

AUSTRALIAN ACADEMY OF TECHNOLOGICAL SCIENCES AND ENGINEERING (ATSE)



# FOCUS

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## WORLD FOOD SECURITY

### NOURISHING THE PLANET AND ITS PEOPLE

Perspectives on the world's most daunting challenge – from national and international authorities, including key speakers at the 2010 Crawford Fund international conference

# “How we can feed ourselves sustainably in a low carbon economy?”



Wanzhuang Eco City © Vyonyx/Arup/Client SIIC

Climate change, water shortages, rising crude oil prices and an expanding population are beginning to question the resilience of our current farming and food supply systems.

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Front cover: Rice paddy in  
Yunnan Province, China.  
Photo: iStockphoto



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## FOCUS

ATSE *Focus* is produced to stimulate discussion and public policy initiatives on key topics of interest to the Academy and the nation. Many articles are contributed by ATSE Fellows with expertise in these areas. Opinion pieces on topics of national interest, particularly the Academy's key interest areas – climate change impact, water, energy and education – will be considered for publication. Items between 800 and 1500 words are preferred. Please address comments, suggested topics and article for publication to [editor@atse.org.au](mailto:editor@atse.org.au).

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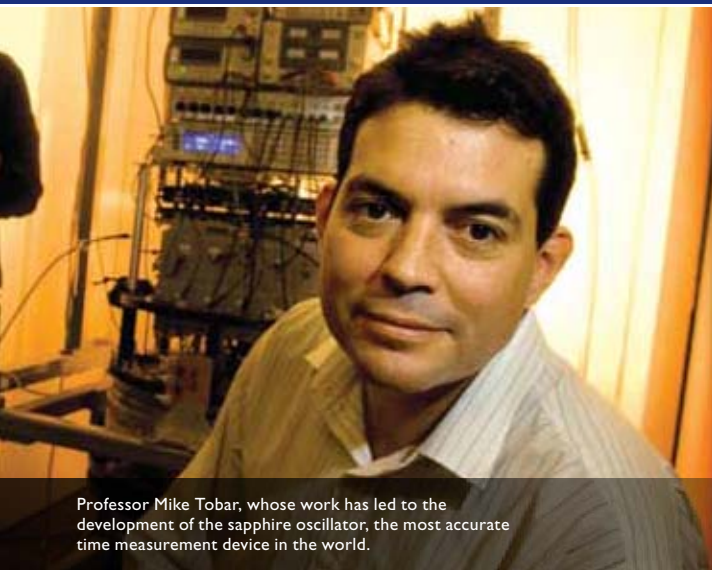
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# Nourishing the planet and its people

Little doubt about the importance of two questions: how to feed a hungry world, nutritiously; and how to better understand and sustain biodiversity.



By Denis Blight

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Can we have our biodiversity and eat it too? This was the pivotal question posed by Professor Hugh Posingham at the Crawford Fund's 2010 Parliamentary Conference in Canberra.

