

The Rainforest Saver

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?

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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 mycorrhizal, 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

Technical Advice

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technical advice

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A new Inga alley cropping demonstration centre and seed farm is being set up in Peru in association with the University of Molina. Substantial funding for this has been obtained from The John Kyle Stone Charitable Trust. Work is well under way, and you can read the report under [Alley cropping in Peru](#).

Fund raising initiatives

We are very grateful to several of our members for fund raising initiatives, and hope that these will inspire more of you to do your own. In August we had a sponsored walk to the [Eden Project in Cornwall](#). A small but enthusiastic group turned up and had a great day out. Then there was a [pub quiz and a pizza and football evening](#). And one enterprising supporter is [repairing and recycling old bicycles to sell](#).

Fund raising aids

We have leaflets to give out and posters, T-shirts with our logo to sell, and a short computer based slide show. If you want any of these please email contact@rainforestsaver.org.

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TECHNICAL ADVICE**System variables within the control of the farmer**

Based on experiences in the La Conquista (La-C), San Juan and other experimental sites, the first outlines of a decision-making structure can be sketched :

The following variables are within the farmer's control; they represent a wide spectrum of choices which will obviously depend upon the farmer's personal and local circumstances :

1) Choice of species :

As argued above, more-durable mulch species are desirable; but mixtures are feasible and might include a proportion of readily-decomposable foliage species such as *Gliricidia sepium* , which is very well-known throughout Central and South America . The research project reported here has trials of pepper (*Piper nigrum*) grown on living supports of this species, between hedgerows of *Inga* . The pepper receives no agro-chemical inputs whatsoever and, in a weed-free environment, appears to be thriving.

The first-choice *Inga* is likely to be the commonest local provenance; and, commonly, the *Inga* species grown for shade over coffee or cacao. However, *I. edulis* is not endemic to Central America , yet appears to have undergone a widespread and spontaneous local adoption as an easily-established shade species.

There exists a wide spectrum of choice within which to choose, and alley-cropping systems with *Inga* appear to be rather forgiving, provided they are pruned with care.

2) Within-row density

Although more detailed work is needed, the indications are that, above a certain planting density, foliage production in an alley hedgerow tends to stabilise at a certain level per metre of hedgerow, while decreasing per tree stem. A useful spacing in the La C and San Juan sites appeared to be about 0.5m, which allows for some sporadic mortality without compromising mulch production; however, this was a somewhat intuitive choice.

3) Alley width

A balance needs to be struck between a wider spacing to minimise competition between the trees and crops and a narrower spacing to maximise weed-control; the working assumption being that the latter is the dominant factor. A general rule-of-thumb would then be : "As wide as is compatible with sufficient mulch production for permanent cover". Any over-dominance by the tree component can be controlled by varying other management practices, such as pruning height or frequency.

The 4.0m alley width for the *Inga* at the san Juan site was also an intuitive choice based upon experiences at La C. The most productive species of the San Juan trials (*I. edulis*; *I. oerstediana*) should be able to achieve permanent mulch cover at 5m. alley width

4) Alley alignment

4. i) It can be argued that, in equatorial regions, an ideal alley alignment would be East-West, because this is likely to impose more competition for sunlight within tree rows than between the trees and



Farmer's family unloading Inga seedlings.

the crops which will be in sunlight for most of the day. This could be important for maize, but beans at both the La C and San Juan sites appeared little affected by a degree of shading, as the sun, in the Northern winter, swung to the Southward of the hedgerows.

4. ii) However, the need for a contouring alignment to counter the risk of erosion on slopes may override this ideal; and this factor, in turn, implies that greater care needs to be taken to reduce shading. It seems, therefore that decisions of this nature need to be integrated with other management variables; such as : "If there is a risk of shading from contoured tree lines, then reduce stem-height or increase pruning frequency".

5) Hedgerow height:

The higher the stem, the greater and more-rapid will be the recovery of foliage; and, probably, the more resilient the tree; whereas, the lower the stem is pruned, the fewer the available nodes for regrowth. *Inga* appears to require a moderate-to-high stem. Pruning-height and frequency are probably the easiest ways of altering the dominance or "presence" of the tree component in an alley system. The height options thus fall within the range :

5. i) To favour the trees and mulch production : As high as is feasible (say up to 1.75m.)

5. ii) To disfavour the trees : Coppiced low to the ground (but the suggested minimum with *Inga* would be about 1m.).

6) Pruning regime

In practice, the timing-and-frequency of pruning are likely to reflect cropping needs, rather than any agenda set by the trees themselves; but there are some exceptions. For example, if experience shows that an alley system may only sustain one crop per annum, then tree growth in the period between crops may, in the case of some *Inga* species, be very vigorous, leaving few branches and little foliage on the lower stem. This, in turn, may leave the stem bereft of foliage when pruned back to the working height. (*I. edulis* at the La C site grew to over 4m. in 9 months from transplanting). In this instance, it is advisable to carry out the pruning in two phases. It may be preferable to cut out the leading central stem, reducing shading and allowing the lower stem to resprout before pruning back the side branches. However, this may not permit enough light to strike low enough on the stem for this to happen. Alternatively, it may be better to cut out all the side branches over the final pruning height, thus leaving the central leader to maintain the tree whilst the lower stem resprouts. When this is clearly under way, the leader (called a "chimenea" in Costa Rican cafetales) can be taken out. The aim would be to time the second pruning for a week or two before the planned crop-sowing; this, in turn, implies a first-phase pruning some month-to-six-weeks earlier. All this would have to harmonise with local perceptions as to what are, or are not, good pruning and sowing times. In any case, a light pruning will be needed to reduce competition perhaps some 4-6 weeks into crop growth.

