

Science in Brazil

By Clive Cookson in São Paulo

No longer stumped: how a space agency is slowing deforestation in the Amazon. See page 50



BIO-ENERGY

A tank of sugar: how Brazil runs on biofuel

In Brazil, sugar is king. In the field, on the table, on the road – and in the laboratory. The world's largest sugar producer has been fermenting sugar cane juice into ethanol (alcohol) for motor fuel since 1975. For many years, the Brazilian bio-ethanol programme carried on in virtual isolation from the rest of the world, using fairly low-tech methods. Now, however, Brazil's federal and state governments are pouring hundreds of millions of dollars into research aimed at improving all stages of the bio-ethanol process, from sugar cane biology to engine efficiency. And the process has become big science, as well as big business.

Brazil has a commendable track record in research in many areas of science and technology, but “bio-energy is the field in which we have most to contribute to the world,” says Carlos de Brito Cruz, scientific director of Fapesp, the São Paulo state research foundation.

Although the development of ethanol has been driven primarily by energy security concerns rather than environmental motives, Brazil is now emphasising the fuel's green credentials. Net emissions of carbon dioxide from a car running on sugar ethanol are just 20 per cent of those from a petrol-fuelled car.

“Until about 2007 the world considered bio-ethanol to be our weird, tropical idea, and left us to get on with it,” says de Brito Cruz. “The game changed when George W Bush made biofuels an energy priority, and other countries entered the field. Then, we set up a bio-energy programme, to protect our intellectual property.”

Brazil produces more than 20bn litres a year of ethanol from sugar, to fuel the country's 13m “flex” cars, which can run either on pure alcohol or on petrol (which itself contains about 20 per cent of added ethanol). A typical Brazilian petrol



A farm worker starts the process of turning sugar cane into ethanol – used as motor fuel in Brazil since 1975

The country already has 13m ‘flex’ cars, which can run either on pure alcohol or on petrol

station offers four fuels: ethanol, petrol, bio-diesel and natural gas.

Increasing demand, combined with poor growing conditions in some sugar cane regions, has led recently to ethanol shortages – and an embarrassing need to import more than 1bn litres of US alcohol, produced from corn (maize), which is far less environmentally friendly.

With Brazilian ethanol demand expected to reach 50bn litres a year by 2020, the bio-energy programme aims to achieve a large increase in supply without a corresponding increase in the farmland devoted to sugar cane.

Currently, this covers just 0.4 per cent of Brazil's total land area, or 2 per cent of the area on which crops are grown. In the case of Brazilian ethanol, biofuel does not represent a significant diversion of land and resources from food production. At present, Brazilian farmers average 84 tonnes of cane per hectare per year, according to Glaucia Souza of the University of São Paulo, who co-ordinates the Fapesp bio-energy programme. She calculates that the yield could be multiplied more than fourfold, to 380 tonnes per hectare, by improving the crop and its cultivation.

The task is made more difficult by the complexity of the biology and genetics of sugar cane, a hybrid of two grass species, *Saccharum officinarum* and *Saccharum spontaneum*. Indeed, the genome of sugar cane has not yet been fully decoded, despite intensive research in recent years.

Marie Anne van Sluys, botany professor at the

University of São Paulo, says the problem is not just the size of the sugar cane genome, which has five times more DNA than humans; the genome's “decaploid” nature means that every sugar cane plant has the equivalent of 10 different genomes, compared with two in “diploid” mammals (one from each parent).

Although genetic modification should be possible without knowledge of the entire genome, attempts to create stable GM varieties of sugar cane have so far failed: introduced genes are quickly silenced or shut down by the plant.

Even so, Brazilian scientists are confident that the genetic mysteries of sugar cane will soon be cracked. According to van Sluys, the priorities then will be to make the plants more resistant to drought and pests, and change their physiology to divert as much metabolic energy as possible into making sugar.

In Brazil, the reign of the cane is just beginning.



Heated debate

CLIMATE CHANGE

The latest climate prediction modelling shows that the Amazon basin may not suffer a catastrophic drought later this century due to global warming, despite recent fears



Pink areas of deforestation in a satellite image of the rainforest

DEFORESTATION

Space agency flies in to save the rainforest

When people think about space science, they usually imagine researchers looking out into the cosmos. But an important role of space agencies is to look down on Earth – and Earth observation is the primary mission of Brazil's National Institute for Space Research.

Inpe (as the institute is known from its Portuguese initials) has developed one of the world's most advanced environmental monitoring systems. It tracks what is happening on the ground – and, above all, in the Amazon rainforest – as this huge country expands its population, economy and agricultural production.

Using its own satellites – and remote sensing data bought in from bodies such as Nasa and the European Space Agency – Inpe monitors Amazon deforestation on a daily basis. A supercomputer processes the raw satellite data, looking for evidence of illegal logging, burning or forest clearance. And when Inpe detects something suspicious it alerts local law enforcement agencies.

