Australian genetics pioneer recognised in global top 50

"Open source" genetics needed to unleash a new green revolution

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Australian molecular geneticist Richard Jefferson's latest inventions could unleash a new Green Revolution, giving farmers, researchers and agriculture businesses across the world access to the potential of modern genetics.

The Canberra based scientist was recognised today by Scientific American, the prestigious international science magazine, as one of the 50 global technology leaders of 2003. The list was published overnight. Jefferson will be honoured at a presentation on Thursday 11 December at the New York Academy of Sciences along with Steve Jobs, CEO of Apple Computers, The Bill and Melinda Gates Foundation, Gro Harlem Brundtland, and other science, engineering, commerce and public policy leaders.

Professor Richard Jefferson and his team of scientists and IP experts at CAMBIA are creating a powerful and freely available genetics and policy toolkit that will allow plant breeders and scientists around the world to add new directions to conventional plant and animal breeding.

China's leading plant geneticist, Professor Zhang Qifa, has already used the toolkit to create 20,000 unique rice lines in his quest for more robust, high yielding rice that uses less water and are resistant to pests and diseases.

"We don't always need to insert foreign genes," says Jefferson, "as we are yet to harness the potential of the crop's own genome."

"Biotechnology is being stifled by the complexity, expense and misuse of patenting. So we are taking a different approach with our toolkit to ensure it's available for all to use," says Jefferson.

"CAMBIA and the Rockefeller Foundation are working together to create an 'Open Access' biological technology movement – just as the computing community has created Linux and other great Open Source innovations. Our tools will be free to all and are crafted to unleash the creativity of researchers and farmers. Companies will have much greater opportunities to create wealth from new crops and products, winning much-needed public trust in the process

Jefferson originally founded CAMBIA in Canberra in 1991, to give developing countries access to the tools of molecular biology. It soon became clear, however that many of the same barriers to the creation and adoption of new technology in developing countries are also hindering businesses and the research community in the developed world – in particular the confused web of intellectual property rights which is hurting both small and large biotechnology companies, and which has gutted the public sector.

Today CAMBIA employs 40 scientists and is working with the FAO, The Rockefeller Foundation, the CGIAR and many other international groups, and is affiliated with Charles Sturt University.

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Background information available at www.cambia.org
CAMBIA is the Center for the Application of Molecular Biology to International Agriculture

"We have barely started to unleash the potential of modern genetics to improve crops and feed the world," says Jefferson. "The key, ironically, is human creativity, and using technology and wise policy to nurture the innate problem-solving capacity within all people"

According to the UN Food and Agriculture Organization's annual report, "The State of Food Insecurity in the World 2003" released today, latest estimates signal a setback in the war against hunger. http://www.fao.org/english/newsroom/news/2003/24779-en.html

Background information

Scientific American (www.sciam.com) says in its citation:

"THE GREEN REVOLUTION—the steady increase in crop yields that started in the 1960s—is starting to bump up against limitations of land use, water supply, pest control and existing plant genetic variety.

Biotechnology may be able to help, but so far it has pretty much passed the developing world by. Few have done more to change that than Richard Jefferson.

Having made his name in the 1980s by creating a technique for probing protein synthesis, he has dedicated himself to ensuring that scientists and farmers in developing countries share the benefits.

In 1991 he established CAMBIA, a non-profit research institute whose mission is to make often proprietary technology more widely available.

For example, CAMBIA is now putting together a do-it yourself kit that lets start-up companies tinker with genes without having to confront battalions of intellectual-property lawyers."

About Cambia's technology

(An article written by Graeme O'Neill in Australian Biotechnology News, and reproduced here with their kind permission)

Coming soon: The DIY plant biotech kit

Graeme O'Neill catches up with CAMBIA's Richard Jefferson

"CAMBIA's aim is to deliver 'open source' genetic technologies"

Within the next 12 months, Richard Jefferson hopes to extricate plant molecular geneticists the world round from the grip of giants, by providing them with a "complete IP and technical workaround" for key technologies for gene transfer in plants.

Jefferson, CEO of the Centre for the Application of Molecular Biology to International Agriculture (CAMBIA) in Canberra, will be one of the speakers at the forum 'Public versus private science — who wins?' at the International Congress of Genetics in Melbourne in July.

He says CAMBIA's do-it-yourself technology package will include an effective gene-transfer tool as well as selection systems for transgenic cells. It will allow almost any small start-up plant biotech company to experiment with its good ideas without necessarily having to enter early-stage licensing or partnering agreements with multinational life science companies that control the genes and the means to transform plants.