Frequency of pruning

Low	High
Greater dominance of the system by the tree component...	...Lesser role of the tree component
Greater shading of weeds...	...Lesser shading of weeds
Less smothering of weeds by mulch...More smothering of weeds by mulch
The greater overall production of pruned biomass...	...Less overall production of pruned biomass
Greater proportion of woody biomass in the prunings...	...Greater proportion of leaf biomass in the prunings
Greater likelihood that 2-phase pruning will be necessary...	...Little likelihood that a 2-phase pruning will be needed



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The possibility that the system will produce firewood...	...The probability that the system will not produce firewood
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Table: Pruning frequency in alley-cropping; a spectrum of effects.

As outlined above, manner-of-pruning is very important to the survival of the trees and any attempt at a 100% foliage removal will involve the risk of killing the tree. Similarly, the damage and ripping associated with pruning too close to the main stem must be avoided. Clean cuts with sharp tools, together with the leaving of short spurs, with some foliage, minimises this risk; also, the branches of some *Inga* species (e.g. *I. marginata*; *I. samanensis*) are characteristically more-slender and appear to suffer much less setback as a result of pruning. It is hoped that more-detailed knowledge of the pruning-tolerance of the species groups may be gained in the future; our knowledge at present is rudimentary.

7) Soil supplements

Rock-Phosphate

As argued above and elsewhere (Palm et al 1991 ; Hands et al, 1995), the minimum condition for any low-input, sustainable agricultural system, as a stable, alternative subsistence strategy to shifting cultivation, will be that maintenance supplies of phosphorus will have to be made cheaply available. For a number of reasons, the obvious source of this phosphorus input is rock-phosphate; and it is suggested that this is more-efficiently applied to the mulch in an alley system, rather than to the soil itself. At a national or regional scale, the logistical difficulties of this are clearly very great and involve social, political and economic issues which go far beyond the scope of this text; the condition itself is, however, ecological in nature (i.e. pertaining to plant ecology) and non-negotiable.

Lime

In addition to rock phosphate, one further long-term ecological condition which may have to be fulfilled on an acid soil relates to slash-and-burn agriculture itself.

One aspect of the short-term success of a slash-and-burn operation in a rain-forest swidden lies in the effect of the ash upon the accumulated organic reserves of the soil (SOM). In short, SOM that may be turning over very slowly may undergo an accelerated decomposition due to a temporary change in the pH of the immediate surface soil (Hands, 1988; Hands et al ,1995). It is the release of nitrogen and phosphorus associated with these reserves that may be the key process in swidden agriculture. In a green mulch system such as a-c with *Inga*, it is likely that, over time, the soil will accumulate a wide range of SOM types with many differing decomposition characteristics. It could prove to be necessary for well-sustained maize yields, for example, that this pH-effect of the ash will have to be simulated, not by burning, but by lime or dolomitic lime (for the magnesium); and, possibly, by some source of potassium. The expectation is that a-c will retain and recycle these supplements better than any bare-soil alternative.

There is wide scope for experiment with all these options and experiences with *Inga* in alley-cropping indicate that these systems are rather flexible, resilient and forgiving. Supplements, as described above, are, of course necessary for long-term sustainability; but the system does not appear to collapse if they are withheld for a while. In the experiments carried out the only supplement that made a difference and was required was an initial application of phosphorus, which was applied as rock phosphate, and after that one initial application the plots have remained fertile without further input, so far for six years.

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The higher the stem, the greater and more-rapid will be the recovery of

New alley cropping Centre in Peru

A new Inga alley cropping demonstration centre and seed farm is being set up in Peru in association with the University of Molina. Substantial funding for this has been obtained from The John Kyle Stone Charitable Trust. Work is well under way, and you can read the report under [Alley cropping in Peru](#).

Fund raising initiatives

We are very grateful to several of our members for fund raising initiatives, and hope that these will inspire more of you to do your own.

In August we had a sponsored walk to the [Eden Project in Cornwall](#). A small but enthusiastic group turned up and had a great day out.

Then there was a [pub quiz and a pizza and football evening](#). And one enterprising supporter is [repairing and recycling old bicycles to sell](#).

Fund raising aids

We have leaflets to give out and posters, T-shirts with our logo to sell, and a short computer based slide show. If you want any of these please email contact@rainforestsaver.org.

