An alternative to slash-and-burn

Daniel Elkan

Mike Hands, a British tropical ecologist, was constantly seeing forests destroyed by slash-and-burn farming. 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. Why did the soil become infertile so quickly? Wasn't there another method of cultivation that would keep the soil 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.

Hands wanted to hear about the kind of problems farmers faced. The best place to go, he decided, was where fertility was failing fastest: the acid soils of the Costa Rican rainforest. 'I asked the farmers about 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 for cropping, 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.'

From everything the farmers had said, it seemed likely that the problem was nutrient levels in the soil. Hands suspected phosphorus might be depleted and contrary to what previous research had claimed, he discovered that the soils cleared by slash-and-burn quickly lost masses of phosphorus. Only a fraction of the phosphorus available in the ashes after burning was used by the crops; the rest of it was being wasted – washed out of the soil by rain.

He knew that alley-cropping 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.

Conventionally, alley-cropping systems use 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, falling leaves would have to provide a thick blanket of mulch to protect the soil from the heat of the sun allowing the roots to rise to the surface and into the mulch itself. In effect, the alley-cropping would have to mimic conditions found in virgin tropical forests. With the right type of tree, the system could be made to simulate what rainforests do naturally: stop weed growth by a combination of shading and smothering and recycle nutrients through slow leaf decomposition.

Hand's 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. Light-hungry weeds and grasses would not survive these conditions. Once the ground was weed-free, the trees could be pruned and the leaves spread on the ground to form a decomposing leaf layer several centimetres thick. This leaf layer would smother any further weed growth and stop the sun from drying out the ground. Finally, holes could be made 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 when the trees were pruned.

With the help of a botanist friend, he selected an Amazonian tree, *Inga edulis*, which had the required qualities: thick, tough leaves, fast growth, and the ability to fix nitrogen in the soil. But most importantly it was intensely mycorrhizal, symbiotically using fungi to absorb phosphorus into its roots. 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. He was sure that instead of the crops feeding on the most recent deposit of leaves, they would feed on older decaying leaves.

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 with plants struggling to survive. 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.

Explaining phosphorus loss

In his efforts to understand the reason for phosphorus loss, Hands analyzed hundreds of soil samples taken at every stage in the slash-and-burn process. His results were surprising: the level of phosphorus in the soil only a few weeks after the forest had been burnt was exactly the same as the level before burning had taken place. Natural rainforest contains little readily available phosphorus, but the ash left over after from burning contains a massive amount. It had been thought that the ash provided the crops with the phosphorus they needed. However, Hands' data showed that the phosphorus contained 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. Hands realized 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.

The data showed that this process only lasted two years after which there was a dramatic drop in phosphorus levels and inevitable crop failure. 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 two years, the microbes feed on the organic matter that has already fallen but when this runs out they die and phosphorus is no longer released. With no phosphorus-retrieving trees to take it up, any remaining phosphorus is washed out of the soil by the rains.

This explained the success Hands had had with the Inga alley-cropping system: The continuous supply of leaves provided by the Inga trees feed the microbes while the trees themselves absorbed and recycled the phosphorus before it could be leached out of the soil.

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 "magic solutions". However, the Honduran NGO *Pico Bonito* encouraged him to go ahead without further experimentation.

He started to look for Honduran slash-and-burn farmers who would be interested in trying out the alley-cropping system. Victor Coronado from Atlantida in northern Honduras was one of the first. Coronado's initial response was sceptical. 'The first thing I thought was it doesn't make sense to plant maize or beans under the trees', he recalls. However, as he was only asked 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 the 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 homes. With the crops so close by, they are easily guarded from wild animals, and the rest of the family members are 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 US$900 for the family', Coronado beams. 'All of us can produce crops that are 100 percent 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 they do not have to deal with weeds. In addition, the trees produce a good supply of fuelwood which otherwise takes many days to gather from the forest.

Converting to the system costs the farmers almost nothing. For each hectare of alley-cropping, farmers need to plant 5000 *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 US$8 sack is enough to supply a hectare of land for a year. 'The low cost makes it sustainable', says Hands. 'Farmers need to invest their time in the beginning, but they don't get into debt.'

Although many farmers want to try the new system, only a few have been able to do so because there is a shortage of *Inga* seed. Although each tree produces about 2000 seeds, those used in alley-cropping are pruned before they produce fruit. Some trees need to be left unpruned so they can produce seed. In the beginning farmers pruned all their trees, a problem that Hands had not foreseen. 'I realize now 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 be interested enough to try the system.'

Hands and *Pico Bonito* have recently set up seed orchards. Within a couple of years these will provide enough seed to meet the steadily growing demand. At the moment some 4000 farmers have seen *Inga* alley-cropping plots at demonstration farms in Honduras. The response from farmers has been overwhelming. They want seeds and technical assistance. Unfortunately until the seed orchards mature there is only a handful of seeds for distribution.

This is Reuben Mendoza; a member of the Pech Maya tribal community in Olancho, Honduras. Reuben is standing among mature maize plants between rows of recovering Inga trees. He states that it is many years since this site could produce any crop. The trees required over 2 years since planting as seedlings to "capture" the site from the invasive grass and other weed species that had dominated it. There are no weeds within the maize itself; their growth was smothered by the deep mulch. The soil had become much degraded following a slash-and-burn operation many years before. This plot produced a large maize crop; its second in consecutive years. The site is close to Reuben's house... a very important factor. Shifting agriculturalists will commonly walk for 2 - 3 hours daily to a temporarily-available swidden site; often high in hilly country. The ability to achieve food security close to the dwelling is of supreme importance in their lives. This factor also opens the possibility of producing cash crops close to where they can be nurtured, guarded and cropped. This in turn opens the farm economy to other members of his family.

With money provided by an individual donor, *Pico Bonito* has set up seed nurseries in the Olancho Province. 'We have 8000 seedlings there,' says the organization'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 only on small plots but on bigger plots as well because they want more maize and beans.'

All across South and Central America, seed orchards are desperately needed, but so far there are no funds available to support their development. 'Even without seed orchards, *Inga* alley-cropping will eventually spread from neighbour to neighbour,' says Hands. '…but this would be a painfully slow process. If we just sit and wait, we will lose the chance to save what remains of the rainforests.'

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