Although Brazil's environmental policing has many imperfections, Gilberto Câmara, Inpe's director-general, insists that the alerts have led to a substantial reduction in Amazonian deforestation in recent years. In 2011, 6,238 sq km of forest were lost – the smallest area since

satellite monitoring started in 1988. As recently as 2005, the annual deforestation rate was more than 25,000 sq km.

Inpe does not send the satellite observations only to its own government and law enforcement agencies – all the data are made freely available to anyone, anywhere in the world.

"We used to sell remote sensing data, like other space agencies," says Câmara, "but in 2004 we opened it all up for free. We used to sell 1,000 images a year; now we distribute 500,000 images freely around the world. Full and open access to space-based information is indispensable for global sustainable development." Câmara is critical of agencies elsewhere that restrict public access to environmental monitoring data.

Satellite monitoring shows not only how much forest is lost, but also what the cleared land is used for – most becomes pasture for low-intensity cattle ranching.

"Of the 720,000 sq km of Amazon forest lost so far, about 65 per cent is used for cattle," Câmara says. "This means that Brazil has lost an enormous amount of biodiversity just to graze cattle at about one head per hectare." Just 5 per cent of former forest land is devoted to growing commercial crops – mainly soya beans.

Such information can be commercially, as well as environmentally, valuable. For instance, Inpe provides the data to enforce Soya Moratorium. In place since 2006, and endorsed by Greenpeace, this agreement commits all of Brazil's big soya traders to buy only from farmers who can prove that their land did not come from illegal deforestation. So, soya grown on uncertified land is worth less on the market.

Câmara says that most space agencies around the world exist at least partly "for geopolitical and military reasons", such as supporting a domestic aerospace industry. Inpe is different, he claims: "Our aim is to support the development of a peaceful, green economy in Brazil."

The Doctor Sophie Harrison Haemorrhoids – why half of us aren't sitting pretty

Pain is miserable. And as if suffering in itself isn't bad enough, many people are afflicted with a condition both embarrassing to talk about and impossible to spell. Haemorrhoids (or, as junior doctors write, "hemoroids", "hemorrhoids" or "?? haemarhids") are thought to affect up to half the population at some point in their lives: the likelihood of getting them increases with age. The ancient Egyptians had them, as did President Carter. Some base spectators have suggested that John Wayne was afflicted: his gait is distinctly haemorrhoidal. Piles even have their own patron saint, St Fiacre, a seventh-century Irish monk who supposedly moulded a rock into a more comfortable shape by sitting on it.

Haemorrhoids may be ubiquitous, but that doesn't mean they are well understood. To understand how piles come about it helps to picture the anatomy. Medicine is oblivious to embarrassment; some of the terminology sounds like it was coined by an alternative comedian trying to find improbable new ways to be rude. Hence the narrow last section of the intestine is called the anal canal. Above it lies the rectum (where waste is stored); below it the anal sphincter (through which waste is expelled). The anal canal is lined with spongy tissue: the attractively named "anal cushions". The cushions are plump collections of blood vessels supported by muscle and elastic fibres. They help maintain continence and smooth the passage of stool. When they're put under pressure – for example, by hard stools or repeated straining – the veins within them can swell. They may bleed if scratched – bright red blood which doesn't mix with the stool but falls separately into the toilet or onto the paper (blood from tumours tends to be darker and mixed in). Eventually, the swollen veins may

prolapse, protruding through the anal sphincter to form, as a patient described it, "a bunch of grapes where no fruit ought to be".

Grade-one or -two piles – that is, piles that remain internal, or can be returned from whence they came, and only signal their presence by causing periodic bleeding or occasional discomfort – are best treated by trying to fix the factors that caused them: avoiding constipation and weight gain, by eating more fibre and drinking more fluids. It's also best to avoid sitting for long periods on the loo, as this relaxes the muscles in your undercarriage (perineum), so allowing everything to droop (the NHS now specifically advises against taking reading matter into the lavatory with you. Hopefully the FT is only read at the breakfast table). You can get soothing and anaesthetic creams over the counter (traditionally cited as the item most shoplifted from pharmacies) or steroid creams from the GP, if you're suffering from a particularly swollen episode.

If your haemorrhoids are resistant to conservative treatment, and causing distress, there are several more invasive treatments available. You can have a quick outpatient procedure where tiny rubber bands are slipped over the pieces of tissue – it's painless, apart from the assault on your dignity. Deprived of its blood supply, the haemorrhoid dwindles away. More troublesome piles may benefit from surgery. The traditional option, a haemorrhoidectomy, does what the name implies: cuts away the haemorrhoids altogether. It's a relatively big operation, requiring a general anaesthetic and a lot of painkillers afterwards. There are other approaches which use variations on stitching and stapling. They'll never sound that appealing, but at least they generally work.

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