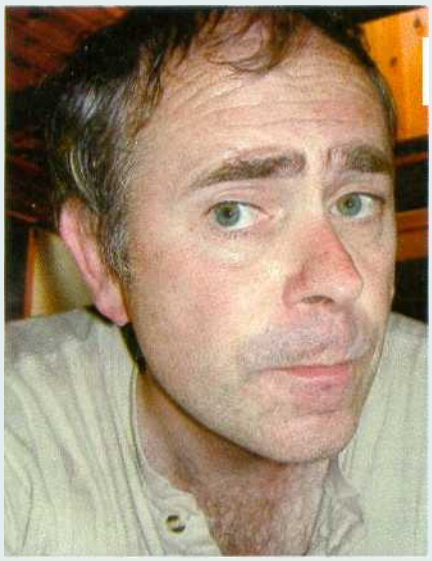
Grassroots innovator



Agriculture's meta-technologist

Richard Jefferson wants to change the face of agriculture, by putting innovation back into the hands of farmers

CATCH him on a good day and Richard Jefferson will play you some bluegrass on his guitar. He keeps a large collection of antique instruments, and often travels to conferences with a laptop in one hand and a mandolin in the other.

Yet get him to talk about his professional interest, agricultural biotechnology, and DrJefferson's tune becomes more sombre. He points to the 780m people in the developing world who are suffering from malnutrition-a large proportion of them farmers who cannot grow, or sell, enough to make ends meet. Science will not solve their problems, says Dr Jefferson. But biotech could help them to improve their lot. The biotech he has in mind, however, is not the sort that agribusiness has perfected-the "Round-up Ready" soybeans or "Bt" maize (corn) that have been genetically engineered with Iowa in mind, not sub-Saharan Africa.

Fifteen years spent consulting on agricultural projects for the World Bank, the UN's Food and Agriculture Organisation and the Rockefeller Foundation have convinced him that the technology needed to boost agriculture in the poorest parts of the world has to emerge from the ground up. In short, from those in the field who know the limits of the land and local culture, and not in far-flung laboratories with one-size-fits-all solutions.

But this sort of grassroots innovation-traditionally done by public-sector researchers working closely with local farmers-is dwindling. It is a fact of life that the tools of biotechnology do not come cheap. It is also undeniably true that, ever since the "green revolution" of the 1960s, governments everywhere have been pruning back agricultural research as well as official development aid-as if hunger had been conquered.

Meanwhile, companies in the rich industrial world have been pouring money into biotechnology, and now account for at least a third of all agricultural research, says Philip Pardey of the International Food Policy Research Institute. This shift in balance between public and private sectors in agricultural research means that commercial interests, rather than food-security needs, are driving the agenda. Much like pharmaceutical companies, agricultural firms are more interested in the concerns of rich than poor countries. Nothing wrong with that: biotech firms are not charities. But it does mean that there are imbalances which global institutions need to address.

One such imbalance is the way intellectual-property rights are distributed between rich and poor. As companies and universities in America, Europe and Japan scramble to stake their legal claims to all the most promising genes, techniques and plant varieties, a tangled web of patents, cross-licences and material transfer agreements is making life difficult for those who want to help. A case in point is so-called "golden" (ie, vitamin A-enhanced) rice, which has been held up in the laboratory while dozens of different patents have had to be dealt with to allow its release.

Breaking down barriers

One way forward, Dr Jefferson believes, is to adopt a more catalytic approach to innovation. What is needed, he muses, are some "meta-technologies" that overcome the technical, capital and intellectual-property barriers in agricultural research and allow others to do the innovating. He likens this decentralisation of agricultural innovation to the way that the Linux operating system, which was created by a global band of dedicated experts and donated free to the world, has become a pillar of e-commerce and a serious alternative to the pricey wares of Microsoft, Sun and IBM. The new meta-technologies envisaged by Dr Jefferson would offer a genuine alternative to agri-business and the network of agricultural research centres (called CGIAR) sponsored in part by the World Bank.

Although they carry out much good work, Dr Jefferson fears that these institutions have become locked into an established way of doing things. DrJefferson's answer is to bring biotechnology closer to the land. Let local plant breeders and growers develop the foods they think best. To this end, Dr Jefferson founded the Centre for the Application of Molecular Biology to International Agriculture in Canberra, Australia, nearly a decade ago.

This not-for-profit centre, called CAMBIA for short, has some 40 researchers drawn from around the world. At the centre's core, and the basis of Dr Jefferson's own expertise, is a set of cutting-edge techniques for agricultural biotech. He made his name in the 1980s with the in-

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vention of GUS, a tool that makes it easier to track the changes made while tinkering with the genetic make-up of plants. He was also the first in the world to plant genetically modified crops in an open field.

