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NEWS FEATURE

The best strategy for using trees to improve climate and ecosystems? Go natural

Despite big headlines and big money devoted to massive tree-planting projects that pledge to stave off desertification, the most effective method may be nurturing native seeds, rootstocks, and trees.

John Carey, *Science Writer*

Near the start of the rainy season in June 1983, Tony Rinaudo hauled a load of trees in his truck to be planted in remote villages in the Maradi region of Niger. Driving onto sandy soil, Rinaudo stopped to let air out of his tires to get better traction, and was hit by a sense of futility. For years, the Australian missionary had been working to improve the lives of people in one of the poorest countries in Africa by planting trees. But it wasn't working. Most of the trees died or were pulled out by farmers. Standing beside his truck, all he could see was dusty barren plain, broken by a few scraggly bushes. "It dawned on me that I was wasting my time," he says.

A man of deep faith, Rinaudo asked God for guidance. In a moment of clarity, his eye caught sight of one of the bushes. At closer look, he realized that it was no mere bush or weed; instead, it was a potentially valuable native tree—if permitted to grow. There was no need to plant trees; they were already there. "At that moment everything changed," he says. Even a seeming desert harbors tree stumps, roots, and seeds that can be encouraged and nurtured—"a treasure chest waiting to be released," says Rinaudo. "And if you allow some trees to grow, amazing things happen."

Starting in 1985, 20 years of regeneration transformed barren, degraded land in the African Burkina Faso village of Ranawa into a fertile farm. Image credit: Chris Reij (World Resources Institute, Washington, DC).

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Rinaudo's epiphany led local farmers to add at least 200 million trees across more than seven million hectares in Niger—at up to 60 trees per hectare. The crucial twist: They did so without planting any new trees.

The regreening brought "spectacular" results in terms of crop yields and farmers' incomes, reports a 2019 article (1), and the idea was used in other regions such as northern Ethiopia, where, over the course of several years, long-dormant springs bubbled to life and living standards climbed as nascent forests captured water, improved soil fertility, and boosted crop yields. The collective effort has been one of the most effective responses to the growing problem of the degradation of the world's drylands (those limited by water scarcity but capable of supporting some vegetation), such as the Sahel region of Africa, says Tim Christophersen, head of United Nations (UN) Environment Programme's Freshwater, Land, and Climate Branch. "It all came together in a perfect storm of success."

Yet these results were largely unknown or simply unaccepted for years by governments and international aid organizations in the battle to restore the world's drylands to fertile lands and to combat so-called "desertification"—the perceived threat of an encroaching desert. Instead, large—and some say flawed—tree-planting efforts often were chosen.

But the idea of nurturing native greenery is now gaining traction—and that, proponents say, will open the door to restoring vast areas of degraded lands, improving livelihoods of millions of smallholder farmers, reducing migrations of impoverished populations, and fighting climate change by soaking up carbon dioxide. "We're passing a tipping point, where the idea of natural regeneration is really beginning to snowball," says Dennis Garrity, Drylands Ambassador for the United Nations Convention to Combat Desertification.

Not Easy Staying Green

Historically, big-ticket tree-planting projects, not natural regeneration, have reaped most of the attention and support globally. In the mid-1980s, Burkina Faso's president Thomas Sankara proposed planting a line of trees 7,000 kilometers long across Africa in a "Great Green Wall" to hold back what was thought to be relentlessly spreading sands, and the Green Wall idea was resurrected by Olusegun Obasanjo, president of Nigeria, in 2005 (1). In June 2019, Ethiopia's minister of innovation and technology, Getahun Mekuria, claimed that his country had set a new record for the number of trees planted in one day, 353 million, garnering headlines (and skepticism) around the world (2, 3).

The focus on tree planting to fight desertification has two main problems, experts now say. First, the Sahara Desert isn't expanding, as was feared to be the case during droughts in the 1960s and 70s—and second, planting trees wouldn't be a solution, in part because the track record for projects to plant trees is so poor. "In the Sahel, the Pavlovian reaction has been to say, 'let's plant trees,'" says geographer Chris Reij, a senior fellow at the World Resources Institute (WRI) in Washington, DC. "But it has had disappointing results." Studies in Kenya and Senegal show that the mortality of the planted trees is high—80% or more (4).

Deep planting pits filled with manure and other organic matter, a traditional technique called *zaï*, has brought life back to hard, barren lands in Africa's Sahel region. Image credit: Chris Reij (World Resources Institute, Washington, DC).

The many reasons for poor survival of trees include lack of watering and proper care, cutting trees for firewood, clearing trees for planting crops, little ownership of trees by local farmers, and mismatches between the species planted and local conditions. "It's easy to entice people to plant trees, by paying or having a big campaign like Ethiopia's," explains Graham Wynne, advisor to the UN Global Commission on Adaptation. "But the trees require watering and nurturing for years, and getting people to do that, especially when the trees may be miles from their houses, just doesn't work." The main successes for tree planting are seen in commercial plantations for timber harvest, not restoring degraded lands.