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rollage; and, probably, the more resilient the tree; whereas, the lower the stem is pruned, the fewer the available nodes for regrowth. *Inga* appears to require a moderate-to-high stem. Pruning-height and frequency are probably the easiest ways of altering the dominance or "presence" of the tree component in an alley system. The height options thus fall within the range :

5. i) To favour the trees and mulch production : As high as is feasible (say up to 1.75m.)

5. ii) To disfavour the trees : Coppiced low to the ground (but the suggested minimum with *Inga* would be about 1m.).

6) Pruning regime

In practice, the timing-and-frequency of pruning are likely to reflect cropping needs, rather than any agenda set by the trees themselves; but there are some exceptions. For example, if experience shows that an alley system may only sustain one crop per annum, then tree growth in the period between crops may, in the case of some *Inga* species, be very vigorous, leaving few branches and little foliage on the lower stem. This, in turn, may leave the stem bereft of foliage when pruned back to the working height. (*I. edulis* at the La C site grew to over 4m. in 9 months from transplanting). In this instance, it is advisable to carry out the pruning in two phases. It may be preferable to cut out the leading central stem, reducing shading and allowing the lower stem to resprout before pruning back the side branches. However, this may not permit enough light to strike low enough on the stem for this to happen. Alternatively, it may be better to cut out all the side branches over the final pruning height, thus leaving the central leader to maintain the tree whilst the lower stem resprouts. When this is clearly under way, the leader (called a "chimenea" in Costa Rican cafetales) can be taken out. The aim would be to time the second pruning for a week or two before the planned crop-sowing; this, in turn, implies a first-phase pruning some month-to-six-weeks earlier. All this would have to harmonise with local perceptions as to what are, or are not, good pruning and sowing times. In any case, a light pruning will be needed to reduce competition perhaps some 4-6 weeks into crop growth.

Frequency of pruning

Low	High
Greater dominance of the system by the tree component...	...Lesser role of the tree component
Greater shading of weeds...	...Lesser shading of weeds
Less smothering of weeds by mulch...	...More smothering of weeds by mulch
The greater overall production of pruned biomass...	...Less overall production of pruned biomass
Greater proportion of woody biomass in the prunings...	...Greater proportion of leaf biomass in the prunings
Greater likelihood that 2-phase pruning will be necessary...	...Little likelihood that a 2-phase pruning will be needed
The possibility that the system will produce firewood...	...The probability that the system will not produce firewood

Table: Pruning frequency in alley-cropping; a spectrum of effects.

As outlined above, manner-of-pruning is very important to the survival of the trees and any attempt at a 100% foliage removal will involve the risk of killing the tree. Similarly, the damage and ripping associated with pruning too close to the main stem must be avoided. Clean cuts with sharp tools, together with the leaving of short spurs, with some foliage, minimises this risk; also, the branches of some *Inga* species (e.g. *I. marginata*; *I. samanensis*) are characteristically more-slender and appear to suffer much less setback as a result of pruning. It is hoped that more-detailed knowledge of the pruning-tolerance of the species groups may be gained in the future; our knowledge at present is rudimentary.

7) Soil supplements

Rock-Phosphate

As argued above and elsewhere (Palm et al 1991 ; Hands et al, 1995), the minimum condition for any low-input, sustainable agricultural system, as a stable, alternative subsistence strategy to shifting cultivation, will be that maintenance supplies of phosphorus will have to be made cheaply available. For a number of reasons, the obvious source of this phosphorus input is rock-phosphate; and it is suggested that this is more-efficiently applied to the mulch in an alley system, rather than to the soil itself. At a national or regional scale, the logistical difficulties of this are clearly very great and involve social, political and economic issues which go far beyond the scope of this text; the condition itself is, however, ecological in nature (i.e. pertaining to plant ecology) and non-negotiable.

Lime

In addition to rock phosphate, one further long-term ecological condition which may have to be fulfilled on an acid soil relates to slash-and-burn agriculture itself.

One aspect of the short-term success of a slash-and-burn operation in a rain-forest swidden lies in the effect of the ash upon the accumulated organic reserves of the soil (SOM). In short, SOM that may be turning over very slowly may undergo an accelerated decomposition due to a temporary change in the pH of the immediate surface soil (Hands, 1988; Hands et al ,1995). It is the release of nitrogen and phosphorus associated with these reserves that may be the key process in swidden agriculture. In a green mulch system such as a-c with *Inga* , it is likely that, over time, the soil will accumulate a wide range of SOM types with many differing decomposition characteristics. It could prove to be necessary for well-sustained maize yields, for example, that this pH-effect of the ash will have to be simulated, not by burning, but by lime or dolomitic lime (for the magnesium); and, possibly, by some source of potassium. The expectation is that a-c will retain and recycle these supplements better than any bare-soil alternative.

There is wide scope for experiment with all these options and experiences with *Inga* in alley-cropping indicate that these systems are rather flexible, resilient and forgiving. Supplements, as described above, are, of course necessary for long-term sustainability; but the system does not appear to collapse if they are withheld for a while. In the experiments carried out the only supplement that made a difference and was required was an initial application of phosphorus, which was applied as rock phosphate, and after that one initial application the plots have remained fertile without further input, so far for six years.

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