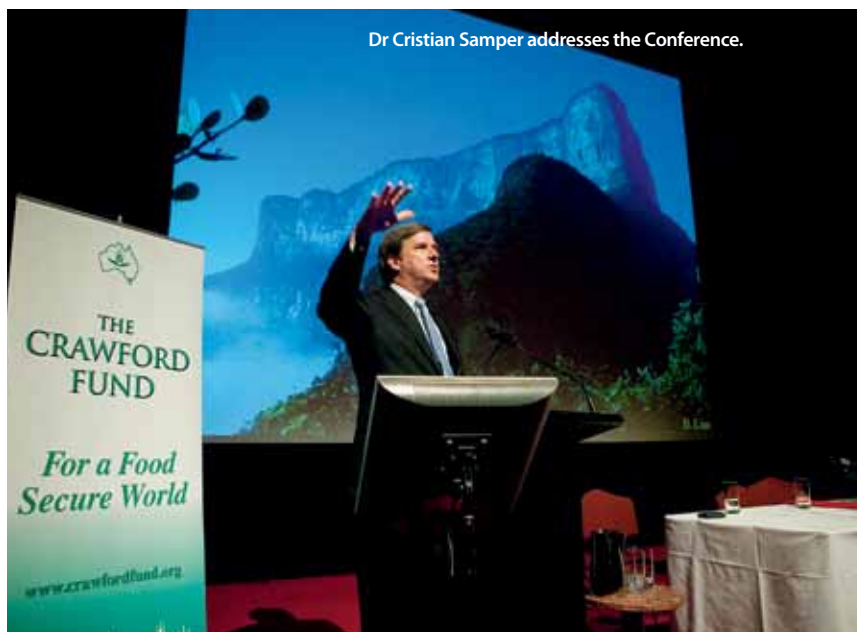
His question, which neatly captures the dilemma faced by a hungry, resource-scarce world, was asked against a remarkable and stark background set by the Conference's two outstanding key note speakers: Professor Stephen Hopper, the Director of the world's most famous garden – the Royal Botanic Gardens, Kew; and Dr Cristian Samper, the Director of the National Museum of Natural History, Smithsonian Institution.

Professor Hopper addressed the global ambition of sustainable healthy living for all, which he said was challenged by accelerating change, entrenched patterns of land and water use, biodiversity loss, rising consumption and population growth. There was, he said, little hope of continuing the green revolution if it remained focused on a few mainstream crops without new land and water ethics, and new economic and political systems that valued social and natural capital as much as financial assets.

He illustrated his thesis with captivating accounts of global plant diversity – a diversity that helps the planet to breathe, as he put it – scientific discovery, and strategies that will help humans live with and sustainably use biodiversity.

Dr Samper said that biodiversity was the basis for agriculture and for a sustainable future. Of the millions of species – some described, many more lost – only a few hundred species of plants and animals had been domesticated, he said and, while biological diversity remained vast and variable in space and time, it was being homogenised.

Yet biodiversity was vital to livelihoods – agriculture and trade were having major impacts on natural ecosys-



The Crawford Fund is a subsidiary of ATSE and holds an annual international conference in Parliament House, Canberra, on an issue that focuses attention and debate on a key aspect of food security and international agricultural research. In 2010, the UN International Year of Biodiversity, the Crawford Fund Parliamentary Conference – titled 'Biodiversity and World Food Security: Nourishing the Planet and its People' – was the key event in the Australasian region on the subject. A number of conference presentations have been developed into articles for this edition of *Focus*.

tems through transformation into production systems, habitat loss and fragmentation, pollution and species invasion. New tools giving insights into the origins of agriculture also offered opportunities for using and changing the genetic diversity of crops and races.

But it was time, he said, to bring together knowledge from biodiversity science and agricultural research through a whole-of-system approach to ensure these opportunities were seized.

Surprisingly, the Crawford Fund Parliamentary Conference was one of few being held in the year of biodiver-

## Contributions are welcome

Opinion pieces on topics of national interest will be considered for publication in ATSE *Focus*. Items between 800 and 1500 words are preferred. They must list full name, title/role, organisation (if relevant), city of residence and email address for publication. Please address to [editor@atse.org.au](mailto:editor@atse.org.au)

sity specifically to bring the two groups together – as many noted in discussions in the Conference surrounds.

These presentations, and others made at the Conference, leave little doubt about the importance of two questions asked separately: how to feed a hungry world, nutritiously; and how to better understand and sustain biodiversity.

Professor Possingham's answer to his own question, however, showed how difficult the policy task will be. He challenged any comfortable assertion that we could do both at once unless we can integrate biodiversity conservation areas with agricultural lands in ways that create win-win situations and rekindle a global affection for conservation in its own right. Even then there would have to be trade-offs.

Dr Megan Clark FTSE, the Chief Executive of CSIRO, said the issues went well beyond just using biodiversity as a new source for new foods or trying to understand the impact of climate change in terms of new threats of pests and diseases.

