Why the US–China trade war spells disaster for the Amazon

Citation for published version:
Fuchs, R, Alexander, P, Brown, C, Cossar, F, Henry, R & Rounsevell, M 2019, 'Why the US–China trade war spells disaster for the Amazon', Nature. https://doi.org/10.1038/d41586-019-00896-2

Digital Object Identifier (DOI):
10.1038/d41586-019-00896-2

Link:
Link to publication record in Edinburgh Research Explorer

Document Version:
Peer reviewed version

Published In:
Nature

US-China trade war imperils Amazon rainforests

Introductory paragraph (referenced) (200 words)

During 2018, the United States introduced tariffs on goods from China worth US$250 billion, initiating a 'trade war' between the two countries. In retaliation, the Chinese imposed tariffs of 25% on US goods worth US$110 billion, including almost all of the soybean exports from the United States to China. As a direct result, soybean exports dropped in November 2018 by 96% from their level of one year previously[1,2].
Trade wars have global consequences, since soybean production in other countries will now supply the shortfall in China's imports. Brazil already supplies 66% of Chinese soy imports and has the infrastructure and potential land area to rapidly increase production. Few other countries are in this position. Historically, increases in global soybean demand have caused agricultural expansion within the Brazilian Amazon, consequently leading to large-scale deforestation. Hence, the current US-China trade war puts tropical forests directly in the firing line.

China is heavily dependent on soybean imports from a small number of trading partners. Brazil is the largest supplier, followed by the US and Argentina. Ninety further countries, including China itself, produce little more than Argentina all together, and only a small number maintain a soybean trading relationship with China (Table 1). For China to make up the shortfall in US soy exports domestically, it would have to triple its soybean production (to cover an area of approximately 13Mha) to the detriment of other food producing land uses.

Some smaller producers have signalled their intention to increase soybean production: Russia, for instance, plans a 20% increase to produce 0.7Mt[3]. However, even these production increases are tiny compared with the total shortfall. More significantly, Argentina and the EU have recently been buying cheap soybean from the US to be used for domestic livestock feed[1,4], potentially freeing domestic soybean (Argentina) or rapeseed (EU) production for export to China (if China allows this indirect circumvention of their tariffs). The Chinese Government has also proposed to reduce the soybean component of livestock fodder, but soy is so dominant that even a 2% reduction would lead to a 10Mt drop in meat production[3]. Chinese soy reserves could replace some imports in the short-term, but the size of these reserves, while unknown, is probably only between 6 and 8Mt[3].

Brazil, in contrast, is poised to increase soy production very rapidly. Recent constraints, in the form of political, legal and trade-system interventions that prevented soy expansion into the Amazon[5,6], are now being weakened[6–9], with the result that deforestation increased by 29% between 2015 and 2016 and a further 50% during the recent Brazilian presidential election campaign[10,11]. Large increases in soy production are likely to lead to considerable further forest loss through both direct expansion into the Amazon and indirect displacement of livestock farming. Indeed, a clear precedent exists in the form of the 1980 US embargo on soybean exports to the Soviet Union, which resulted in Brazil massively increasing soy production to replace the US exports[12,13]. Soy cultivation in Brazil grew from 9.7Mha in 1990 to 24.2Mha in 2010, causing nearly a quarter of the total Amazon deforestation in some years and additionally pushing cattle farming from the southern Cerrado savanna into the Amazon[14,9]. Even though the embargo was withdrawn only one year later, the Soviet Union did not resume imports from the US, having come to regard them as unnecessary and unreliable[12,13].

Commented [AP1]: How much did US exports to all countries drop? I suspect not as much. Which countries saw a rise and by how much?

Commented [BC2]: by 96% from their level of the year before?

Commented [FR3R2]: No, ago (if my grammar is correct). I meant November 2017 and not the whole year of 2017.

Commented [AP4]: 'May'? There are other alternatives, that seem likely to at least reduce this outcome to some extent.

Commented [RM5]: We need to check this (critical) point, since I think that much of the expansion has been in the Savannahs/grassland. This of course might also have led to displacement of other land uses into the tropical forests. But we need to be precise with this point. A reference would be useful here to support the statement.

Commented [RM6]: Just using the same wording a the title (useful to reiterate this)

Commented [BC7]: Just to check as I've become mixed-up: is this ranking correct? The US isn't a bigger supplier?

Commented [FR8R7]: No Brazil is. They overtook the US a couple of years ago.

Commented [RM9R7]: Add a reference here? Even if it's to the FAO database.

Commented [AP10]: There is the potential for China (and other countries) to adapt to the change in tariff that does not seem to be addressed here. That is, to reduce the amount of soy used and substitute for other products. If soy imported to China becomes more expensive then there would be expected to be some substitution to other commodities (maize or other oilcrops, perhaps). The same applies to imports in other countries, if global import prices rise to this shortfall in exports. It is going to be one of the first things an economist reviewer will consider, I think.

