

'Bad science': Planting frenzy misses the grasslands for the trees

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There's a tree-planting frenzy everywhere you look. In August 2019, the state of [Uttar Pradesh](#) in northern India announced that more than a million Indians had planted 220 million trees on a single day. A month earlier, Ethiopia had made a similar [declaration](#): more than 350 million trees had been planted in one day.

"Always be suspicious of such big claims," says William Bond, a grasslands researcher and emeritus professor at the University of Cape Town in South Africa. "It's taken for granted that tree planting is good. But look at what they're planting, where they're planting."

Intuitively, planting trees makes sense, especially given the high levels of forest loss and fires around the world. Even in 2020, when it was in the throes of the COVID-19 pandemic, the world lost 4.2 million hectares (10.4 million acres) of old-growth tropical forest in places such as the Brazilian Amazon — 12% higher compared to the previous year, according to data from the University of Maryland and [Global Forest Watch](#). Carbon emissions from fossil fuel burning and forest clearing are also at an all-time high. Where pre-industrial levels of atmospheric carbon dioxide were about 278 parts per million (ppm), contemporary levels exceeded 420 ppm in April 2021, according to data from the [Mauna Loa observatory](#) in Hawai'i.



Reforestation after logging in western U.S. Image by Downtowngal via Wikimedia Commons (CC BY-SA 3.0).

Planting trees, then, can seem like the easiest way to battle both problems — it has the potential to create “forests” and soak up excess carbon dioxide from the air. This narrative is what many campaigns are relying upon. Take for example, the [one trillion tree](#) initiative launched by the World Economic Forum in January 2020. The project notes that “trees and forests are a critical part of the solution to the climate crisis and biodiversity collapse. That’s why we aim to mobilize, connect, and empower the global reforestation community to conserve, restore and grow one trillion trees by 2030.” The Bonn Challenge aims to bring 350 million hectares (865 million acres) of degraded and deforested land into restoration by 2030. An offshoot of the Bonn Challenge, AFR100 (the African Forest Landscape Restoration Initiative) wants to restore 100 million hectares (247 million acres) of land in Africa by 2030.

Restoring lands sounds like a good idea. But there is a widespread perception that “restoration” means “planting forests,” says Giselda Durigan, a forestry engineer and plant biologist at the São Paulo State Forest Institute in Brazil.

“I am primarily a forestry engineer, and that is why I take those concepts so seriously,” Durigan says. A good forest-restoration project, she says, must recreate a forest ecosystem where it was a forest before, a process also called reforestation. But afforestation, or planting a new forest in an area where there was no forest to begin with, can often be problematic.

This is because planting forests requires a lot of land. And areas that were never forests historically, but seem open and available for planting trees, are usually another critical ecosystem: grasslands, savannas, shrublands, meadows, rocky outcrops, or dry lands. For long, though, forests have been viewed as the default natural vegetation. And large tracts of non-forest areas, including shrublands, grasslands and savannas, continue to be viewed as unproductive, or historically forested land that humans have degraded to barrenness.

Where is all the unforested land?

In 2019, a paper titled “[The global tree restoration potential](#),” published in the journal *Science*, created a furor. The authors of the study estimated, using remote sensing and machine learning, that the Earth had available land for about 900 million hectares (2.2 billion acres) of forest restoration. Foresting this tree-less land would help store 205 gigatons of carbon, they wrote, making it “our most effective climate change solution to date.”

The study was, however, based on various flawed assumptions and data, several independent groups of researchers countered. Among the many problems, one group [noted](#), was that the study had relied heavily on foresting grasslands and savannas.

A few years earlier, the World Resources Institute had published the [Atlas of Forest Landscape Restoration Opportunities](#) in collaboration with the IUCN. This influential map identified more than 2 billion hectares (5 billion acres) of land as presenting an opportunity for forest restoration. But [subsequent analysis](#) by independent researchers including Durigan showed that the *Atlas* had classified 900 million hectares of grassy biomes as “deforested” or “degraded.”

“They mapped the major game parks of Africa as degraded and deforested, defining degradation as anything that damages trees,” Bond says.



