The Rainforest Saver

Daniel Elkan 01/02/2005

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After more than 20 years work, Mike Hands, a British tropical ecologist has come up with a groundbreaking way to stop vast areas of rainforest from being destroyed. But will his pioneering technique be given a chance?

Mike Hands could hardly bear to look. Only a few years ago it had been thick rainforest. Now it was just grass and weeds. Slash-and-burn farmers had cut down and burnt the forest to grow crops to feed their families. After only a year or two the land had become infertile, forcing the farmers to move on.

Working for the Honduran government as a surveyor of river-flood control, Hands was constantly seeing forests destroyed by slash-and-burn farming. Each time, the same questions plagued him. Why did the soil become infertile so quickly, compelling farmers to leave? Wasn't there another method of cultivation that would keep the land fertile, so that the farmers could stay on the same land?

As a keen organic gardener he was convinced there had to be a simple, non-industrial solution to the problem. Night after night he pored over books and journals on soil husbandry, organic gardening and farming. While they were full of techniques for keeping soil fertile, they shed very little light on why tropical soils can sustain crops for one to two years but then no more.

A few hours reading after work just wasn't enough. Hands realised he was going to have to study the problem full time. But at 39, with a wife and four young children to support, he wasn't sure he was up to it. And with no savings of any note, the only way to finance his studies would be to get a loan using his Cornish home as security. But he felt compelled. So in April 1984 he returned to the UK, and persuaded Cambridge University to let him start a one-year MSc on slash-and-burn.

Today there are estimated to be more than 300 million slash-and-burn farmers worldwide, each one clearing about a hectare of forest a year. 'El Salvador has been completely deforested, as have the virgin forests in the lowlands of Costa Rica, Peru, Honduras, Venezuela, Columbia and vast areas of Brazil,' says Hands. With as much as 40 per cent of the planet's carbon being stored in forest vegetation, slash-and-burn is an increasingly significant factor in climate change.

For the slash-and-burn farmers themselves, the situation only gets worse. With the land around their villages long since exhausted, they typically have to trek two or three hours into the hills to work. As this prevents other family members from helping with cultivation, the farmers are left with a backbreaking workload. All around, available land is running out fast. Often farmers slash-and-burn their way up to the top of a hill, only to meet other farmers who have slashed and burnt their way up the other side.

Increasingly with no fresh forest to slash-and-burn, farmers are going back, too soon, to previously farmed areas. With the land not yet recovered and the soil still infertile, the returns are meagre. Facing starvation, the farmers try their luck on any remaining patches of forest that were missed the first time round, usually on steep slopes unsuited to cultivation. Tragically, this destroys the last remaining forest seed sources in the area, and makes natural forest regeneration impossible.

In desperation, some farmers move to cities. There, they mostly end up begging or trying to live off rubbish dumps. Their only other option is try to get temporary work on a plantation: hazardous toil for a pittance, in slave-labour conditions.

Meanwhile, the slash-and-burn problem rarely makes news. 'It's partly because, unlike damage from hurricanes, the destruction is gradual,' says Hands. 'But it is also because people feel so helpless. They think: “Don't show me a forest burning. What the hell can I do?”'

In Cambridge Hands attended as many as 30 lectures a week, on subjects ranging from soil ecology, plant ecology and soil chemistry to the geography and climate of Central America. As the undergraduates partied and enjoyed their newfound freedom, Hands was running from lecture to lecture like a man possessed. Meanwhile, his weekends were spent in the library digging up obscure papers, hoping to unravel the mysteries of crop failure on tropical soils.

Despite exhaustive research, however, it remained a frustrating puzzle. Nobody could say for sure whether the cause was insect pests, crop disease, nutrient-depletion in the soil, or weed growth. Two leading studies suggested that soil on slash-and-burn sites might be losing phosphorus, an important element in plant growth, but went no further.

When the year was over, Hands still hadn't found the answer. And although he stayed on for a second year, by the time his second term was halfway through he had had enough of theory. He wanted to hear from the farmers themselves about the kind of problems they faced.