At the Parliamentary Breakfast session, Dr Emile Frison, the Director of Bioversity International, argued a compelling case (see page 9) that agricultural biodiversity offered an alternative approach to global malnutrition and poor health in a world where roughly two billion people suffer malnutrition associated with a lack of micronutrients and vitamins. He illustrated the point by describing a successful effort in Kenya to revitalise interest in indigenous leafy vegetables that were more nutritious, for example, than introduced cabbages, which now dominated diets at their expense.

In science as in politics, everything is related to everything else. Pests and diseases, elements of the biodiversity

mosaic, were a threat – entering Australia – to our biodiversity as well as to agriculture, Mrs Lois Ransome, Australia's Chief Plant Protection Officer, told the conference.

Dr TJ Higgins, from CSIRO Plant Industry, said (see page 13) a case could be made, on the grounds of conserving biodiversity, for the incorporation by different genetic tools of traits that will reduce the need for pesticide spraying. But, he said, there were limits to genetic manipulation – nitrogen fixation, for example involved a complex set of genes which would be difficult to transfer without further extensive research and development and legumes in farming systems already provided means for adding nitrogen to soils.

In the developing world, the balance between development and the environment was even more delicate, given the enormous demands for food and fibre of a growing population, said Dr Keng-Yeang Lum, CABI's chief scientist for Southeast and East Asia – and one that could only be achieved through policy and regulatory frameworks formed by bio-security and bio-safety combines.

In Africa, the diverse and genetically unique ruminant livestock and wildlife species were being lost at an alarmingly fast rate, according to Dr Ally Okeyo Mwai from the International Livestock Research Institute. By smartly conserving those at risk, genetic attributes for world food security could be saved.

A profound revolution in food from marine and freshwater – from fishing to aquaculture – was exploiting and altering the biodiversity on which they are based, Dr Meryl Williams FTSE, the Chair of the ACIAR Commission, told the Conference (see page 15). She said that aquaculture focused on the production of a few preferred

## Food security a focus at soils congress

More than 1800 of the world's leading soil scientists met in Brisbane recently to discuss major issues facing the world in relation to global food security, global warming and agricultural sustainability.

International Union of Soil Sciences President, Professor Roger Swift FTSE, from the University of Queensland, said the week-long 19th World Congress of Soil Science was a huge success and would help direct further research to tackle these globally important issues.

"We have heard from scientists from around the world who are doing important work towards helping us better understand the complex soil ecosystem," he said.

"We have heard about new research on soil carbon sequestration, methods to clean-up soil contamination, new sustainable practices to increase soil productivity and exciting projects that are mapping the planet's soil."

## Twice the food means twice the water

Food shortages will be more common in more countries in the next 40 years and food production will need to double by 2050 to accommodate the anticipated extra 2.5 billion people – and water is the key, according to Dr Colin Chartres, Director General of the International Water Management Institute.

He told the recent 19th World Congress of Soil Science in Brisbane that wealthy countries

had a responsibility to share their knowledge and technologies in irrigation and better agricultural practices with developing countries to help them increase food production.

"In order to double food production we need to double the water volume we use in agriculture, and there are serious doubts about whether there is enough water available to do this," Dr Chartres explained.

"Water scarcity is the major threat to agriculture and food security in developing countries and more of a threat than access to land. There is no one-size-fits-all policy – we need to understand all socio-economic and other economic factors when approaching the issue.

"Soil researches and hydrologists need

strains and on creating new strains thus reducing and increasing diversity.

Microorganisms, the first forms of life on Earth, had evolved into the most diverse species on earth and continued to nurture and sustain the environment, plants and animals on which human society depended, said Emeritus Professor Lindsay Sly, from the University of Queensland. And yet the preservation of authentically stable microbial and cell cultures, access to information on cultures and characteristics, and identification description of new species – all vital services of microbial resource centres – were relatively neglected, including in Australia, he said.