The California-born molecular geneticist, an Australian resident for 11 years, is the inventor of the renowned glucuronidase (GUS) reporter-gene system — when co-expressed with a chosen gene, the blue-staining enzyme highlights the gene's expression pattern in plant tissues. His technology has been used in thousands of field trials, is licensed by over 50 corporations, and was instrumental in the development of many of the products of agbiotech, including Roundup Ready soybeans.

Broader horizons

Jefferson's horizons today are now much broader. He wants to radically reform the way gene technology is applied to agriculture. Instead of transplanting whole genes, molecular breeders would use minor HART surgery (HART stands for homologous allelic recombination/replacement technologies).

HART would involve subtle, *in situ* surgery on the plant's own genes, yet it could dramatically change the performance and productivity of today's crops.

Jefferson says it is now clear that the often dramatic phenotypic differences between even distantly related plant and animal species arise in subtle changes in gene regulation, and their rippledown effects through gene networks, rather than from changes in protein sequence.

Rice and maize, for example, diverged some 60 million years ago, but their genes retain a high degree of homology, and are still arrayed in essentially the same order on corresponding chromosomes.

Jefferson believes HART technologies, developed as an international collaboration with an open-source licensing platform, could address the anti-GM movement's perennial complaint that introducing 'foreign' DNA into plants could have unpredictable consequences. More importantly, HART could allow the community to reap the benefits of DNA-sequencing projects much more rapidly and effectively. These technologies are not yet available to plant sciences, and must be developed and shared in new ways.

Jefferson says HART could be described as 'stealth' genetics. With *in situ* modification, there will be no super fluous DNA code to indicate where or what changes were made — just tweaking the odd DNA base will change the protein sequence, or the gene's expression.

"When HART is achieved, the critics doubtless will bemoan the absence of the very genetic flotsam they currently decry," he said.

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But CAMBIA's major drive is to deliver a suite of 'open source' genetic technologies, and plant transformation tools, to molecular plant breeders around the world, breaking the stranglehold that multinational agbiotech companies exert on the technology and its applications.

Jefferson wants to give plant breeders and scientists technologies in a form inspired by computing's Linux operating system. But he stresses he is not suggesting that companies make their valuable patents free to all.

"What I want is to democratise innovation — to ensure that the core of innovative capability is distributed and shared in such a way that people are bound legally, in acquiring access, to share improvements they might make themselves.

"But it will only work with intellectual property as a binding mechanism. The licensee would be required to agree that any improvements would either be shared, or if they were maintained as an in-house trade secret, they would not stop others developing the same improvements.

"Keeping in mind Thomas Jefferson's idea of using a formal grant of intellectual property rights to balance social benefit with private gain, a cogent argument can be made that HARTs for agriculture and medicine would qualify as a unique public good."

Jefferson says that the agbiotech sector is currently confronting "complete and total constipation" — companies and institutions are fighting over who owns the tools for gene technology, rather than getting on with the far more important business of applying them widely to developing new crops that will be more productive, will improve human health, and benefit the environment, and which will thereby win the support of a sceptical public.

The current wrangle over ownership of the intellectual property for RNA interference is a case in point — Jefferson believes the powerful new tool for modifying plants, and exploring plant gene function, is so fundamental to progress in molecular plant breeding that it should be part of the open source package for plant breeders around the world, a view he shares with Nobel laureate John Sulston, one of his fellow speakers at the delegates forum at ICoG2003.

Gene activity

Jefferson is unimpressed by what he regards as "some overly-reductionist genomics projects" in plants and animals — having a map, a complete catalogue and the full DNA code of a tomato, a cow or a wheat, provides little information about what individual genes do, much less how gene activity is networked to influence desirable traits.

CAMBIA's Transgenomics Initiative is based on the premise that an orchestrated change in a group of genes will have a more profound and valuable impacts on a selected population than the conventional, single-gene transplant approach.

Rather than slog through billions of DNA bases, CAMBIA has developed an innovative technology that involves inserting a specially constructed reporter gene linked to a transcriptional activator sequence into plant cells; the construct will insert randomly at locations throughout the species' genome.

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Harnessing patterns

By chance, the construct will sometimes insert next to a gene that is active only in a specific tissue — say, in root cells, or pollen, or floral tissues. The activator will ‘capture’ the expression pattern of the adjacent gene, so that any new gene introduced into the plant will be expressed in the same tissue-specific pattern.

Jefferson says CAMBIA researchers have generated thousands of plants in which the expression patterns of anonymous genes have been harnessed in this manner. It then becomes a matter of selecting the appropriate plant, introgressing a candidate gene and, it will ‘play’ in the target tissue.

CAMBIA’s technology has been used by China’s leading plant biotechnologist, Prof Zhang Qifa at Huazhong University, to create more than 20,000 unique lines for field-testing.

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