New game theory model taps power of cooperation to promote sustainable palm oil production in Indonesia

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Credit: Pok Rie from Pexels

"Tropical forests are a critical resource," says Xavier Warnes, Ph.D. '21, a postdoctoral researcher at Stanford Graduate School of Business.

"They store huge amounts of carbon, they affect weather patterns and water systems, and they contain around 80% of the world's biodiversity."

Stopping deforestation is one of the most effective and immediate steps we can take to slow global warming. It's not just that trees help absorb CO_2; the logging and burning of forestland accounts for 15% of greenhouse gas emissions worldwide.

According to the United Nations, nearly 39,000 square miles of forest are wiped out annually. Most of that deforestation occurs in tropical regions, driven mainly by agriculture. In Indonesia, that means growing palm fruit—the source of palm oil, the most widely used vegetable oil in the world.

Efforts have been made to curb the economic incentives behind deforestation. Some multinational firms that are major users of palm oil, like Unilever and Nestlé, offer a price premium for oil that is not sourced from newly cleared land.

Paying the people who grow oil palms to protect the forest can be a win-win, but it's challenging to make it work, Warnes says. One issue is monitoring. "With thousands of small farms, you just can't know where all the fruit is coming from."

Another issue is that the price typically isn't high enough to flip the incentives for everyone. "It's hard to target," Warnes says, "because the profit calculation differs from one case to the next. You also end up paying people who wouldn't have deforested anyway." And since price premiums are only available to landowners, they don't sway illegal loggers or settlers, the source of roughly half of all tropical deforestation.

Warnes, with Stanford GSB professors Erica Plambeck and Dan Iancu

and MIT professor Joann de Zegher, has an idea for a new approach. What if, instead of certifying each farmer, palm oil buyers could contract with an entire village and let the community do the enforcement? If anyone in the area violated the terms of the agreement, no one would get the premium.

And instead of making the deal contingent on no deforestation, they propose a more flexible condition they call "regeneration." If any forest was cleared in the specified area, locals could still get paid if they made sure it wasn't farmed and was allowed to regrow.

To test their idea, the team built an innovative game theory model, presented in a working paper, and simulated different plans, using survey data de Zegher collected from 58 villages in East Kalimantan, Indonesia—a region where deforestation has been rampant.

The result? Area-based plans work better, in part because they foster cooperation between farmers. And in the all-too-common case where outsiders sneak in to exploit local forests, a regeneration rule is more effective than a no-deforestation rule.

Changing the game

"This study is part of a broader research agenda at Stanford," says Plambeck. She and Iancu, both professors of operations, information, and technology at Stanford GSB, work on ways of improving environmental and social outcomes in complex value chains where firms can't directly control the actions of their suppliers.

"The goal is to create incentives that are not only effective but efficient, giving you the most bang for your buck," Iancu says. One advantage of an area-based agreement for palm oil production is that you don't need to set a price premium high enough to work for every farmer.

That's vital because a premium is worth the least to those with the least land. These smallholders have the most incentive to deforest and are the hardest to monitor. By tying all the farmers in a village together, an area-based approach shifts the monitoring to the local level, where the information is, and relies on peer pressure to make it self-regulating.

Just as important, Warnes says, it allows for mutually beneficial side deals. "Let's say we're farmers, and I strongly prefer the incentive, but you'd be worse off by not deforesting," he explains. "If you do deforest, I don't get the premium. So instead, I might come and offer you a portion of my profit if you go along with the plan, and we both come out ahead."

That might sound improbable, but it doesn't require any cash to change hands. Rural economies run on such quid pro quos of tools, labor, and other services.

That was the researchers' idea, anyway. To test whether it would lead to the desired outcome—eliminating deforestation with a reasonably priced incentive—they needed a model that could incorporate all those strategic interactions between individuals. It was time for some game theory.

Game theory can be a great way to test new policy ideas, Iancu says. "Ideally, you'd like to run some field trials, but that takes a long time, and this is an urgent issue. As a first cut, a model lets you easily try out a bunch of policy alternatives to predict what will work."

The dynamics in the Indonesian palm oil scenario are complex. There might also be competing factions, which means multiple possible outcomes with deforestation and non-deforestation at the same time. "We had both externalities and multiple equilibria, and there wasn't a good way of dealing with that in the literature," Plambeck says. So the researchers came up with a new approach they call a "partition

correspondence form."

When they ran the setup with varying prices, the area-based approach consistently outperformed contracting with individuals. "If they can cooperate, you don't need a premium that makes every farmer better off. You only need to make the community better off in the aggregate," Iancu says. "That means you can get by with a lower premium."

If a tree falls

Yet the most interesting result came when they introduced incursions by outsiders. A big problem in Indonesia (and elsewhere) is that people who are not part of a community may sneak in and burn down secluded patches of forest. Because they don't own the land, they can't be influenced by price incentives.

Penalizing local residents for these bad actors wouldn't be fair (or helpful). So the team proposed the less stringent "regeneration" condition: If villagers block intruders from producing oil palms on cleared land, giving the forest a chance to grow back, they still get their premium.

Of course, if the trespassers are part of a big commercial operation, that might not be feasible. But often, they are also small farmers. Warnes says he's heard stories of locals cutting down newly planted palms to stop illegal farming, even without such incentives in place.

"In any case, the policy implication is that you want to reduce the cost of blocking—for instance, by setting up systems of monitoring or reporting where locals have a number they can call, and the police can do something about it," he says.

When they ran the model with these considerations factored in, the

researchers found that the area regeneration plan would deter outsiders and do the best job of preventing deforestation in most villages.

Plambeck stresses that this approach could be widely applicable. "We used data from palm farmers in Indonesia to illustrate the results, but the results are very general. The approach could be useful to halt illegal deforestation in Thailand, Congo, or elsewhere, or engage communities to prevent other sorts of illegal activity, like tapping wires to steal electricity."

The next step, Warnes says, is figuring out how best to implement these ideas on the ground. For instance, how much land should an agreement cover? "The bigger you make it, the fewer you have to set up and run. But you might get better cooperation in smaller areas, where people know each other and share a sense of common identity."

He also suggests that NGOs could help communicate the vision and teach villagers how to facilitate cooperation. Luckily, he says, there's already an infrastructure in rural areas, in the form of traditional village councils, which have credibility and authority.

The goal, of course, is to put these ideas into practice as soon as possible. Iancu says they're pursuing leads in Thailand and Indonesia to run randomized controlled trials. "We'd love to partner up with any other institutions and parties who are interested in testing this out."

More information: Area Conditions and Positive Incentives: Engaging Local Communities to Protect Forests. www.gsb.stanford.edu/faculty-r … ng-local-communities

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