Brazil's Soy Moratorium

Supply-chain governance is needed to avoid deforestation

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POLICY

Brazil's Soy Moratorium (SoyM) was the first voluntary zero-deforestation agreement implemented in the tropics and set the stage for supply-chain governance of other commodities, such as beef and palm oil [supplementary material (SM)]. In response to pressure from retailers and nongovernmental organizations (NGOs), major soybean traders signed the SoyM, agreeing not to purchase soy grown on lands deforested after July 2006 in the Brazilian Amazon. The soy industry recently extended the SoyM to May 2016, by which time they assert that Brazil's environmental governance, such as the increased enforcement and national implementation of the Rural Environmental Registry of private properties (Portuguese acronym CAR) mandated by the Forest Code (FC) (*1*), will be robust enough to justify ending the agreement (*2*). We argue that a longer-term commitment is needed to help maintain deforestation-free soy supply chains, as full compliance and enforcement of these regulations is likely years away. Ending the SoyM prematurely would risk a return to deforestation for soy expansion at a time when companies are committing to zero-deforestation supply chains (*3*).

Between 2001 and 2006, soybean fields expanded by one million hectares (Mha) in the Amazon biome, and direct conversion of forests for soy production contributed to record deforestation rates (*4*–*6*). Farms violating the SoyM were identified using a satellite and airborne monitoring system—developed by industry, NGOs, and government partners—and were blocked from selling to SoyM signatories. Monitoring data confirm high compliance with the SoyM (*6*).

ESTIMATING IMPACTS. In the 2 years preceding the agreement, nearly 30% of soy expansion occurred through deforestation rather than by replacement of pasture or other previously cleared lands. After the SoyM, deforestation for soy dramatically decreased, falling to only ~1% of expansion in the Amazon biome by 2014 (see the chart) (SM, table S1) (*6*). Soy increased by 1.3 Mha in the Amazon biome during this period (*5*).

In the Cerrado biome, where the SoyM does not apply, the annual rate of soy expansion into native vegetation remained sizable, ranging from 11 to 23% during 2007–2013 (SM, table S2). In Brazil's newest agricultural hotspot—the eastern Cerrado region in the states of Maranhão, Piauí, Tocantins, and Bahia (Mapitoba)—nearly 40% of total soy expansion (2007–2013) occurred at the expense of native vegetation (table S3). About half of the Cerrado biome has been converted for agricultural production in recent decades, and these woodlands and savannas have less protection than Amazon forests under environmental laws (*7*). Further study is needed to assess potential leakage into the Cerrado and other countries and to quantify the avoided deforestation from the SoyM.

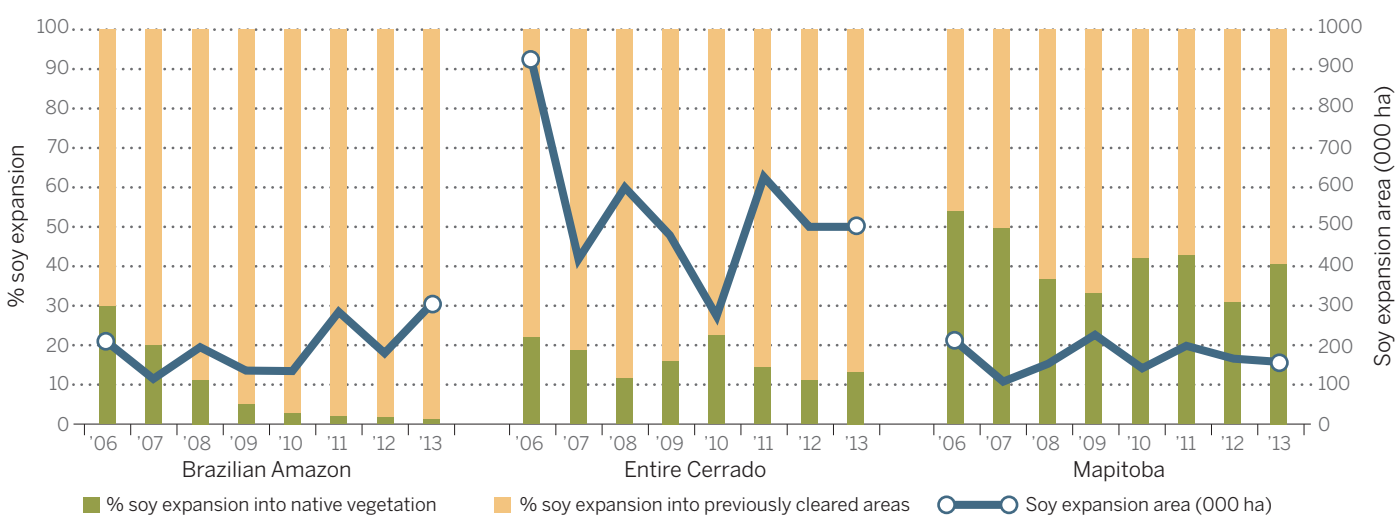
PROPERTY REGISTRATION. The CAR provides the first transparent mechanism to evaluate compliance with the FC and other regulations by linking a responsible landholder to land use on a particular property. All rural properties across Brazil are required to obtain the CAR by May 2016, although delays are expected, given the formidable task of demarcating more than 5 million properties. In Pará and Mato Grosso, the two states with the highest CAR participation, more than 65% and 48% of the agricultural land, respectively, is registered (SM).