The best place to go, he reasoned, was where fertility was failing fastest: the acid soils of the Costa Rican rainforest. In March 1986 Hands arrived in Costa Rica and headed for the 'agricultural frontier', where farmers were hacking into virgin forest. He stayed in an old crumbling farm and befriended a forest guard, who introduced him to the farmers. Once they were assured that Hands was not from the government, they were happy to talk.

'I asked the farmers about the cropping sequence and yields,' says Hands. 'They were tremendously patient. They showed me the different textures of fertile and infertile soil; how, as soon as they cleared the land, rampant weeds and grass would invade. One of them had spent 160 days a year hacking at grass with his machete just to be able to get a crop to eat. I said to them: 'Suppose you had a system that simply let you stay in one place, cropping maize…' They replied: “Ah, yes - that is a dream!”'

From everything the farmers had said, it seemed likely that the problem was nutrient levels in the soil. Hands suspected phosphorus might be being depleted. Was there a crucial difference between soil from slash-and-burn sites and soil from virgin rainforest? Although comparisons had been made some years before, Hands wanted to do the tests himself to see if something important had been missed. So he returned once again to his laboratory at Cambridge, this time with 50 kilogrammes of Costa Rican soil.

It took many months of seemingly fruitless experiments, many consultations with different chemistry experts, before Hands found what he had been looking for. Contrary to what previous research had claimed, but as Hands had thought for some time, the soils cleared by slash and burn had lost masses of 'total' phosphorus. Even though he did not yet have the data to show when, or how quickly, the loss had taken place, one thing was certain: only a fraction of the phosphorus would have been used up by the crops; the rest of it was being wasted - washed out of the soil by rain.

Having proved his theory, he turned his attention to finding a way of combating the problem. He knew that alley-cropping, a method of farming pioneered in Nigeria and in which crops are grown between rows of trees, allowed nutrients to be retrieved from the soil and recycled by the crops. But Hands also knew that for alley-cropping to work on rainforest soils, it would not only have to stop phosphorus and other elements getting leached out of the soil; it would also have to fix nitrogen, control weed growth, and be practical for some of the world's poorest farmers.

Up till then alley-cropping systems had used fast-mulching, small-leaf trees, but in these Latin American tropical conditions the trees would need to be adaptable to very shallow acid soil. Furthermore, when the leaves fell they would have to provide a thick blanket of mulch to protect the soil from the heat of the sun so as to allow the roots to raise to the surface and into the mulch itself. In effect, the alley-cropping would have to mimic the conditions found in the virgin tropical forests.

Could this be achieved? Hands was confident that with the right type of tree the system could be made to simulate what rainforests do naturally: first, stop weed growth by a combination of shading and smothering; and secondly, recycle nutrients through slow leaf decomposition.

His plan was to plant seedlings of fast-growing, thick-leaved trees in long rows a few metres apart. When the trees had grown, the leaf canopy formed would shade the alleys between the rows of trees. In the dark alleys, the light-hungry weeds and grass would not survive. Once the ground was weed-free, the trees would be pruned and the leaves put on the ground to form a decomposing leaf layer several inches thick. This leaf layer would smother any further weed growth, and at the same time stop the sun from drying out the ground. Finally, holes would be poked in the leaf layer, and crops planted in the holes. The crops would get nutrients from the decaying leaves, while excess nutrients would be absorbed by the trees' roots and returned to the ground in subsequent prunings.

The theory seemed sound; what wasn't was the financial backing to carry out a pilot study. Since 1986 Hands had been applying to several UK governmental and European organisations for funds to carry out a seven-year research project in Costa Rica. After 18 months, though, all he had was a pile of rejections. Even the Overseas Development Agency, on which he had pinned much hope, had written him a curt reply that didn't give any clue as to why his application had been unsuccessful. It seemed nobody was interested in what he was doing.

Then, in March 1988, Hands received the letter he'd never fully believed would come. He had to read it three times before he could believe it. The European Economic Council was offering him £2m to fund his project.