Arid savannah in the Kaolack province of Senegal. Image by Tobias 67 via Wikimedia Commons (CC BY-SA 4.0).

Authors of both maps countered by saying that their maps simply point out areas that can be potentially forested. Each area, however, needed to be assessed individually.

But critics say that by marking broad areas as potential sites for restoration — a term usually conflated with planting forests — the maps prompted a flurry of massive tree-planting campaigns and projects around the world. AFR100, for instance, is aiming to plant trees across 100 million hectares of mostly savanna in Africa by 2030, write Bond and his colleagues in a 2019 paper published in *Trends in Ecology & Evolution*.

“These maps have been extremely damaging,” Bond says. “It was really superficial, bad science, but then international policies are feeding into this. The vast areas then became the targets for reforestation, supported by the World Bank, the IUCN, the German government and so on.”

At the heart of many of the disagreements lie muddled-up ideas. When is an area a “forest”? What is a “degraded” forest? How is it different from a grassland or savanna with trees? How far back in time do you go to see what the original habitat of the area was like? Does a forest always trump a non-forested area?

Degraded or naturally unforested?

The WRI Atlas considered all areas with more than 10% tree cover as a form of forest; this is the broad definition also used by the Food and Agriculture Organization of the United Nations (FAO). Only land with less tree cover was considered to be either naturally non-forested or converted to some other land use.

Now, deforestation and degradation of forests can create open areas with few trees. But non-forested areas like grasslands and savannas, too, naturally have trees. Sometimes the trees are scattered, sometimes they occur in dense lots. This means that when viewed from above, many of these areas will have more than 10% tree cover and look like degraded forests.

“You’ve got to be careful of the word forest and what it means — the definition of forest is critical,” Bond says. “The definition provided in global terms by the FAO is more than 10% tree cover, which includes nearly all the world’s savannas, which are not forests at all.”

If you’re thinking just in terms of tree cover in an area, it can be hard to distinguish between a “degraded forest” and a naturally non-forested area. But there are better ways to do so. Let’s consider tropical savannas. In a paper titled “When is a ‘forest’ a savanna, and why does it matter?” published in *Global Ecology and Biogeography* in 2011, Jayashree Ratnam, an ecologist at National Centre for Biological Sciences, Bengaluru, India, and her colleagues recommend looking carefully at the kinds of plants growing on the land, and the kinds of evolutionary adaptations they show.

Tropical savannas, such as the Serengeti in Tanzania, the Cerrado in Brazil, or the grasslands of central India, they write, are dominated by species of grasses that use a form of photosynthesis called C4. These grasses don’t like shade, which means that the trees that grow in these landscapes are typically short, and have smaller leaf areas and open crowns that let sunlight filter to the ground. By contrast, a tropical forest tends to have grasses that use more shade-tolerant C3 photosynthesis because trees there grow tall and wide and have denser canopies.

The C4 grasses in savannas are highly flammable. The wet season prods the grasses to grow long and thick, while the prolonged dry seasons turn them into potent fuel for fire. Savanna fires, however, tend to be low on the ground, burning the grasses and young saplings, but not big or hot enough to scorch adult trees. Once the fires ebb, the grasses regenerate quickly. It’s perhaps counterintuitive, but many savannas *need* fires to remain savannas. Even the trees that grow in these areas have adaptations like thick bark to live with fire.

Fires in forests, on the other hand, tend to be very hot, burning not just the understory but the crowns of tall, adult trees as well. They spread rapidly to other trees, and can turn catastrophic. In fact, Ratnam and colleagues note that many areas in South Asia, currently classified as tropical dry forests, such as [Bandipur Tiger Reserve](#) in southern India, have such C4-dominated grasses with interspersed fire-resistant tree species. These areas are more like savannas than forests. “Having worked for a while in African savannas and being very familiar with the idea that mixed tree-grass ecosystems were distinctive from forests, when we returned to India and started visiting various field sites, we were struck by the similarities of these sites with African savannas,” Ratnam told Mongabay-India in 2019.



The Cerrado is a mix of shrubby dry forest and savannah, and is one of Brazil's most exploited ecosystems. Image by Fabricio Carrijo via Wikimedia Commons (CC BY-SA 4.0).

