg and Brazil 169 kg on nutrient-poor tropical soils. Only Russia (26 kg of fertilizer per hectare) and Argentina (14 kg) could produce more crops per land area by using more fertilizer⁶.

In fact, our figures might well be underestimates. They do not account for hikes in demand that are unrelated to the trade war. In the past two decades, China's use of soya has risen exponentially; since 2000, the country's imports have gone up by 200% from Argentina, by 700% from the United States and by 2,000% from Brazil (see 'Soya swings', panel B). It is highly likely that China's enormous appetite for livestock feed and bioenergy will continue to grow.

A LOSING BATTLE

China will probably want to reduce its dependence on the United States, even if US President Donald Trump decides to abolish the tariffs on its imports. (These are currently being heavily negotiated.) For instance, the Soviet Union did not go back to buying US soya beans when the 1980 embargo was withdrawn only a year later, seeing them as unnecessary and unreliable⁷. Thus, even under the most optimistic scenarios, millions

USES OF BRAZILIAN SOYA
Globally, most of the crop is fed to animals.



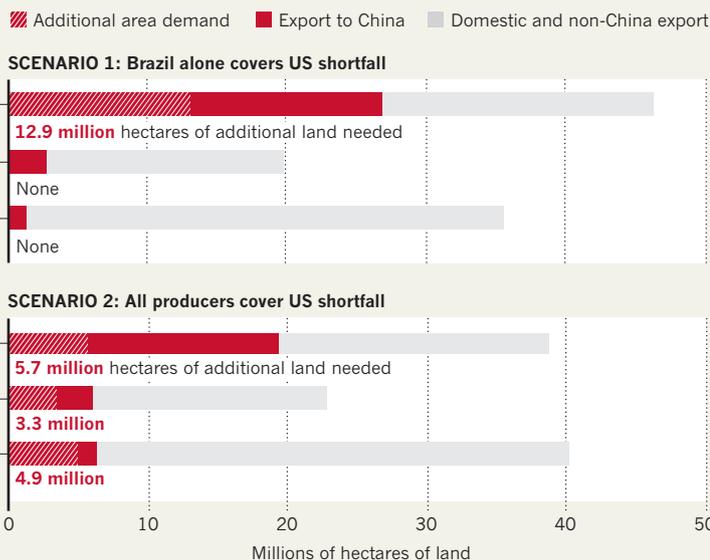
SOURCE: FAOSTAT/R. FUCHS ET AL.

SOYA SWINGS

Trade wars have caused massive deforestation in the Amazon in the past. The same is likely to happen now, if China continues to import more soya beans from Brazil (A) instead of from the United States (B).

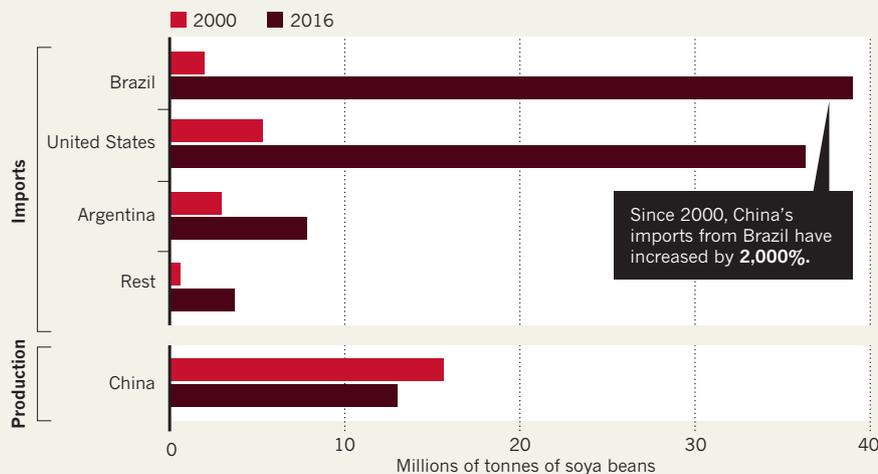
A) SHIFTING PRODUCERS

The US–China trade war could change global production, and shift global land use.



B) SOYA IN CHINA

Demand for soya has increased exponentially over the past two decades in China; domestic production has decreased by 17%.



more hectares of the Amazon rainforest are now threatened. Indeed, the expansion of soya-bean production in areas other than the Amazon, such as in Brazil's Cerrado tropical savannah, will lead to further loss of tropical forest, for example through the displacement of pasturelands⁸.

Leaving aside these potential major changes, current rates of tropical deforestation are projected to release between 87 and 130 gigatonnes of carbon by 2100, and land conversion in general is expected to release more carbon in the tropics than in any other biome this century^{9,10}. Likewise, species extinctions in tropical forests are already expected to increase until the 2050s, with as many as 19 of every 20 species lost being unknown to science¹¹.