By March 1989 Hands was back in Costa Rica. With the help of a botanist friend from Kew, he had selected an Amazonian tree Inga Edulus, which had the qualities required: thick, tough leaves, fast growth, and the ability to fix nitrogen in the soil. But most importantly it was intensely mycorhizal, symbiotically using fungi to absorb phosphorus into its roots. He was ready. Across his two-acre site he set up a range of study plots. Areas of slash-and-burn stood side by side with virgin forest and alley-cropping test plots sown with thousands of Inga seeds.

Researchers he talked to in Costa Rica were not convinced. They said the Inga leaves would decompose far too slowly to feed the crops: the system was bound to fail. Hands remained convinced. He knew about organic decomposition in rainforest soils. He was sure that instead of the crops feeding on the most recent deposit of leaves, they would feed on the decaying leaves laid down one or two years previously.

It was to be another four years before Hands would have the evidence that Inga alley-cropping really worked. The maize crop was in its second year, weeds were being stopped, and the Inga was recycling nutrients, including phosphorus. More importantly though, Hands was able to find out just how crucial phosphorus was to the plants.

After three years of cropping, the soil on the slash-and-burn patch was infertile, the plants on it struggling. Hands divided the area into smaller plots, and to each plot he had added a different soil nutrient. Three weeks later he returned to find that no plot had changed - except the one to which he had added phosphorus. On that plot, every kind of plant had suddenly flourished. So desperate were the plants for phosphorus that they neglected every other element.

To uncover the reason for phosphorus loss, Hands analysed hundreds of soil samples taken at every stage in the slash-and-burn simulation. The data revealed a total surprise: the level of phosphorus in the soil only a few weeks after the forest was burnt was exactly the same as the level before the burn. Rainforest naturally contains too little readily available phosphorus to provide for the needs of crops, but the ash left over after burning the forest contains a massive amount. It had been thought that the ash provided the crops with the phosphorus they needed. But Hands' data showed the phosphorus in the ash was being washed out before the crops could absorb it.

This created a puzzle. The farmers were getting decent crop yields for the first year or two, so the extra phosphorus needed must be coming from somewhere. If not from the ash, then where?

Hands realised what was happening. Ash on the soil has the same effect as liming a compost heap: it speeds up the process by which soil microbes decompose organic matter, such as dead leaves and branches. It was this process which was releasing the phosphorus.

However, new data revealed this extra phosphorus release was only lasting two years. Then, coinciding with the crop failures, there was a dramatic drop in phosphorus levels. Again, Hands had an explanation. Phosphorus is released as a result of microbes in the soil feeding on fallen organic matter. When the farmers clear and burn the forest, this supply of organic matter is cut off. For the following two years, the microbes feed on the organic matter that has already fallen. But when this runs out, they die. In turn, phosphorus-release ceases. With no phosphorus-retrieving trees there to take it up, any remaining phosphorus is washed out of the soil by rainfall.

This also explained the success that Hands was getting with the Inga alley-cropping: the continuous supply of leaves was feeding the microbes, while the Inga trees absorbed and recycled the phosphorus before it could be leached out of the soil.

By 1996, despite the success of his experiment, Hands wanted a further series of trials. He knew that farmers had been let down too many times by much-hyped 'magic solutions'. A conversation with a Honduran NGO called Pico Bonito soon changed his mind.

'They told me the destruction of rainforest out in Honduras was so awful that I should stop pussy-footing around and let farmers try my system immediately,' remembers Hands. Just three weeks later, with Pico Bonito's help, he began approaching Honduran slash-and-burn farmers.

Victor Coronado from Atlantida in northern Honduras was one of the first. His initial response was sceptical. 'The first thing I thought was that it doesn't make sense to plant corn or beans under the trees,' Coronado recalls. However, as Hands was only asking him to give up a small part of his land, not large enough to risk his livelihood, he agreed to give it a try.

Six years on, Coronado stands surrounded by proof that Hands' technique works. Where there used to be grass and weeds, tall, leafy maize plants now rise above his head. In a field nearby, alley-cropped pepper plants are flourishing, while in Coronado's kitchen there is plenty of the vanilla that he grew last year.