Today, CAMBIA has half a dozen technologies on the boil. One of its most ambitious is called "transgenomics". instead of using the conventional approach of shooting "foreign" genes into a plant, transgenomics takes advantage of the genetic diversity that is already within the plant itself. Through this genetic sleight of hand, CAMBIA has created more than 5,000 strains of rice which have the capacity to turn on genes in different ways than normal-in, say, a root rather than a leaf, or at an earlier time. These "activating" strains can then be crossed with normal plants of interest to breeders. In turn, the breeders can look for novel traits which crop up in these plants' offspring. Tests are under way at Wuhan University in China. If it works in rice, the technology could be extended to a variety of crops.

While it is early days in transgenomics, CAMBIA'S project on patents has reached fruition. With a grant from the Rockefeller Foundation, the centre has spent two years building a searchable web-based database (www.cambiaip.org) that contains more than 257,000 agriculture-related patents from America, Europe and the international Patent Co-operation Treaty system. The aim was to create a simple means of letting ordinary users tap the wealth of technical and commercial information contained in a vast library of patent documents that would otherwise be far too costly and tricky to access. The searchable website, launched in August, is already getting hundreds of "hits" a day from users around the world.

Immaculate conception

Another project that Dr Jefferson has on the boil is an international consortium that he is setting up to develop apomixis- "seeds without sex". He is convinced that apomixis will transform agriculture, particularly in poorer parts of the world. Some plant species, such as wheat, reproduce through seeds created by the union of male and female sex cells when pollen from one plant drifts on to the flower of another. Other species, such as bananas, opt for asexual reproduction, sending out biochemical signals to transform bits of themselves into new plants. But a few curious crops-plants related to pearl millet, for instance-can, in effect, clone themselves, by producing seed without the need for pollination.

To DrJefferson and his colleagues, this immaculate conception is more than a botanical curiosity. Today, millions of people in sub-Saharan Africa rely on cassava, a starchy root, as their main meal. Cassava propagates asexually, which means that viruses or fungi present in the parent tissue will carry into the offspring. However, if cassava could be made to reproduce through seed, as in apomixis, this infectious legacy might be left behind. According to the Boston Consulting Group, apomixis technology could save cassava and potato growers as much as $3.2 billion a year.

Apomixis might also offer a quick and easy means of mass-producing hybrid seed. Hybrid cereals, created through selective breeding of elite species, often have higher yields and more desirable features than their common-or-garden relatives. But this genetic superiority is lost within a generation if the hybrids reproduce sexually through seed.

That means that farmers cannot simply save grain from one harvest to plant the next season, but have to buy fresh hybrid seeds. By generating seed which is essentially a carbon copy of the original hybrid, apomixis overcomes this problem of genetic dilution. Even such firms as Pioneer which earn their living from selling hybrid seeds are interested in apomixis. Producing hybrid seeds is a costly business; apomixis could cut those costs by more than a third.

Formidable hurdles lie ahead. Some of the genes that play a part in apomixis have been identified. But that is a far cry from working out the full complement of molecules and mechanisms involved. And while few patents have so far been awarded on the genes and processes involved in apomixis, that could change.

Three years ago, Dr Jefferson led a group of experts in signing the "Bellagio Declaration", which pledged to keep apomixis free of intellectual-property restrictions. Nobody developing apomixis technology wants a repeat of the messy "Terminator" affair of the late 1990s Then, non-governmental organisations came to blows with Monsanto over patents on a genetic system which, activists claimed, could prevent farmers from saving and planting seeds year after year.

Dr Jefferson believes the capacity for apomixis lies dormant in most plants. And, like transgenomics, it is not so much a question of giving crops entirely new components through genetic engineering, but rather a matter of stimulating the plants to use the genetic resources that are already in them.

Much the same could be said of the universities, agricultural research stations, biotech firms and seed companies that Dr Jefferson wants to mobilise to turn apomixis into a practical technology. The scientific, commercial and regulatory expertise needed for what many have called the "Manhattan Project" of farming already exists. The problem is getting the varied interests to pull together in a coherent way-just as the Linux "open source" fans did-and make the product accessible to all.

To its credit, CAMBIA has resisted the lure of exclusive licences and shareholder investment, because it wants its work to be freely available and widely used. As Dr Jefferson points out, "it takes a lot of money to be dumb and survive, but you don't need much money to be smart."

That said, understanding-and exploiting-apomixis is going to take a lot more than seed funds. So Dr Jefferson is doing the rounds of leading philanthropic organisations. He wants to raise $100m-200m for a ten-year campaign to get apomixis out of the test-tube and on to the dinner table. Getting this show on the road will be his toughest act yet.

Minstrel of apomixis