

Scientists team with industry to tackle one of the world's most destructive crops

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On a plantation in West Kalimantan in Indonesia, oil palms have replaced all but small patches of forest. ARROWHEAD FILMS

Crickets were chirping one clear morning in April when Anak Agung Aryawan walked under the canopy of a quarter-century-old oil palm plantation here. Suddenly Agung, an agroecologist, stopped. "Look, that's a *Sycanus*!" He pointed at a black insect perched on a fern in the forest understory. Known as an assassin bug, *Sycanus* uses its mouthpart to stab its insect prey, including the fire caterpillar, one of the most important pests of oil palm trees. He soon found more insect killers in the palm grove: a *Nephila* spider, known for its big, elaborate web, and the bright yellow *Cosmolestes*, another species of assassin bug.

Agung works for SMARTRI, an oil palm research institute here owned by Sinar Mas, one of Indonesia's largest business conglomerates. The study plot he was visiting was managed without herbicides or insecticides; plantation workers weeded it by hand, and only in a small circle around each tree. As a result, many tall ferns and shrubs were growing beneath the canopy, creating a home for insects, spiders, and snakes.

Many Indonesian planters would abhor this semiwilderness, worrying the understory would compete with oil palm trees for water and nutrients. Agung sees it differently. Allowing a luxuriant understory to grow in plantations can protect insects and some small mammals, such as the leopard cat—and ultimately benefit the oil palm trees as well. *Sycanus* and other predators control pests, for example, and other invertebrates improve the soil and pollinate the palms.

Oil palm (*Elaeis guineensis*) is one of the most controversial crops today, because the plantations often replace tropical rainforests rich in biodiversity, depriving iconic species such as the orangutan of their habitats. Vast swaths of Indonesia and Malaysia are given over to the crop. But Agung and a growing number of other

scientists say it's time to work with oil palm companies—some of them in the crosshairs of environmental activists—to make the best of a bad situation.

Researchers have accepted industry funding to study habitat fragmentation and advised oil palm companies on how to best manage the surviving wildlife in their concessions. And at SMARTRI, a long-term ecological experiment called Biodiversity and Ecosystem Function in Tropical Agriculture (BEFTA) is testing whether the plantations can host more biodiversity without affecting yield. Finding a way to protect species while satisfying the world's demand for palm oil is "a vital conservation priority of the modern era," Edgar Turner, a conservation scientist at the University of Cambridge in the United Kingdom who heads BEFTA, wrote in a 2011 paper.



Anak Agung Aryawan inspects a tree planted in 2018 as part of a study seeking to restore riverbanks in plantations to a more natural state. DEDY SUTISNA/RIAU IMAGES

Some critics call the approach naïve. By accepting industry funding—and using its giant plantations as laboratories—scientists risk losing their independence, they say, and they legitimize the companies' business by giving it a veneer of sustainability. "They take a pragmatic approach in the face of a desperate situation," says David Gaveau of the Center for International Forestry Research in Bogor, Indonesia. "If funding and prestige that comes with access to large data sets lures scientists to a particular direction while ignoring the big elephant in the room, then this is problematic," says Maria Brockhaus, a forest politics expert at the University of Helsinki.

But scientists working with oil palm companies say they don't feel constrained scientifically, and they welcome the money. "It's hard to find long-term funding for research," says Matthew Struebig, a conservation scientist at the University of Kent in the United Kingdom who has consulted for two plantations owned by Wilmar International, the world's largest palm oil trader. Moreover, the demand for vegetable oil will only grow, and palm oil is the most efficient way to produce it, Turner says. Biodiversity loss is a "complete tragedy," but "we need to feed the world," he says. "We need to produce crops that are very productive ... in the smallest area possible. And oil palm is the best."

PALM OIL IS USED in a staggering number of consumer products, from fast food, chocolate spread, and cereals to toothpaste and dog chow. It is also a source of biodiesel. Some 90% of the global supply comes from Indonesia and Malaysia, where plantations cover 17 million hectares, almost half the area of Germany. Growing demand is pushing the industry into Africa and South America.