Apart from needing fire and light, savannas also have a long association with animals that graze, studies have found. They've evolved to support both large, wild herbivores like wildebeest, rhinoceros, zebras, and antelopes, as well as nomadic pastoralists whose livestock feed on the grasses and small plants and keep the savanna ecosystem an open one.



Zebra in Namibia. Photo by Rhett Butler/Mongabay.

Still, for many, the image of a fire, or of a goat pulling out young saplings, might seem like a “disturbance” that humans have introduced to forests, resulting in forest degradation. Moreover, tropical savannas and forests can often occur side by side, within the same wet and warm climatic conditions. That raises the question: did savannas exist before humans started cutting down forests, or did humans degrade forests into savannas?

Current evidence suggests that many of the world’s tropical savannas are ancient. In Africa, for example, studies have found that savannas started spreading 10 million to 15 million years ago and were extensive by around 3 million years ago — long before humans started clearing large tracts of forests. Even in Asia, evidence suggests that these habitats existed before human arrival.

If you had to look at more recent history, a study from South Africa found that there were around 471,100 hectares (1.16 million acres) of “forests” in the country in 1750; the authors consider this to be a baseline, before humans started widespread conversion of land for other uses. Yet, AFR100 has a reforestation target of 3.6 million hectares (8.9 million acres) in the country. “So the target has got nothing to do with restoring forest. It was an arbitrary number, it was pulled out of a hat. It had no relationship to the real need to reforest areas that had been deforested,” Bond says.

AFR100 did not respond to a request for comment, but on its website describes Forest Landscape Restoration as “more than just planting trees” and mentions including savannah restoration as part of its commitment.

Collateral damage

Much of the recent emphasis on planting trees comes from international agencies and individuals from the Global North, and is based on the assumption that tree-less areas store very little carbon. Forests, on the other hand, are considered miracle carbon sequesterers.

Forests are great at storing carbon; there’s little controversy there. In fact, the loss of tropical forests contributes some 5 billion metric tons of carbon dioxide per year, which means that halting deforestation, and reducing fossil fuel emissions, are two powerful actions to take, if tackling the climate crisis is the goal. But Durigan says that tree-planting programs often “create the illusion that if we can plant trees in the whole world, we’ll neutralize all carbon emissions.”

For the goal of storing carbon, planting forests on grasslands or shrublands, however, can backfire.

In general, forests store most of their carbon in woody trunks and leaves aboveground. But much of the carbon in grasslands is in the soil (in extensive root systems of the grasses as well as decaying organic matter). In fact, grasslands, covering a quarter of the Earth’s surface, can store up to 30% of the world’s carbon, per some estimates. “Replacing savannas, grasslands and wetlands by tree plantation[s] is expected to decrease carbon storage in the soil, despite increasing aerial biomass,” Durigan says.

There is also the question of fire. Afforestation projects in grasslands or savannas have rarely planted “forests” of native tree species, and typically involved establishing monoculture plantations of fast-growing exotic species like eucalyptus or pine. These trees burn very well, and in case of fires, can turn devastating.

“Since fire is a natural factor in savannas, it will happen in the dry season despite human efforts to avoid,” Durigan says. In open savanna systems, such fires usually cause low carbon emissions and this carbon is quickly captured back when the grasses and plants regenerate after the fire, she adds. But “firestorms in forest plantations will irreversibly send huge amounts of carbon dioxide to the atmosphere.”

Tree-planting programs and governments say they’re paying attention to the kinds of species they grow. But it isn’t hard to imagine that plantations of eucalyptus and pine trees will still be common, especially with the kinds of targets they want to achieve in a short period of time. “Planting indigenous trees is slow and difficult,” Bond says. “We often don’t know how to get them to grow, and you can’t plant them over a million hectares. It’s difficult.”

On the other hand, growing large populations of pines and eucalyptus is easy; people have been doing it for a long time, Bond adds. Madagascar’s latest mass tree-planting drive, for example, includes exotic species like eucalyptus and acacia along with some fruit trees. But with a warming climate making droughts and heat waves worse, establishing plantations on vast tracts of grasslands could put the very forests you’re trying to protect at risk.