Property registration alone, however, does not safeguard forests (*8*, *9*). In 2014, for example, nearly 25% of Amazon deforestation in Mato Grosso and 32% in Pará occurred within registered properties (*10*) (SM). In both states, nearly half of this clearing occurred in the Legal Reserve (LR) areas designated as set-asides required by the FC. Most of this clearing was illegal; few registered properties with deforestation in Mato Grosso (9%) or Pará (4%) had the ≥80% forest cover mandated by the FC (SM).

Comparing property-level compliance with the SoyM and the FC illustrates the relative response by soy farmers. In Mato Grosso, which accounts for 85% of the soy produced

Annual soy cultivation expansion by region

Annual soy expansion and land sources after the 2006 SoyM. Note that the Mapitoba area is included in the Cerrado (see SM).



in the Amazon biome, mapped farms with ≥25 ha of soy violated the FC, even while complying with the SoyM (table S4). Only 2% of mapped soy farms in Mato Grosso had sufficient LRs, making almost all deforestation illegal (table S5). At least 627 soy properties in Mato Grosso violated the FC and cleared forest illegally during the SoyM. Yet only 115 properties were excluded by soy traders for SoyM violations (*2*). This discrepancy can occur because the SoyM regulates only the portion of the property where soy is grown—not the entire property. The larger number of FC violations suggests that producers are more likely to comply with the SoyM.

LIMITED FEDERAL ENFORCEMENT. Without the SoyM, federal enforcement mechanisms would be the primary intervention against deforestation in the soy supply chain. Brazil's environmental protection agency, IBAMA, uses satellite data and field visits to issue fines and embargo economic activities on rural properties with illegal deforestation. The number of properties listed as embargoed more than tripled in the last 5 years (SM). However, thousands of deforestation events occur in the Brazilian Amazon each year across an area spanning 550 Mha, which makes it difficult to achieve enforcement (*11*). As of May 2014, roughly half of the registered properties with deforestation ≥25 ha, 2009–2013, were not embargoed (tables S6 and S7). Most of this deforestation was illegal. Government monitoring of embargoed properties is limited; production could continue in embargoed areas and be transferred to another nonembargoed property or farmer for sale ("laundering"). Producer information was inconsistent between the embargoed list and the CAR system for more than half of the registered properties with embargoes. Soy traders and others use the CAR to check for embargoes; inconsistent information makes it difficult to avoid transactions with embargoed properties (SM).

Federal enforcement mechanisms are unlikely to be an effective substitute for the SoyM in the near term, because there is no simple way to identify properties that are in compliance with the FC. Recent changes to the FC have created the forest certificate (Portuguese acronym, CRA)–trading schemes, which allow landholders to purchase CRA from other properties and compensate for LR deficits accrued from illegal deforestation before 2008 (*1*). A system is not yet in place to monitor this off-property LR compensation. Enforcement is more straightforward under the SoyM, because all clearing for soy is prohibited. Of the existing policy and enforcement regimes, only the SoyM allows buyers to ensure deforestation-free supply chains over the next several years. Over the long term, elements of the SoyM and FC monitoring systems could be combined to satisfy market demands for information. However, even with eventual full compliance under the FC, legal deforestation could enter the soy supply chain without the SoyM (*1*).