More than 30 farmers have adopted the scheme, each with a plot of Inga alley-cropping located only metres from their home. With the crops so close by, they can be more easily guarded from wild animals, and the rest of the family members are more easily able to help in the field. 'When I go out it does not worry me now, because my wife, my daughter or a neighbour can look after the crops,' says Coronado. In fact, Coronado's wife took over the running of the pepper crop completely. After harvesting and grinding, she mixed it with cumin and sold it in the town square. 'She has made $900 for the family selling pepper,' Coronado beams. 'All of us can produce crops that are 100 per cent organic. If more farmers get involved, between us we could even sell some of the crops abroad.'

Once it is set up, say the farmers, Inga alley-cropping requires less time and effort than slash-and-burn. From the second year of harvesting onwards, they save at least 40 days work a year, because there are no more weeds to deal with. On top of that, the trees produce a copious supply of firewood, which the farmers would otherwise have to spend many days gathering from the forest.

Moving over to the system costs the farmers almost nothing. For each hectare of alley-cropping, farmers need to plant 5,000 Inga trees. Once these are grown and the system is up and running, farmers can replace the phosphorus the crops use up by adding rock phosphate to the soil. This organic supplement is cheap: an $8 sack is sufficient for an entire hectare of land for a year. 'The low cost makes it sustainable,' says Hands. 'They need to invest their time at the start, but they don't get into debt.'

Sadly, only a few of the many farmers wishing to do so have been able to try the scheme. The problem is a shortage of Inga seed. Although they produce 2,000 seeds each, the Inga trees used in alley-cropping are pruned before they produce fruit. Some trees need to be left deliberately unpruned to act as a seed source. Initially, farmers like Coronado did not do that: a problem Hands had not foreseen. 'In hindsight, we should have told the farmers to keep some trees aside for seed production,' Hands says. 'But at the time we just wanted them to try the system in the first place.'

Hands and Pico Bonito have recently set up seed orchards, which within a couple of years should be providing some of the seeds needed to cope with demand. For the time being, however, farmers wanting to adopt the system are having to wait. And there are lots of them. So far, 4,000 farmers have been shown plots of Inga alley-cropping at demonstration farms in Honduras. 'The response was overwhelming. The farmers were all clamouring for seeds and technical assistance,' says Hands. 'Unfortunately, we could only give out handfuls of seeds.'

To make matters worse, at exactly the time when investment in Inga seed orchards and demonstration farms is most needed, funding from the EU has dried up. So Hands is once again back in his native Cornwall applying for funds. Meanwhile, Pico Bonito has to rely on donations to carry on the work.

With money from an individual donor, Pico Bonito has set up seed nurseries in the Honduran province of Olancho. 'We have 8,000 seedlings there,' says the organisation's Gerado Vasques. 'But we desperately need more money to expand. The eagerness of the indigenous people is encouraging. They want to try Inga alley-cropping not just on small plots but on big plots of over a hectare, to produce large crops of maize and beans. We hope we can fulfil Mike Hands' dream.'

With no response from the EU, Hands is hoping that charitable and philanthropic organisations might recognise the value of alley-cropping. Demonstration farms and seed orchards have the potential to save vast areas of rainforest for minimal outlay. A farm visited annually by 4,000 slash-and-burn farmers would cost only $12,000 a year to run. If those 4,000 farmers then converted to Inga alley-cropping, 4,000 hectares of rainforest would be saved - each year. Seed orchards cost next to nothing to set up and run, and a one-hectare seed orchard provides enough seed for 1,000 hectares of Inga alley-cropping. At a time of growing alarm over the worldwide loss of rainforest, it seems absurd that money is not being made available.

Unfortunately, too few people even know that this proven alternative to slash-and-burn exists. Hands admits he is not good at publicising his work. Yet all across South and Central America, seed orchards are desperately needed. 'Even without these, Inga alley-cropping will spread from neighbour to neighbour,' says Hands. 'But that would be painfully slow. If we just sit and wait, we will lose this chance to save the rainforests forever.'

Daniel Elkan is a freelance journalist