Gaveau, a landscape ecologist, has tracked the spread of plantations on Borneo—home of Indonesia's largest rainforest—in images from NASA's Landsat and data on oil palm concessions to produce the Borneo Atlas, a new online platform. In the past 2 decades, he found, big oil palm companies have cleared 24,000 square kilometers (km²) of Borneo's forests—almost five times the area of Bali. (Pulpwood production, smallholder farming, mining, dam construction, and other development consumed another 36,000 km².)

Policies to stem the tide have not worked very well. In 2011, the Indonesian government issued a moratorium on deforestation, and in 2016 it halted the draining and clearing of peatlands for plantations. In September 2018, President Joko Widodo also stopped issuing new oil palm permits, which for now has stalled deforestation in the province of Papua—another biodiversity mecca—where 1800 km² have been cleared so far.

Yet banning palm oil would not end biodiversity loss, according to a 2018 report by the International Union for Conservation of Nature (IUCN); it would only displace it to other parts of the globe and possibly worsen it. One hectare of tropical land can produce 4 tons of oil annually, at least four times the yield of 1 hectare of rapeseed, sunflowers, or soybeans planted in temperate regions. Unlike those crops, the oil palm is a tree that can live up to 25 years—enough for a diverse ecosystem to thrive in a plantation, if growers allow it. "It's actually a good crop for conservation, but it just happens to grow in the most biodiverse parts of the world," Turner says.

Instead of urging a ban, the IUCN report calls for reining in deforestation and discouraging the use of unsustainable palm oil. (Some 19% of the global output is certified as "sustainable" by the Roundtable on Sustainable Palm Oil, which includes thousands of growers, traders, and manufacturing companies as well as groups such as the World Wildlife Fund and Oxfam. To qualify, a company needs to show it's not contributing to deforestation and is treating its workers well, among other things.)

One of the lead authors of the IUCN report is Dutch ecologist Erik Meijaard, who runs his own consultancy company from Brunei. Meijaard is a prominent figure in Indonesian conservation science. In 1997, he discovered an orangutan population in a small patch of forest in North Sumatra; a decade later, he and others found that genetic and morphological characteristics set it apart as a separate species, now named the Tapanuli orangutan, after the place they inhabit.

Meijaard feels palm oil is unjustly vilified. There are many other threats to Indonesia's biodiversity, he notes. "We always assume that the forest would have remained if oil palm plantations had not been developed, but my lesson from Indonesia is that forests that are unmanaged are ultimately cut down, either legally or illegally."

Meijaard is pragmatic when it comes to collaborating with palm oil companies. In 2011, he decided to accept an offer to advise ANJ Agri on how to manage a patch of forest within the company's concession in West Kalimantan—an Indonesian province on Borneo—that is home to 150 orangutans. That raised eyebrows among some other conservationists. According to Gaveau's Borneo Atlas, the company cleared 38 km² of primary orangutan habitat in West Kalimantan in 2012, a year after the Indonesian moratorium on deforestation began. And Greenpeace included ANJ Agri on a blacklist for clearing forests without permission from local indigenous people in South Sorong in West Papua; it also says the company's private police beat a Papuan man during a 2017 demonstration.

Meijaard says that in Kalimantan, the company only cleared second-growth forests, which have less biodiversity than primary rainforest; he declined to comment on the South Sorong accusations. (An ANJ Agri spokesperson in Jakarta says an in-depth investigation showed the beating didn't happen.) In any case, Meijaard says, the company is serious about protecting the orangutans in its concession. "They worked hard in getting rid of rampant illegal logging and hunting, and invested heavily in forest fire prevention," he says. "Without the company, that piece of forest would be gone, just like a community forest located nearby."

Meijaard stresses, "There are plenty of companies I wouldn't take money from." When he was invited in 2018 for a "dialogue" by PT North Sumatera Hydro Energy, a company building a hydroelectric dam that threatens the home of the Tapanuli orangutan, his answer was resolute. "There is nothing to discuss or have a dialogue over, apart from the total cancellation of the project," he wrote to the company.

Yet Gaveau says it's hard for scientists to know exactly what the companies they work with are doing. In 2018, for instance, Greenpeace accused Wilmar of disguising its de facto ownership of plantations to avoid accountability and buying palm oil from 18 companies that had cleared forests, despite Wilmar's 2013 adoption of a "no deforestation" policy. (In a press release, Wilmar denied some of the allegations, but the company did adopt a plan to better monitor its suppliers 3 months later.) "We cannot trust the companies blindly," Gaveau says. "They will seek loopholes to cheat the system for their advantage whenever they can."