One issue underpinning many presentations and the extended question and answer session, moderated by CSIRO's Dr James Bradfield Moody, was the lack of capacity to record and describe biodiversity – and in particular the shortage of trained taxonomists who could do the work.

In all this there are elements of paradox and contradiction. A number of questions and comments during the Q&A (including one from a respected veteran agricultural scientist) urged that the benefits of modern broadacre agriculture, developed over years of careful research and application, and its contribution to world food security, not be discounted. Other questioners emphasised the benefits of 'healthy soils'. Even parasites are elements of biodiversity and have important roles in pest and disease management.

The difficulty of the policy challenge will be illustrated by Associate Professor Luca Tacconi, Director, Environmental Management and Development Program, at the Crawford School of Economics and Governance on tropical forestry biodiversity loss. He pointed to the need

To encourage greater participation by younger people in international agricultural research, the Crawford Fund encouraged attendance at the Conference by Australian agricultural science students – and some 30 young or trainee scientists who joined the event.

for governments to commit to:

- changes in existing policies which drive deforestation and forest degradation;
- adjusted policies and property management rights;
- clearer lines of authority for every level of governance;
- addressing of corruption; and
- stronger law enforcement.

The challenges posed on biodiversity and food security in Australia – where plant and microbial genetic resource collections were, according to speakers and questioners, in need of urgent national attention – also existed internationally and called for policy leadership of the kind provided by Sir John Crawford, a visionary who helped to lead Australian food and fibre production, trade policy, universities and international agricultural research systems. ◀

**DR DENIS BLIGHT is Executive Director of the Crawford Fund.**

**Dr Blight's career has included positions as an Australian diplomat, public servant and chief executive. His association with international agricultural research began in earnest some 25 years ago. Prior to working for the Crawford Fund, he was Director-General of CAB International, an intergovernmental body in research, training and publishing in the life sciences, and had 15 years with IDP Education Australia, the international development program of Australian universities and colleges, including the position of Chief Executive.**

to get together to work through the issues. Currently there is a world congress for soil and there is a world congress for hydrology, but we need to get together and compare notes to combat these issues.

"Currently one litre of water is required to produce one calorie of food. Recent investigations by a team of over 700 international scientists have demonstrated that if we continue with the currently low levels of water productivity we will not have enough water to produce enough food.

"We need a Blue-Green revolution to deliver water productivity increases and this involves significant investment in reducing water losses from water storages and canal distribution systems and similarly requires

significant on-farm investment in better irrigation technologies."

## Salt-tolerant rice offers global hope

A team of scientists at the Australian Centre for Plant Functional Genomics (ACPFPG) has successfully used genetic modification (GM) to improve the salt tolerance of rice, offering hope for improved rice production around the world.

The research team has used a new GM technique to trap salt in the root of the rice plant, reducing the amount of toxic salt building up in the plant and increasing its tolerance to salinity.

This new research into rice builds on previous work into the salt tolerance of plants

led by scientists from ACPFG. The research has been conducted in collaboration with scientists now based in universities in Cairo, Copenhagen and Melbourne.

"Rice is often grown on land that is prone to high levels of salinity," said Dr Darren Plett, lead author and Research Associate with the ACPFG, a key partner of the Waite Research Institute at the University of Adelaide.

"Lands that accumulate salt have lower crop yields, which can threaten food supply. This has made salinity tolerance an increasingly important factor in the efforts to secure global food production."

The new GM technique was an "efficient and robust biotechnological approach" to helping rice grow in saline conditions, he said.

# Food security for a sustainable future.

Sustainability is both a national research priority and a 'hot topic'. It's an emotive issue but at its heart is scientific knowledge.

For more than a decade, the University of South Australia (UniSA) has been providing hard facts on sustainability issues. By working with governments, industry and community groups, UniSA has significantly influenced the development of products, programs and policies at a national and international level.