“Unbelievably, people are planting eucalyptus in Madagascar, next to the last remnants of their forests, and they’re bringing fire right into those forests,” Bond says. “It just indicates such ignorance. When the fires do happen, which they will happen undoubtedly, they’re increasing the risk to the forest massively.”



Eucalyptus plantation in Madagascar. Image by Rhett Butler/Mongabay.

Impacts of tree planting on climate change are complicated by other factors like albedo, the amount of sunlight that’s reflected back into space without being absorbed as heat by the Earth’s surface. Since land surface covered by forests is much darker than if covered by grasses or even crops, afforestation can lead to a decrease in albedo, Durigan says, which can lead to an increase, instead of the desired decrease, in air temperature.

Afforestation of grasslands, shrublands, or even native forests with plantations, a widespread practice for timber, are also known to create water woes. Several studies have found that, in general, such plantations consume more water than the original vegetation, which, in turn, reduces flow of rivers downstream. Long-term experiments have found this to be the case in South Africa, for example, which has extensive areas, including montane grasslands and shrublands, under eucalyptus plantations. Based on these results, the country formulated legislation to restrict afforestation with plantations.

Then there are the more obvious impacts of converting open, airy grasslands, savannas and shrublands into plantation forests: the loss of unique biodiversity. Losing savanna grasslands can mean losing animals like wildebeest, giraffes, rhinos, lions, blackbucks, and the great Indian bustard. The great Indian bustard (*Ardeotis nigriceps*) is one of the world’s heaviest flying birds. Once widespread, fewer than 150 are thought to remain in the wild today and the species is listed as Critically Endangered by the IUCN. One of their chief threats is the decline of India’s grasslands. Image by Prajwalkm via Wikimedia Commons (CC BY-SA 3.0).

So, planting thousands of seedlings in naturally open areas can, in fact, be disastrous if done too quickly without adequate evaluation. But there *is* value in planting trees in non-forested areas like agricultural lands, or in helping native trees in degraded grasslands and arid areas regenerate.

Restoring degraded habitats

Let’s consider Regreening Africa, a program that aims to “reverse land degradation on 1 million hectares [2.5 million acres] across 8 countries in sub-Saharan Africa.” Since the demand for agricultural land is a major driver of deforestation in sub-Saharan Africa, the program focuses on restoring degraded lands in agricultural farms and community lands by integrating trees into the landscape. Not just any trees, but trees that the communities want.



“Rule number one is let natural regeneration occur, especially in areas where you don’t have a lot of human pressure,” says Susan Chomba, a social scientist and program manager of Regreening Africa. “It’s going to encourage not just the tree species themselves, but other kinds of biodiversity that naturally exists in that area. It’s less expensive, and it’s the most kind of effective way of letting nature heal itself.”