SMARTRI IS RUN BY Jean-Pierre Caliman, a French agronomist with a passion for oil palms who moved here from Africa in 1993. Employed by Sinar Mas, he leads a team of 81 Indonesian scientists and has a \$10 million annual budget. Until recently, its the institute's research focused on increasing yield or reducing cost; biodiversity wasn't really on their radar. Now, SMARTRI scientists are studying the carbon dynamics in plantations and putting a price tag on the ecosystem services provided by hundreds of species living among the oil palms. "How much money do we have to spend if a species disappears?" is a key question now, Caliman says.

The Sumatran barn owl (*Tyto alba*), for instance, is a scourge of the rats that eat the fruits of the oil palm tree, lowering yield. Without owls, Caliman says, plantation managers would need to buy rodenticides worth up to \$4 per hectare annually; to lure the birds, Sinar Mas has installed 26,000 artificial nest boxes on Sumatra.

SMARTRI's major effort to find a place for biodiversity in palm plantations began in 2011, when William Foster, a Cambridge insect ecologist and Turner's Ph.D. supervisor, asked Caliman whether he wanted to collaborate on a long-term ecological study. Caliman embraced the idea, which became BEFTA. Turner got some of his ideas for BEFTA while doing research in Sabah in Malaysia. "From walking around plantations [there], it's quite clear that plantations with a higher level of understory have a high level of biodiversity, and we would like to find out what impact that had on functioning and yield," he says.

Sinar Mas provides BEFTA with funding—Turner and Caliman declined to say how much—and Turner was given 18 research plots, each measuring 150 by 150 meters, at the plantation. On six of them, researchers used herbicides to remove all of the understory, as well as ferns living on palm trees, which many plantation owners do. In six others, they used standard Sinar Mas practice, which is to spray herbicides only on paths and in a circle around each tree to give plantation workers access, while leaving most of the understory alone. On the last six plots—including the one where Agung found his *Sycanus*—they used no herbicides at all; workers manually removed plants around the trees and on paths.

Data collection finished last year, and some results have come out. In a paper published in December 2018, the team reported that abandoning herbicides improved the condition of the soil and increased the diversity of soil macrofauna, such as earwigs (Dermaptera) and millipedes (Diplopoda), which break down leaf litter,

making nutrients available to other species. Another paper reported that the plantation is home to 69 species of dragonfly, including five never before spotted on Sumatra. And the herbicide-free plots had soil nutrient levels just as high as the chemically treated ones, suggesting worries about competition from the understory are unfounded. As-yet-unpublished findings show that even the most ecofriendly regimen had a negligible impact on yields, Caliman says. He and Turner are optimistic they can persuade Sinar Mas management to adopt the strategy widely.

ALTHOUGH ENVIRONMENTALISTS are wary of such collaborations, some oil palm experts dismiss the results. Agus Eko Prasetyo, an expert on plant protection at the Indonesian Oil Palm Research Institute in Medan, says scientists have known since the 1980s that most ferns and shrubs don't decrease palm oil yields. But he says planters do need to control certain species—especially woody plants whose roots suck up more water and nutrients—and doing so manually rather than with herbicides will drive up cost. "I bet Sinar Mas won't adopt" the ecofriendly regime, Prasetyo says.

Others say that in working with large companies, ecologists are missing worse offenders: smallholder farmers who own 40% of Indonesia's oil palm plantations and may be less informed about biodiversity and oil palm management. If researchers "focus on large companies to 'help' them do a little bit less harm to nature, then who is going to study the unsustainable practices?" Brockhaus asks.

The Indonesian government, not industry, should fund oil palm research, Brockhaus says: "The country has the responsibility to ensure independent and critical research to serve the interest of the wider society and not in favor of selected interests." The government could also study social and economic aspects of the industry, adds Hariadi Kartodihardjo, a forest policy expert at Bogor Agricultural University. Revenues primarily benefit the country's ruling elite and a small number of tycoons, Kartodihardjo says; meanwhile, millions of plantation workers toil, often on low wages, in isolated places with conflicts over land use and few educational opportunities. "This is something that needs to be solved," he says.