UniSA's Institute for Sustainable Systems and Technologies (ISST) combines expertise in natural and built environments, energy, water, transport, land use and engineering for agriculture.

Through this skills mix, ISST delivers integrated solutions to complex problems, such as systems analysis, modelling, decision-making support, technology development or simply lateral thinking.

Led by Dr Jack Desbiolles, some of ISST's contributions to multi-disciplinary international projects are playing an important practical and collaborative role in food security by addressing sustainability issues in world farming. Projects in South East Asia, the Middle East and the Maghreb region of North Africa are set to deliver valuable change through integrated engineering solutions for improved farming sustainability and productivity. ISST's activities include developing improved seeding machinery suitable for local conditions and targeted training of stakeholders in advanced farming technologies and practices, with a particular focus on conservation agriculture (CA).

In Cambodia, current project work is focused on improving rice crop establishment practices in irrigated wetlands and increasing cropping efficiency and intensification to raise production and consequently increase food security in the South East Asian Mekong region.

In the Middle East and North Africa, dry land farming projects have a strong focus on CA principles. These projects are designed to lift crop productivity by enhancing soil conservation and water-use efficiency, improving drought management and overcoming land degradation. These approaches benefit from ISST's wealth of experience in the Australian no-till farming context.

The far reaching outcomes of research projects tackling farming sustainability and productivity are critical in reducing rural poverty and helping to feed the planet, and an example of how UniSA is engaged in positively changing the way our world lives.

For further information about research at UniSA visit [unisa.edu.au/research](http://unisa.edu.au/research)

*In Iraq and Syria, key stakeholders such as farmers, researchers and advisors are being trained and supported in the development and adoption of no-till seeder technologies and associated conservation cropping practices.*



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# Agricultural biodiversity for nutrition and health

Current approaches to the problems of malnutrition are clearly not working. It is time for a fresh set of solutions, based on using agricultural biodiversity.



By Emile Frison

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**D**espite massive efforts over the past 60 years, since the start of the Green Revolution, there are still far too many chronically hungry people in the world. Last year, the Food and Agriculture Organization of the United Nations estimated that more than a billion people were hungry, partly as a result of sky-high food prices.

That would be bad enough, but at the same time the World Health Organization (WHO) estimates that more than a billion people are seriously overweight. And then there are believed to be two billion people – mostly young women and children – who suffer from a lack of essential micronutrients such as vitamin A and iron.

The problem is not simply one of lack of proteins or calories. It is about the lack of diversity in the diet, because dietary diversity is one guarantee of an adequate supply of essential micronutrients. Without diversity in their diet, people can have enough to eat and yet still suffer the hidden hunger of malnutrition.

There is very good evidence from several studies, mostly in the rich world and also increasingly from developing countries, that a diverse diet protects people from several non-communicable diseases and is associated with a longer, healthier life and greater productivity.

Non-communicable diseases, such as obesity, Type 2 diabetes, heart disease and cancers, were long thought of as diseases of affluence, but they are growing fastest in low- and middle-income countries, where 80 per cent of the deaths from these diseases occur. They account for 70 per cent of all adult deaths in the Western Pacific Region, and the Food Summit held in Vanuatu in April 2010 cited “declines in traditional food crops, increased dependence of imported foods and growing vulnerability to climate change” as among the most important reasons.

Current approaches to the problems of malnutrition are clearly not working. It is time for a fresh set of solutions, based on using agricultural biodiversity not simply as a source of traits for scientific breeders but as a component of healthy diets and resilient food systems.

## Many levels

Agricultural biodiversity exists at many levels – in ecosystems, among species, and among different populations, or varieties, of the same species.

For example, in Kenya people traditionally ate more than 200 different species of leafy vegetables. In almost all cases, these species are much more nutritious than the cabbages and kales that are often the only green vegetables on sale in cities. However, they have also had to cope with a barrage of obstacles to their wider use – they are perceived as backward, supplies were erratic and unhygienic and younger adults, especially in the cities, had no idea how to prepare them.