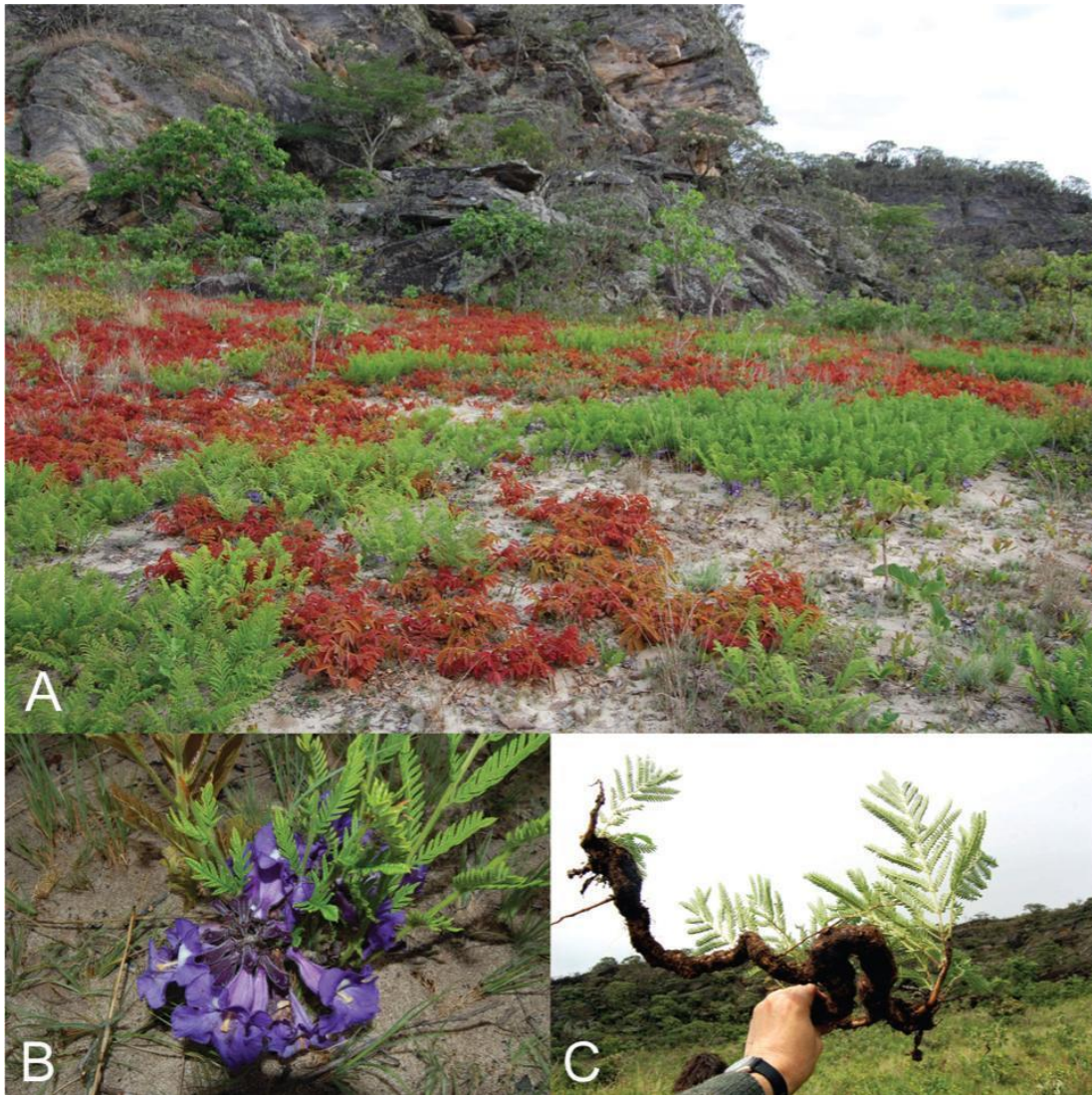
But where there is human pressure and natural regeneration might not work well, the program asks a fundamental question: what is it that needs to be restored?

The answer isn’t based on scientific measurements alone, but also on what farmers and pastoralists in the area want. Do they want more fruit trees to earn more income? Do they want more water in the area? Do they want the soil on their lands to be more productive, and wash away less frequently when it rains? “If fruit trees is the end goal, we need to understand what kind of diversity of food resources are suitable for that area and are needed by farmers,” Chomba says. “If farmers want water, we try to figure out what kind of tree species native to these ecosystems can help restore hydrological functions.”

This may look like a meadow of small groundcover plants (A), but it’s actually the canopy of a *Jacaranda decurrens* tree in Brazil’s Cerrado. In addition to leaves, the tree also flowers aboveground (B). Like conventional trees, the underground branches of *J. decurrens* are woody (C). Photo courtesy of Alves et al., 2013.

It’s not been easy, Chomba says, because governments and various NGOs still tend to hand over hundreds of eucalyptus saplings to farmers to grow on their lands. Farmers, too, accept these species as the default trees to plant. This was the case in Rwanda, the team found.

“We engaged with the local district and subdistrict government, and we found that most of the seedlings being prepared by the cooperatives were eucalyptus,” Chomba says. “When we discussed this, they said, ‘Oh, but if you grow other kinds of seedlings the farmers are not going to be interested. These are the ones that farmers are interested in’.”



But when the team started holding discussions with the farmers themselves, with the government officials present, the narrative shifted. “We asked them, ‘Could you please tell us historically what kind of tree species existed in these ecosystems?’ And my goodness, they were naming hundreds and hundreds of different kinds of tree species and their functions.”

