RECOGNISING ACHIEVEMENT

ADVANCED SUBSIDIARY GCE **2843/01**

SCIENCE

Interpreting Scientific Information

INSERT

THURSDAY 22 MAY 2008

Afternoon

Time: 1 hour

CUP/T48682

INSTRUCTIONS TO CANDIDATES

- All questions are based on the abridged article which follows on pages 2 and 3 of this insert.

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The Rainforest Saver

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 in Honduras 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. Hands believed there must be another method of cultivation that would keep the land fertile.

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. Often farmers slash-and-burn their way to the top of a hill, only to meet other farmers who have come 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. In desperation, some farmers move to the cities where they mostly end up begging, or trying to live off rubbish dumps.

In 1984, Hands began his work. At this point no one could say for sure whether the cause of the problem was insect pests, crop disease, nutrient depletion in the soil, or weed growth. From everything the farmers said, it seemed likely that the problem was nutrient levels, and indeed, in time, he found that these soils were severely depleted in the element phosphorus, much of it having been washed out of the soil by rain.

He turned his attention to finding a way of combating the problem. He knew that alley-cropping, a method of farming pioneered in Nigeria in which crops are grown between rows of trees, allowed nutrients to be retrieved from the soil and recycled by the crops. But Hands knew that for alley-cropping to work on rainforest soils, it would not only have to stop phosphorus and other elements being 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. Furthermore, when the leaves fell from the trees, they would have to provide a thick blanket of mulch to protect the soil from the heat of the sun to allow the roots to rise to the surface and into the mulch itself. 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, and the crops planted into 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 tree he selected was the *Inga Edulis* from the Amazon. It would be another four years before he had the evidence that *Inga* alley-cropping really worked.

Meanwhile, Hands turned his attention to why slash-and-burn sites were infertile. He took such an area and divided it into smaller plots, and to each he added a different soil nutrient. Three weeks later he found that only the plot with added phosphorus had changed. There, every kind of plant had suddenly flourished. To uncover the reason, he analysed the soil at every stage in the slash-and-burn routine. 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 soil naturally contains too little readily available phosphorus to provide for the needs of crops, but the ash left 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 must be coming from somewhere. Hands realised that the ash on the soil was speeding up the process by which soil microbes decompose organic matter, such as dead leaves and branches. It was this process that was releasing the phosphorus.

However, the extra phosphorus release was lasting only 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, and 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 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 leached out of the soil.

In 1996, Hands set up a further series of trials in Honduras where there was a large amount of rainforest destruction. One of the farmers involved, Victor Coronado, was initially sceptical. 'The first thing I thought was that it doesn't make sense to plant corn or beans under the trees' he recalls, however, he agreed to give it a try. Six years on, he is surrounded by proof that the technique works. Once it is set up, say the farmers, it 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 5000 *Inga* trees. Once these are grown and the system is up and running, farmers can replace the phosphorus the crops use by adding rock phosphate to the soil. This is cheap; an $8 sack is sufficient for an entire hectare of land for a year.

Sadly, only a few of the many farmers wishing to do so have been able to try the scheme. The problem is the shortage of *Inga* seed. Although they produce 2000 seeds each, the *Inga* trees used in the 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' he says 'but at the time we just wanted them to try the system in the first place'.

Seed orchards have now been set up 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, 4000 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 a handful of seeds'.

Currently, they are still seeking funds to continue their work.