Working with a range of partners Bioversity International trained farmers to grow traditional leafy vegetables and worked on quality control and supply chains. Supermarkets were brought in to help make the produce available in cities, and colourful recipe leaflets showed how to prepare them. Celebrities from entertainment and government endorsed traditional foods publicly and on mass media.

The result was an increase in deliveries to markets from about 30 tonnes a month to about 400 tonnes a month over three years. More telling, supplies in supermarkets and open-air markets, where traditional leafy vegetables are now much more common, regularly run out by early afternoon, indicating that there is still considerable unmet demand. Incomes have increased between two and 20 times among the farm families supplying these vegetables.

An expanded follow-up is now looking at 20 villages in Kitui district, east of Nairobi. Ten control villages are being compared with 10 matched intervention villages, where a whole range of activities designed to promote agricultural and dietary biodiversity are being undertaken. There is preliminary evidence that dietary diversity has increased in the houses, markets and restaurants of the intervention villages, and while it is very early days yet to see improvements in health, there are already hints of lower levels of anaemia.

It is important to note that the work in East Africa is not intended to be replicated directly elsewhere with the same species and the same interventions. Indeed, I would not expect it to work in other countries and other cultures. It is the methods and the ideas behind this food-based approach that are intended to be globally applicable – and Bioversity has other successful projects on Andean grains in Bolivia and Peru and nutritious millets in India and Nepal.

Similar food systems approaches based on locally available agricultural biodiversity are making headway in the Western Pacific Region. One is in Pohnpei (formerly Ponape) in the Federated State of Micronesia (FSM), where the Island Food Community of Pohnpei has been a leader in promoting the nutritional value of local fruits and vegetables using a whole range of innovative approaches.

Specific varieties of Pandanus fruit, for example, are much richer in vitamin A precursors than others, and a poster helps people to choose them and plant the best varieties. The community also worked with the FSM to issue a set of stamps promoting karat bananas, which are also very rich in pro-vitamin A. Every stamp carries a message explaining that karat is an ideal food for babies older than six months, in addition to breast milk.

## Encouraging results

Many of the bananas of the Pacific are richer in vitamin A precursors than any other varieties of the plant. However, the knowledge that they exist has prompted Bioversity research in Cameroon in West Africa to look for high pro-vitamin-A bananas there, with encouraging results. Considerable work remains to be done to make these an integral part of a food-based approach to vitamin A deficiency, but such an approach is likely to be the most sustainable solution.

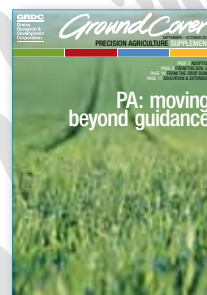
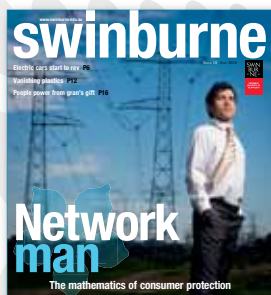
Indeed, the food-based approach is long overdue for re-examination. When the WHO and other organisations first began to sound the alarm about micronutrient deficiencies, they specifically said that dietary diversity embedded in a food systems approach was the preferred option for tackling the problem. This original emphasis was slowly overtaken by a much more medicalised approach, which saw each deficiency as a disease to be cured by the administration of a specific supplement.

A recent analysis by Professor Michael Latham of Cornell University has pointed to what he calls “The Great Vitamin A Fiasco” with claims that this sort of reductionist intervention has done almost no good and may well have done harm, not least by blocking funding for more

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sustainable approaches. Critics have responded strongly to Professor Latham, who has also brought out supporters and, perhaps most importantly, re-opened the debate.

While not in itself evidence for the medical “capture” of the treatment of malnutrition, it is salutary to realise that the pharmaceutical companies who manufacture vitamin A supplements were subjected to the largest fines ever issued in the US and the European Union, for price-fixing.