The farmers named species that were extremely important to them for their medicinal value. Some species gave them important food, fruits and nuts. Then there were tree species, whose presence indicated there was water around. When the team asked them if they would like to see these species come back in their areas, there was a resounding “yes.” Eucalyptus was good for timber and firewood, they said, but they would like to see the other ecosystem services, like more water, return to their lands. Chomba’s team then worked with the government, cooperatives and farmers to revive some of the native species.

“In some areas in Rwanda now, farmers really demand these indigenous tree species,” Chomba says. “We saw a big transformation there, not because of something that was completely out of big scientific innovation, but by engaging with the local knowledge in communities to look back at what used to exist in their landscape and what they’d like to see.”

Such engagement is uncommon, though. In India, for example, the law requires “compensatory afforestation” whenever infrastructure or mining projects involve cutting down forest areas; the forest loss has to be “compensated” for by either establishing a plantation over an equivalent area or by depositing money with the forest department to do so. In a country where land is an incredibly valuable resource, marginal communities often end up [losing their lands](#) for these “compensatory forests,” usually without their knowledge or any form of consultation on what the communities might want.



Grassland mixed with forest in Bandipur Tiger Reserve, India. Image by Jaseem Hamza via Wikimedia Commons (CC BY-SA 3.0).

Even if the local communities are consulted, whether they will support those trees' growth for years to come and care for them depends on whether they see more value in the trees remaining standing, or in cutting them down or not tending to them. Land tenure, where the farmers have an ownership in the trees and land, can provide that value, [examples](#) from Africa have shown. "Everybody now knows that land tenure is a big problem," Chomba says. "People also know the solution, but they don't want to get into that because it means you have to engage with the local authorities for a long period of time in trying to change the laws. It's not as simple as planting a tree and saying I planted a million trees. So we need to be able to understand the policy bottlenecks and be prepared to do the hard work to change them."

Overall, agroforestry, if done well and keeping in mind the local context, can achieve lots: it can increase the productivity of soil, improve microclimate as well as water and food security, and build resilience to climate change. But whether these benefits actually materialize needs to be monitored systematically, Chomba adds.

Durigan says planting trees in farmlands is a good way to restore degraded lands. But she doesn't consider agroforestry to be true reforestation or afforestation.

"I do like productive systems with trees spaced, especially in degraded land, no matter if it was not a forest before. It is better than monocultures," she says. "But agroforestry does not result in a true forest. It is not afforestation nor reforestation, since both are expected to create a continuous canopy and a forest structure. Agroforestry is a productive system where trees and crops share the space, aiming at improving degraded soils or to have an ecologically 'healthier' land use."

Not everyone loves a forest

Forests are culturally important for many people around the world. Dense, mysterious forests have been a part of stories, nursery rhymes, poems and movies. But those who live in areas that have naturally been non-forested — grasslands in India, [rolling meadows](#) in Scotland, Cerrado in Brazil — don't necessarily want them.



Shola grassland in India's Kudremukh National Park. Image by Kousik Nandy via Wikimedia Commons (CC BY-SA 4.0).

The loss of open areas to forests or plantations can mean losing an entirely unique landscape.

"We cannot see the horizon anymore," Durigan says. "We cannot see the blue sky, the rain falling, the mountains and the valleys, we cannot feel the breeze on our faces. Unfortunately, this ecosystem service is not perceived by the urban society."

The Shola grasslands atop the mountains of the Western Ghats in India, home to the pastoral [Toda community](#), for instance, now have extensive stands of invasive acacia trees that have spread from plantations that were originally established by the British who settled there. With the trees proliferating, the community's traditional cattle rearing has become difficult. Unlike the grasslands that made spotting predators easier, the trees now provide cover for carnivores, increasing human-animal conflict. There's been loss of grasses that the community used in their daily lives; wetlands have disappeared; tribe members are increasingly forced to migrate to other places for work.

Bond says he loves trees, but he doesn't want them everywhere. "My garden is full of trees; I love them," he says. "But a forest is a dank dark place. Here in my part of the world, we love the open spaces too. We love grass. This is my mantra: 'the right tree / in the right place / for the right reasons'."

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