The big, expensive tree-planting projects purportedly aimed at land restoration still continue, however, whereas the idea of naturally regenerating trees that are cared for by local communities typically has gotten short shrift, says Reij. "Too few people know the story."

Planting the Seed

For years, Rinaudo has been trying to tell that story. Now at World Vision Australia, a Christian humanitarian organization based in Melbourne, he is bringing the approach to 27 countries and is finally winning international recognition (5, 6). Under the African Forest Landscape Restoration Initiative (AFR100), 28 countries have committed to restoring 113 million hectares with various approaches, and in the last couple of years the Great Green Wall effort has shifted its focus: less tree planting, and more work with local communities to promote natural regeneration. "We moved the vision of the Great Green Wall from one that was impractical to one that was practical," says Mohamed Bakarr, the lead environmental specialist for Global Environment Facility (7).

At Climate Week in September 2019, Garrity and a group he chairs called the Global EverGreening Alliance launched an effort to massively scale up the

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approach to capture significant carbon emissions at a fraction of the cost of other solutions such as alternative energies. And the World Bank, long wedded to big tree-planting projects, is beginning to switch to land restoration efforts based on natural generation. "All of a sudden the major giant donors are waking up," says Rinaudo.

Even in areas where the ground is so hard and dry that virtually nothing grows—"as hard and barren as your desk," says Garrity—drylands can be restored without planting trees. Locals use an ancient technique called *zaï*, revived in the 1980s by a farmer in Burkina Faso named Yacouba Sawadogo. People dig deep planting pits and stuff them with manure and other organic matter (8). The holes trap water, making it possible to grow crops again, and tree seeds in the manure germinate to bring back the tree canopy.

Rinaudo's key insight, however, was that tree stumps, roots, or seeds still exist in the soils of most degraded land in the Sahel region of Africa and in drylands around the world, just waiting for the right kind of changes in land practices (including grazing patterns and burning practices) that allow trees to grow. "Most ecosystems in the world have remnant seeds in the soil, and natural regrowth can be cheaper and more successful than tree planting," says Christophersen.

> "The desert is not advancing, and even if it were, a line of trees would not make much of a difference."
>
> —Jonathan Davies

The approach is almost "embarrassingly simple," says Rinaudo. Stumps, rootstocks, and tree seeds in the soil naturally sprout. Instead of clearing the fields for crops, farmers allow 20 to 60 trees per hectare to grow. Each year, the farmers prune the trees, lopping off the weaker shoots to create a tree with a trunk and a canopy. In as little as two years, the tree can spurt up 10 feet (6). Such agroforestry was common in Africa before colonization, Rinaudo explains, "but with modernization and colonial agriculture methods of clearing the trees, people lost the habit of leaving trees on their land."

Bucking Tradition

Bringing back agroforestry and proving its benefits wasn't easy, however. "The idea of trees being compatible with crops like sorghum, millet, and maize was basically anathema to Western agricultural science practices," explains Garrity. "The mindset was to have monoculture of crops like in the United States, the United Kingdom, and Europe." Plus, devastating droughts in the Sahel region of Africa in the 1970s and early 80s had caused desperate people to cut most of the few remaining trees for fuel or for wood to sell to buy food.

Nor did it help that in many African countries, especially those colonized by France, trees were legally owned by the national government. Local farmers were not allowed to cut, prune, manage, or benefit from them without a permit that was costly and often difficult to get. "That policy alone was a huge disincentive," says Garrity. "Farmers were afraid to have trees on their farms."

So when Rinaudo proposed to farmers in Maradi that they grow and prune trees, they were skeptical. "Most people thought I was mad," he says. In 1983, he was able to convince only one farmer in each of a dozen villages to bring back trees on small parts of their land—and "they were laughed at and ridiculed," he recalls.

Then another severe drought struck in 1984. The organization Rinaudo was a member of, Serving in Mission (SIM), mounted an urgent food distribution effort to fight starvation. Rinaudo saw an opportunity. SIM required that people getting aid in about 100 villages also allow trees to grow—hundreds of thousands of new trees.

When the next two years brought bountiful rains, the farmers saw that crops grew just fine—better in fact—when trees dotted the fields. Plus, regular pruning of weaker shoots gave local people fuel wood and fodder as well. "The spark was there, and it began to spread," says Rinaudo. The approach became known as farmer-managed natural regeneration (FMNR).

No one knew for sure how much FMNR had caught on until WRI's Chris Reij had what he calls his "Apostle Paul" moment in 2004. After giving a presentation on farmers' innovations at a university in Niger, the faculty dean took him to see lands where farmers had brought back the trees. Reij was amazed at the transformation. He snared funds for a research study. With flyovers and satellite images, he and Gray Tappan of the US Geological Survey showed that local people—on their own—had naturally grown trees on more than five million hectares without any planting (9). And a study just concluded in Malawi found that trees have been brought back by farmers on 3.2 million hectares, 70% of all cropland in the nation. Until the studies were done, "no one had the slightest idea that this was happening," says Reij.