> ***"Federal enforcement mechanisms are unlikely to be an effective substitute for the Soy Moratorium ..."***

VULNERABLE CERRADO. In the Amazon biome, there are an estimated 14.2 Mha of unprotected tropical forest considered suitable for soy production, and up to 2 Mha of this forest could be cleared legally under the FC (SM and fig S3). These forests would be vulnerable to soy expansion without the SoyM. However, the bank of eligible, previously cleared land suitable for soy production is more than six times the area planted in 2014 indicating the expansion is possible under the SoyM (table S8) (*12*).

More than 20 Mha of natural vegetation in the Cerrado are considered suitable for soy expansion, and up to 11 Mha of these lands could be legally converted under the FC. Large areas of cleared lands suitable for soy (42.5 Mha) also exist in the Cerrado, enough to triple current soy production, but these lands are not located in the regions with the most rapid recent expansion of soy into native vegetation. In the Mapitoba region, for example, there are fewer than 2 Mha of cleared lands considered suitable for soy production (fig. S3). If large-scale soy expansion continues in Mapitoba, remaining natural vegetation could be highly susceptible to soy conversion without additional safeguards. Expanding the SoyM could reduce the ongoing direct conversion of cerrado vegetation to soy.

By prohibiting new deforestation, the SoyM incentivizes soy expansion into already-cleared areas, which may displace pastures and could indirectly lead to more deforestation. Zero-deforestation agreements in the cattle sector, together with national and municipal policies, may partially mitigate the risk of this indirect deforestation (*11*). Ongoing efforts to increase production on existing pasturelands could free additional areas for production (*13*).

CONCLUSIONS. Since the SoyM's inception in 2006, only a small area of soy expansion in the Brazilian Amazon occurred in newly deforested areas. Soy farmers are about five times as likely to have violated the FC as the SoyM (627 versus 115 violations) (SM). The success of the SoyM is due to an array of factors, including (i) a limited number of soy buyers that exert considerable control over soy purchase and finance; (ii) simple requirements for compliance; (iii) streamlined and transparent monitoring and enforcement systems; (iv) simultaneous efforts by the Brazilian government to reduce deforestation; and (v) active participation by NGOs and government agencies (*14*). Monitoring and compliance mechanisms established by the SoyM offer a model for expanding supply-chain governance to other soy-producing regions and commodities.

We argue that the CAR and FC are not yet sufficient replacements and are unlikely to be fully implemented when the SoyM expires in 2016. Instead, the SoyM should be further extended and strengthened in the Amazon biome through expanded monitoring and exclusion of all deforestation on soy-producing properties, including small clearings and those located in indigenous lands and rural settlements, where soy production is expanding (SM). The SoyM should also be expanded to include the Cerrado biome to reduce conversion of remaining native vegetation.

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REFERENCES AND NOTES

1. B. Soares-Filho *et al.*, *Science* **344**, 363 (2014).
2. Brazilian Vegetable Oil Industries Association, "New agenda for soybeans in the Amazon biome" (ABIOVE, São Paulo, 2014); www.abiove.com.br.
3. United Nations, New York Declaration on Forests (UN, New York, 2014); http://bit.ly/1KmeuRW.
4. D. C. Morton *et al.*, *Proc. Natl. Acad. Sci. U.S.A.* **103**, 14637 (2006).
5. M. N. Macedo *et al.*, *Proc. Natl. Acad. Sci. U.S.A.* **109**, 1341 (2012).
6. B. F. T. Rudorff *et al.*, *Remote Sens.* **3**, 185 (2011).
7. G. F. Rocha *et al.*, *Rev. Bras. Cartogr.* **63**, 341 (2011).
8. A. A. Azevedo *et al.*, *Boletim Amazônia em Pauta* **3**, 1 (IPAM, Brasília, 2014); http://bit.ly/17j4REk.
9. R. Rajão *et al.*, *Public Adm. Dev.* **32**, 229 (2012).
10. In Pará, one-third of this was in INCRA settlements.
11. J. Börner *et al.*, *Glob. Environ. Change* **29**, 294 (2014).
12. E. F. Lambin *et al.*, *Glob. Environ. Change* **23**, 892 (2013).
13. B. B. Strassburg *et al.*, *Glob. Environ. Change* **28**, 84 (2014).
14. D. Nepstad *et al.*, *Science* **344**, 1118 (2014).

ACKNOWLEDGMENTS

See SM for thanks and funding.

SUPPLEMENTARY MATERIALS

www.sciencemag.org/content/347/6220/377/suppl/DC1

10.1126/science.aaa0181