Commented [RM11]: Is this the increase in production or the total production? Qualify by either writing 'in production of 0.7', or 'in production to 0.7'

Commented [AP12]: Importing and exporting the US Soy to China indirectly might not be allowed. However, one would expect some reconfiguration of international trade flows. That is, for the US to now export more to Europe and other non-China importer, and from existing exports (Brazil and Argentina) to having the opposite switch. Given the levels of Chinese imports from the US, this might still leave a shortfall.

Quick look at FAO 2013 data…
Rest of world imports: 36.5Mt
US exports: 39.2 Mt

So, this type of reconfiguration in the global market (without cheating indirect imports), would just leave a 3Mt shortfall ...

Commented [RM13]: OK, this was my point above, and I like the way it's discussed here. Perhaps just nuance the bolded text a bit?

Will such a scenario happen again? In the present case, there are a number of ways in which US exports to China could be replaced. In principle, the entire shortfall could be met by increased production in Brazil, although it is more likely that a few major producers will share the extra production. In either case, the level of remaining trade between the US and China (currently 4% of its initial value[1]) would determine the magnitude of consequent land use changes, as would the level of demand in China and globally. The geographical extent of these changes further depends upon the soy yields that are achievable under different price and trade conditions (Figure 1, Table 1).

Commented [RM14]: I don't really understand this point.

In spite of these uncertainties, it is possible to calculate a potential range of the increase in Brazilian soybean production. Assuming no change in total global demand, an extra 22.6-37.6Mt of Brazilian soybean production would satisfy China's demand (Figure1/Table1). Under current Brazilian soybean yields, this would require an additional area of 7.8 - 13.0Mha, an increase of 23.5% to 39.1%. At most, this is just over 4-years' worth of the 3Mha/yr of deforestation seen in the peak deforestation years of 1995 and 2004[10]). Alternatively, a proportional sharing of production between countries would reduce the extra Brazilian contribution to 10.0-16.7Mt, giving an additional area requirement of 3.4-5.7Mha (an increase of 10.4% to 17.3%) (Figure1/Table1). Argentina would then supply an additional 6.1-10.2Mt (2.0-3.3Mha at current yields), with other producers, excluding China, producing somewhat less than this amount (Figure1/Table1). While these figures are large, they do not account for increases in demand unrelated to tariffs that would increase production further. They also do not account for the potential substitution of soybean by other protein and oil crops elsewhere in the world, which would have the effect of limiting the soybean production increases. Chinese soybean demand has increased exponentially in recent years, with imports increasing since 2000 by 200% from Argentina, 700% from the US and 2,000% from Brazil. It is almost inevitable that further rapid rises will occur, largely driven by demand for livestock feed and bioenergy. This implies that increases in demand might well outstrip the potential effects of substitution meaning that the production changes presented here are relatively conservative.

Commented [AP15]: This is the point I was making above, but is still a concern.

Commented [AP16]: Don't find that statement sufficiently supported? Greater evidence seems needed to support this strongly worded claim.

The impacts of these rises could be ameliorated by yield increases (through intensification), but the potential for this is not great. The top soybean producers in the world currently achieve yields of 1.5-3t/ha (Brazil: 2.9t/ha; Argentina: 3.0t/ha; Canada: 2.7t/ha; Russian Federation: 1.5t/ha), compared to the United States' 3.5t/ha. This suggests some potential for intensification rather than area expansion, but simple intensification options such as increasing nutrient supplies through fertilizers (e.g. synthetic nitrogen, potassium and phosphorus fertilizers) have already been widely deployed. While the US currently applies fertilisers to soybean at an average rate of 62kg/ha, Canada uses 60kg/ha and Brazil 169kg/ha, on nutrient-poor tropical soils. Only Russia (26kg/ha) and Argentina (14kg/ha) have clear potential for intensification. If yield increases continued at historical rates, Brazil would need around 10 years to achieve even the lowest estimate of extra production presented above without area expansion (Table 1). The substitution of other crops could also reduce the need for extra production, but technical and political issues limited this option. In Brazil's case, soybean, sugarcane and maize represent ca. 85% of total crop production, with sugarcane providing independence from the global oil market, and maize used for livestock fodder. Substitution with palm oil from Malaysia or Indonesia is possible, but this would also cause tropical deforestation in those countries[15–17].

Should tariffs remain in place, therefore, even the most optimistic scenarios imply massive additional tropical deforestation in Brazil as well as West Africa and South-East Asia. This will have profound impacts on global attempts to mitigate climate change and to protect biological diversity. For instance, Brazil's contribution to the Paris Agreement promises forest-based mitigation amounting to half of the global total, making it essential to efforts to limit average global temperature increases to 1.5°C[18].