Growing Together

There are good reasons why traditional agriculture in the drylands of Africa typically included trees. In modern Western systems, such as the cornfields of Iowa, crops and trees on the same field would compete for water, sunlight, and nutrients during the growing season. In the drylands, in contrast, "crops only grow in the rainy season, but trees grow all year," explains Garrity. One especially important tree, the acacia, drops its leaves during the wet season, so there's no competition at all with crops, and it also offers a host of benefits. It grabs nitrogen from the air, helping to fertilize the soil, and provides high-protein fodder for livestock. "It's a wonder tree," says Garrity.

Similarly, baobab trees offer nutritious leaves and fruit, and shea trees provide oil for cooking and cosmetics. These trees also shade the soil and crops, cutting soil temperatures by as much as 36 °C and

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increasing the humidity in the crop canopy, thereby promoting crop growth. Branches and foliage slow winds, reducing the threat of blowing sand covering up crops, and the trees increase infiltration and storage of rainfall. Some species even pull up water from far below ground using deep tap roots and spread water through the soil. And when trees come back, lizards, birds, and spiders return too, helping to fight insect pests.

In the early 1980s, scarcely any trees could be seen between the village of Dan Indo in Niger and the paved road almost two kilometers away, village elder Sule Lebo recalled to journalist Johannes Dieterich (10). At best, Lebo harvested 150 kg of millet per hectare. Then he became one of the first to buy into Rinaudo's vision. Now he gets 500 kg of crops per hectare, while also raising goats, sheep, and chicken and selling timber.

Indeed, studies have documented remarkable transformations. A 2009 article reported that the first five million hectares regreened in Niger with farmer-managed natural regeneration, then home to more than 14 million people, produced at least 500,000 additional tonnes of food per year, enough to feed 2.5 million people (9, 11), and over the course of roughly 20 years, the daily time spent gathering firewood—a task that mainly falls to women—dropped from 3 hours to 30 minutes (12). After Mali changed its forest policy to allow local farmers to manage trees in 2000 and 2001, there was an explosion of FMNR, says Garrity. Yields for millet and sorghum rose up to 30% (11). In the Kiambogoko district in Nakuru county in Kenya, bringing back trees has lifted incomes from maize, honey, and milk by 170% to 900% (13).

Some countries have actively encouraged farmer-led efforts. As in Mali, Niger changed its tree ownership law in 2000, giving farmers more control over their trees; "that was a major catalyst," says Jonathan Davies, Global Drylands Coordinator at the International Union for Conservation of Nature. When Macky Sall became president of Senegal in 2012, he reversed the previous long-standing push to clearcut fields. "Now there are millions and millions of trees growing in fields," says Garrity.

But the success stories to date cover just a small fraction of the estimated 350 million hectares of degraded land. Part of the reason for this slow progress is the desertification misconception, dating back to the 1920s, that the Sahara Desert was relentlessly marching south, swallowing up farms and villages, and could be stopped with a line of trees. The problem is that "a wall of trees doesn't make any sense," says Davies. "The desert is not advancing, and even if it were, a line of trees would not make much of a difference."

Bearing Fruit

Yet major development banks, national governments, and national forestry departments have still been mostly wedded to large, costly tree-planting projects, which bring in revenue for countries and generate publicity. "Forestry departments are set up to make money and they want to plant trees," Garrity says. "There is some logic to it, but in most parts of the world, these projects fail—and they keep doing them over and over." At an estimated cost for tree planting of about $500–1,000 per hectare, wasted investment has climbed into the billions of dollars. In contrast, tending and pruning naturally regenerated trees is dirt cheap, with a price tag of less than $20 per acre, Reij estimates—hardly the stuff of splashy headlines. "Neither donor agencies nor governments like low-cost projects," says WRI's Reij. Another reason has been the reluctance to believe that uneducated poor farmers, using cheap natural regeneration or ancient techniques such as *zaï*, could do better than the experts.

Nevertheless, Reij and others are starting to change the narrative. "There's now a growing movement around the world on landscape restoration," says Paola Agostini, lead environmental economist in the Environment and Natural Resources Global Practice at the World Bank. The ramifications have included the first scaled-up projects funded by the Bank in countries like Ethiopia. In March 2019, the UN declared the start of a "Decade of Ecosystem Restoration" to encourage techniques like the natural regeneration in Niger (14, 15). And the Great Green Wall project has shifted to become a metaphor for such restoration, rather than a literal line of trees.

Christophersen also anticipates rapid growth in international finance for restoration projects, given the proven returns in increased agricultural productivity and in monetizing carbon capture and storage. He sees a parallel with renewable energy; few invested until the incentives and market forces changed sufficiently. "Financing the transformation of the landscape could be a new era for big development banks," Christophersen says.

For Rinaudo, the growing support for natural restoration is a vision realized. "There is something glorious about going out there and planting trees," he confesses. "But I do farmer-managed natural regeneration 10 times more vigorously because I can have so much more impact."

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