But government funding for research is scarce; many Indonesian scientists can only dream of the budget SMARTRI has. The Indonesian Oil Palm Estate Fund, a government body that collects taxes on palm oil exports, also funds some research, but most of it is in agronomy and postharvesting processing, not on biodiversity or social and economic issues.

Turner has no qualms about the collaboration with Sinar Mas: "For large experimental trials, you need a lot of resources," he says. Struebig sees the overall balance as positive as well. Working with companies gives researchers access to sites and data and helps build trust between science and the industry, he says. "To me, working with the industry will lead to bigger improvements in sustainability than working without," he says.

AFTER A LONG DRIVE through the plantation, Agung got out of his Land Cruiser and walked toward a narrow stream. The area looked very different; there were no palm trees in sight, only young forest trees and wild shrubs. They formed part of a new long-term experiment by the Cambridge team, launched in 2018 and called Riparian Ecosystem Restoration in Tropical Agriculture.

Under a 2015 government policy, companies can't plant new oil palms in 50-meter-wide ribbons along rivers in their plantations; the idea is to start to give these zones back to nature. How best to restore them to a more natural state is not clear. The team is now testing four different strategies. In one plot, all palm trees were cleared and replaced with six native tree species. Some were struggling. A young red meranti (*Shorea leprosula*), an icon of the lowland tropical forest on Sumatra and in Kalimantan, was dying.

A more natural plantation

A large-scale ecological experiment on a plantation in Indonesia tested three different understory treatments. It suggests reducing herbicide use can lead to a more diverse understory without affecting yield.

Eliminating the understory

All understory vegetation is removed using herbicides—a practice used by many growers, who worry the plants will compete for water and nutrients with oil palm trees.



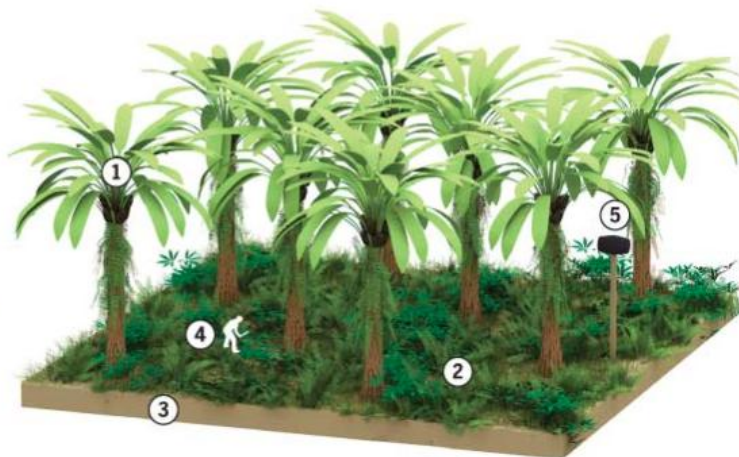
Normal understory complexity

The standard practice at this plantation: Herbicides are sprayed in a circle around each tree and on paths, and some woody vegetation is removed manually.



Enhanced understory complexity

No herbicides are used. Plants near the trees are removed by hand, leaving luxuriant understory where invertebrates thrive, controlling pests.



1 Negligible impact on yield

2 Increased soil biodiversity

3 No decline in soil fertility

4 Pesticide cost down, labor cost up

5 Nest boxes attract barn owls, which prey on rats.



Many planters remove the epiphytic ferns living on oil palm trees. In a large-scale experiment on Sumatra in Indonesia, they are left in place as part of an effort to enhance biodiversity. DEDY SUTISNA/RIAU IMAGES

But Agung's face lit up in another plot, where the researchers had left the oil palm trees in place and had planted native trees between them. Here, a red meranti was thriving; maybe it needed to be shaded by the aging palm trees early in life, Agung speculated. Another native forest tree, *Peronema canescens*, which the team had planted last year, was already taller than Agung. He stood next to it to take a selfie, ignoring a weaver ant crawling on his neck. "I just can't wait to see the plot in a few years," he said. "It's going to look like a forest."

Source: <https://www.sciencemag.org/news/2019/07/courting-controversy-scientists-team-industry-tackle-one-world-s-most-destructive-crops>