Commented [RM17]: This sort of appears form nowhere, since west Africa hasn't been discussed at all until now. Perhaps mention it earlier in the text, e.g. when talking about

Commented [RM18]: Does this relate to the palm oil discussion above? If yes, then state the countries involved.

However, even current rates of tropical deforestation are projected to release between 87 and 130Gt of carbon by 2100, and land use change is expected to increase more in the tropics than in any other biome this century[18,19 20,21]. Similarly, species extinctions in tropical forests are already projected to increase until the mid-21st century, with as many as 19 of every 20 species lost being unknown to science[22,23]. Where soy expansion occurs in other areas (e.g. Brazil's Cerrado tropical savannah, an invaluable ecosystem in its own right), displacement effects will lead to further tropical forest loss[14].

Whatever the outcome of the current 'trade-war', it has become clear that tropical forests, some of the most important ecosystems in the world, remain highly vulnerable to disruptions in international trade. The lack of tangible financial benefits arising from these large forests has consistently put them at a disadvantage compared with smaller, more intensively-utilised areas, the conversion of which would have numerous complex implications for human activities. The status of tropical forests as expansion zones for agriculture has been confirmed repeatedly, with legal interventions proving too weak or temporary to protect them. Even if the trade war comes to an end, the damage to tropical forests will already have been done, since they cannot be reinstated.

Commented [RM19]: Not sure that I really follow the point here.

The US-China trade war highlights the need for better protection of tropical forests to conserve their unique contributions to the global climate system, biodiversity and human wellbeing. Protection needs to be robust to the inevitable political and economic 'shocks' that have caused so much deforestation in the past, and to neutralise the corrosive effects of international agricultural trade that does not account for environmental damage. Without protection, the increasing scale and volatility of international agricultural trade, combined with the massive increase in the consumption of livestock products, will single-handedly undermine attempts to locate a safe operating space for humanity.

Commented [BC20]: I've written this in a rush and it's not good at all. But I think we have ~250 words left at this point to be more forward-looking, emphasise the risks and make proposals (if we have any). Obviously needs to be a lot more specific, but I've run out of time and inspiration now!

Commented [FR21R20]: We should mention the possibility to lower pressures on these ecosystems by changing towards diets with less meat. We could even refer to how much space this would save based on Peters and Marks paper. Another important pressure is bioenergy. I will look for the reference of the EU directive that does not allow for direct, but indirect land use changes.

Current soybean trade makes up 16% of total agricultural trade (increasing)

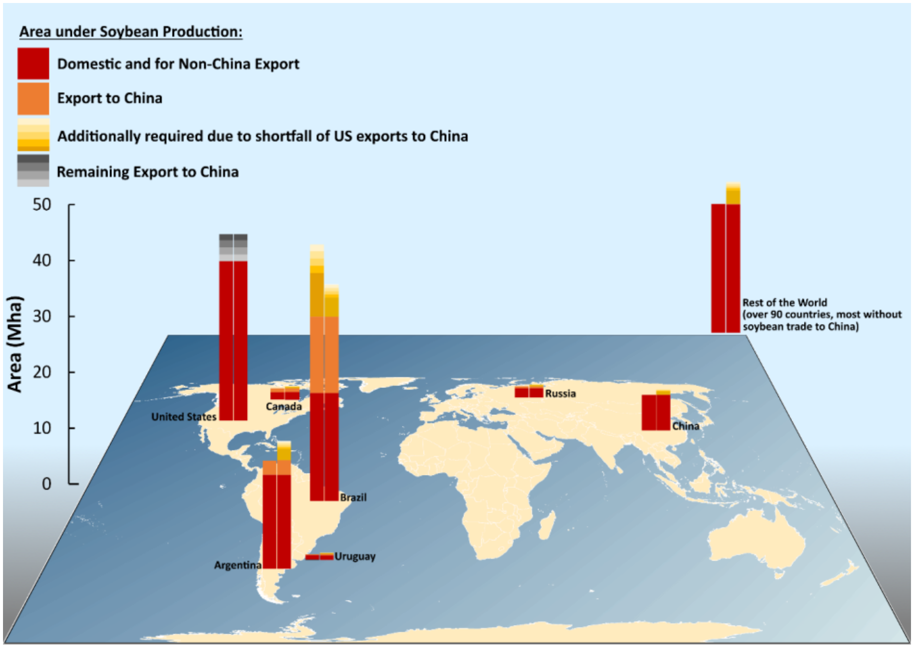

Figure 1: Soybean area of top producers for domestic production and export. The two bars for each region refer to different cases: 'worst-case' (left) and 'shared responsibility' (right). The yellow shadings refer to 60% (dark) to 100% (bright) shortfall from the US that is supplied by the country. Conversely, the grey shadings refer to the remaining 10% (bright) to 40% (dark) export from the US to China under the tariffs. Exports from the US to China recently dropped by 96%, and therefore all results assume a substantial increase in exports from their current levels.