The medical establishment currently sees three approaches to tackling malnutrition – supplements, fortified foods and biofortified staples. This is echoed in the cost-benefit analyses of economists. The Copenhagen Consensus, for example, identified tackling malnutrition as one of the most pressing problems for humanity, with the highest return on investment of all the problems that it looked at. It did not, however, even consider food-based approaches, because there have not been enough detailed studies to enable comparison with the more medical approaches. In this way the medical establishment maintains its pre-eminent position.

The original food-based solutions advocated by the WHO and others need to be reassessed, not least because placing a greater emphasis on food and diet as a whole will enable medical interventions to be used where they are most needed and most effective. Both are needed in a balanced approach, with greater weight given to food-based approaches than at present.

In pursuit of this, Bioversity’s nutrition program is working to build the evidence base of what works on the ground, and how that can best be applied to other places and other cultures. Policy-makers need to understand that there are alternative approaches to tackle malnutrition, and that they often have multiple benefits beyond improving nutrition and health.

## Virtuous circles

There are many virtuous circles that improve the resilience and stability of farm systems, adaptability to changing circumstances, such as climate change, household incomes and productivity, and long-term sustainability.

Most efforts to tackle malnutrition in the recent past have adopted a reductionist one-at-a-time approach to specific disorders. These will still be needed in the future, but a



PHOTO: S. MANN/BIOVERSITY

shift to more food-based approaches offers more comprehensive solutions to a range of interlinked problems.

Hunger and undernutrition are part and parcel of almost all development goals, influencing – and in turn being influenced by – health, income, education, gender equity and the environment. Implementing such approaches will require effort and funding, and – more than that – collaboration and coordination among different sectors that have not been used to working with one another.

This is hard. The benefits, however, will be seen in long-term improvements that will be self-sustaining, as healthier communities engage in a diversified and less destructive agriculture that offers a nutritionally superior diet, which in turn keeps communities healthier – all with profound effects on economic development. ◀

*Bioversity International is the operating name of the International Plant Genetic Resources Institute (IPGRI) and the International Network for Improvement of Banana and Plantain (INIBAP).*

**DR EMILE FRISON**, Director General of Bioversity International, has spent most of his career in international agricultural research for development. Dr Frison leads Bioversity and its partners in the formulation of a strategic vision in which nutrition and agricultural biodiversity play an important role in the overall goal of reducing hunger and poverty in a sustainable manner. He also leads the CGIAR System-Wide Genetic Resources Program and is a member of the CGIAR Genetic Resources Policy Committee. In 2007 he was appointed as Extraordinary Professor by the Catholic University of Leuven, Belgium. Dr Frison is also a Member of the Executive Board of the Global Crop Diversity Trust.

Shopping for nutritious African leafy vegetables in a supermarket in Nairobi.



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# GM and biodiversity: partners in conservation and productivity?

Over the next 40 years there will be marked increases in agricultural inputs and an additional billion hectares of wild land will be appropriated for crops and pastures.



By T J Higgins

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**T**he *Nature* editorial of 29 July 2010 was very upbeat about feeding the projected nine billion people in 2050 on the one hand but raised a very sobering question on the other. Even the sobering question raised the prospect that “cost to the planet” could be saved by technology, both low and high forms.

Not too many people are as sanguine as the editor of *Nature*. Many people would subscribe to a more complex set of conditions to be met if we are to feed and clothe the future billions of human bodies. At the very least we will need:

- policy and social changes;
- new regulatory regimes controlling food production; as well as
- the major scientific and technological advances envisaged by *Nature*.

Luckily, the next 50 years is likely to be the last period of rapid agricultural expansion. Thereafter, the planet should be in a “steady state” and let’s hope it is indeed steady.