Massive deforestation of the Amazon over what's already happening will have profound impacts on global attempts to mitigate climate change and protect biodiversity.

So how can such devastating environmental outcomes from this or future trade wars be avoided?

Remove soya from tariffs. First and foremost, China and the United States should publicly acknowledge their roles in indirectly driving tropical deforestation, and take immediate action to at least remove trade tariffs on the crop.

Diversify suppliers. China should also seek a wider range of suppliers. Even the

European Union could be a candidate, although to compete with major producers such as the United States, it would have to reconsider its opposition to genetically modified soya-bean strains that are tolerant to pesticides such as glyphosate.

Improve Brazil's environmental protection schemes. The international community must do more to encourage the Brazilian government to enhance environmental protections. Initiatives such as REDD+, which aims to reward developers and others financially for not clearing forests, provide mechanisms for coordinated action.

Regulatory interventions designed to control the drivers of environmental degradation — or to limit its extent — are also needed. Such interventions are inevitably controversial and contingent on volatile political circumstances, but precedents exist. For example, the European Commission's 1991 Nitrates Directive has led to a 22% decline in the use of fertilizer across Europe since 1990 (ref. 2). It forms part of another instrument, the Water Framework Directive, which has reduced nitrogen concentrations in rivers by 21%, ammonium by 75% and phosphorus by 59% since 1992.

Most pertinently, Brazil's Soy Moratorium, in which major traders agreed not to buy soya grown on lands deforested after July 2006, has helped to reduce the conversion of forest to cropland¹². This was a partial success owing to the various monitoring systems that were deployed to enforce it, such as police helicopters to track illegal logging. That achievement is now threatened, given the rise in rogue logging, indirect land-use changes and political machinations under Bolsonaro's presidency.

Grow locally. Ultimately, growing crops in the countries where they will actually be consumed would give nations better control of production levels and environmental impacts, as well as more economic security.

As part of the mix of solutions, it would help if both China and the European Union intensified their efforts to produce protein crops. This would mean investing more in research and development, as well as in training farmers. Since the early 2000s, China has decreased the amount of land it dedicates to soya-bean production by around 25%, in part because it is cheaper to import from Brazil. The country's five-year average yields are now half of those in Brazil or the United States² (see 'Soya swings').

Change consumer behaviour. Over the next few decades, the long-term solution has to involve the global reduction of meat consumption.



Animal feed made from soya beans is unloaded in Nantong, China.

One thing that might help is the growing awareness among consumers globally that eating less meat, or buying meat that is sustainably produced, benefits the environment. So far, such awareness has had little impact on production or consumption. A major supermarket chain in Germany reported in June 2018 that, despite consumer surveys indicating demand for sustainable meat products, its customers continued to select the less-sustainable options because they are cheaper.

Educational measures to change consumer behaviours, such as the use of food labelling or 'eco-certification', or information campaigns involving schools, are relatively easy to introduce. But making such measures a legal requirement, and actually changing behaviour, would take too long to lift the current pressures on tropical forests¹³.

Subsidies and taxes that favour sustainable forms of production tend to be effective. But these can require considerable up-front investment from governments. Even then, such market-based policies are often insufficient to avert severe environmental degradation¹⁴.

In our view, what could be most effective are mechanisms that include the environmental costs of agricultural production in the price of the product. Making these costs unavoidable (rather than relying on consumer choice) could be a robust way of stemming the loss of crucial natural systems. Obviously, proper valuation of environmental costs would have to occur alongside vigorous efforts to reduce those,

to ensure that such a strategy does not threaten food security.

WARNING SIGNS

Early signs in the current US–China trade war are not encouraging. Brazil has already begun to strengthen its negotiating position

“Brazil has already begun to strengthen its negotiating position by boosting its production.”

by boosting its production. As of late 2018, 75% of China's soya-bean imports came from Brazil — a new record — meaning the entire US shortfall was substituted

with Brazilian soya beans (see go.nature.com/2hizafd).

And traders have made their bets. The MSCI Brazil index, which lists the country's 52 largest companies, has risen by roughly 35% since October 2018 (when Bolsonaro was elected and Trump introduced the latest tariffs on Chinese imports). This represents the largest increase of all regional markets at present (see go.nature.com/2cstcwj).

Governments, producers, regulators and consumers must act now. If they don't, the Amazon rainforest could become the greatest casualty of the US–China trade war. ■

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Supplementary information accompanies this article: see go.nature.com/2tjkaeh

CLARIFICATION

In the Comment 'Four steps to global management of space traffic' (*Nature* **567**, 25–27; 2019), the graphic 'Traffic jam' originally implied that all 12,000 SpaceX satellites will orbit at 1,325 km; in fact, around 7,500 of them will fly at very low Earth orbit (340 km).