Commented [AP22]: Why in the 'worst-case' is there any orange bar for Argentina? Isn't the assumption all production is met by Brazil in that case.

Commented [RM23]: I don't understand this point

Commented [AP24]: Agree with Mark that this is confusing, how about:
"Exports from US to China taken from October 2018, i.e. prior to the introduction of additional tariffs."

Table 1: Soybean production and area of top producers, based on FAO data in 2016. Additional production and area requirements refer to 'shared responsibility' amongst soybean producers, with '*' indicating where Brazil alone makes up the shortfall

	Argentina	Brazil	Canada	Russian Federation	United States of America	Uruguay	Rest of the World	China
Area								
Soybean for export to China (Mha)	2.6	13.7	0.7	0.3	10.8	0.2	>0.1	0
Soybean total (Mha)	19.5	33.1	2.2	2.1	33.5	1.1	23.3	6.6
Minimum additional area required, assuming 60% loss of US export (Mha)	2.0	3.4 (*7.8)	0.2	0.2	n/a	0.1	2.4	0.7
Maximum additional area required, assuming 100% loss of US export (Mha)	3.3	5.7 (*13.0)	0.4	0.4	n/a	0.2	4.0	1.1
Production								
Soybean for export to China (Mt)	7.8	39.7	1.9	0.5	37.6	0.4	0.2	0
Soybean total (Mt)	58.8	96.3	5.8	3.1	117.2	2.2	39.4	12.0
Minimum additional production required, assuming 60% loss of US export (Mt)	6.1	10.0 (*22.6)	0.6	0.3	0	0.2	4.0	1.2
Maximum additional production required, assuming 100% loss of US export (Mt)	10.2	16.7 (*37.6)	1.0	0.5	0	0.4	6.8	2.1
Relative								
Minimum increase (%)	10.4	10.4 (*23.5)	10.4	10.4	0	10.4	10.4	10.4
Maximum increase (%)	17.3	17.3 (*39.1)	17.3	17.3	0	17.3	17.3	17.3

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Acknowledgements This work was funded by the Helmholtz Recruiting Initiative. The article processing charges for this publication were paid from funds from Helmholtz Recruiting Initiative and the Karlsruhe Institute of Technology.

Commented [FR25]: Correct?

Commented [FR26]: Check! Correct?

Commented [BC27R26]: Prob not necessary at this stage?

Author contributions R.F. did the analysis. All authors contributed ideas for analyses, comments and critiques on drafts. R.F., C.B. and M.R. wrote the article.

Commented [FR28]: Correct?

Commented [BC29R28]: Closer than usual contributions statements, but always unfair on the 1st author ;-)

Author Information Reprints and permissions information is available at www.nature.com/reprints. The authors declare no competing financial interests. Readers are welcome to comment on the online version of the paper. Correspondence and requests for materials should be addressed to R.F. (richard.fuchs@kit.edu).

METHODS

1. Data

1.1. Data on soybean harvest, yield, production and trade

Harvested area, yield, production and trade data from the various countries were obtained from FAOSTAT database hosted by FAO[24]. In our analysis, we used the latest available year, 2016. For the trade analysis we used the trade matrix of the FAO considering the following soy products: ‘soybeans’, ‘oil, soybean’, ‘cake, soybean’, ‘soya sauce’, ‘soya paste’.

1.2. Data on fertilizer use for soybean

We used fertilizer data (N+P+K) for soybeans from the report ‘Assessment of Fertilizer Use by Crop at the Global Level’ published by the International Fertilizer Association (IFA) an International Plant Nutrition Institute (IPNI)[25]. This report contains fertilizer data of the year 2014 for the US, Brazil, Canada, Russia and Argentina.

2. Calculation of additional soybean demand due to shortfall of US exports to China

We deducted the ‘US soy exports to China’ from the ‘total soybean imports to China’. For the ‘worst case’ scenario, we redistributed the US shortfall in exports to the Brazilian production. For the ‘shared responsibility’ case, we redistributed the US shortfall amongst all soybean producers, including China. In this case, the fractional additional demand for the producers was calculated on basis of the share in global total soybean production. Production demands were converted into area demands using the estimated additional demand of production each country divided by the current yield of this country.

3. Calculation of annual yield increases of Brazil

Commented [FR30]: Needs to be done

Data availability: The datasets generated during and/or analysed during the current study are publicly available as referenced within this published article. The files are available from the corresponding author on reasonable request

References (Methods)