To guide us about the next 50 years, let’s first examine what happened over the past 50 years. World population more than doubled but crop production kept pace – in fact, it almost tripled. This was achieved by a modest increase in cropped area (to 1.5 billion hectares) combined with a better than doubling of yield per hectare. This doubling of yield was achieved by a combination of factors including better plant varieties, more pesticides, more fertiliser, more irrigation and more mechanisation.

We can conclude, therefore, that there had been increased agricultural intensification which had undoubted benefits and, also equally undoubted, costs. The benefits included sparing of wild lands for biodiversity. There was less malnutrition of the human race. The costs, however, included much more water use and abuse, more chemical run-off (closely related to water abuse), more soil erosion and increased greenhouse gas emissions.

The ecosystem is divided into the managed part and the wild part, with the managed part comprising nearly 40 per cent of the total.



Cowpeas and one of their major insect pests, the podborer moth (*Maruca vitrata*).

About one-third of the managed ecosystem is cultivated (nine per cent of this is under genetically modified, or GM crops) and about two-thirds is under pastures. Almost one fifth of the cultivated land is irrigated. To obtain the massive increase in yield/ha, more than 120 million tonnes (MT) of nitrogen and phosphorus fertiliser were applied, as well as nearly four million tonnes of pesticides. These inputs are not just increasing yields – they are having negative impacts on both the managed and wild ecosystems.

Over the next 40 years there will be marked increases in agricultural inputs and an additional billion hectares of wild land will be appropriated for crops and pastures. That means there will be less wild land and that still left is likely to be negatively affected by what will then be 10 million tonnes of pesticides and more than 200 million tonnes of fertilisers – remembering that we reach peak oil (which means nitrogen fertiliser) in 2014 and peak phosphorus in 2035.

### 50 critical years

The next 50 years are critical both in terms of meeting human needs through the managed ecosystem and minimising damage to the wild ecosystem. It is now recognised that crop yield increases are falling behind projected demand and unless this is corrected (largely by more investment in R&D), then the area under cultivation will increase even further.

It is clear that we should not just be talking about food security but food and ecological security, since they are so interlinked. Yield must increase or the area under cultivation must be greatly expanded. A partial win/win could emerge in which intensive production makes use of better practices in managing crops, soils, water, fertilisers and pesticides while at the same time more diverse cropping and forestry systems could provide better livelihood options that support biodiversity and environmental services.

Such “Sustainable Intensification” is emerging as a strategy to increase yields (and thus spare as much land as possible for wild land) and to manage the soil and water quality by using inputs such as pesticides and fertilisers with even greater efficiency and sensitivity than over the past 50 years.

Will GM play a role in this sustainable intensification strategy? Bear in mind that GM crops are still only nine per cent of the world's cropped area, are grown by three per cent of the world's farmers and have only been on the scene since 1996.

Nevertheless, that 15-year period is long enough to evaluate whether GM crops can help steady a trend line going towards the target of food and ecological security by 2050.

Studies of GM crop yields in developed and developing countries have shown that the majority reported in-

creases – but nearly a quarter found no increases and some even found yield reductions. Fortunately it was in developing countries where most of the yield increases were found. Studies of economic impacts of GM crops reported mostly positive outcomes but one quarter were neutral or negative. Again, there was a greater proportion of positives in developing economies.

The average yield of cotton in India increased by 70 per cent between 2001 and 2008. Half of the gain was attributed to GM cotton – which serves to emphasise the very substantial gain being made in conventional agriculture as well. There was more than 50 per cent decrease in cotton bollworm insecticides used in India between 1998 and 2006. In China, in 2009, seven million farmers grew GM cotton – yield was increased by more than nine per cent while insecticide use decreased by 60 per cent.

In Brazil, between 1997 and 2008, herbicide sprays were reduced, which meant that less diesel and water inputs were needed and there were reduced CO<sub>2</sub> emissions. Further dramatic gains are expected in the next 10 years.

So far we have concentrated on developing countries since that is where most of the people are as well as much of the remaining biodiversity, but what about GM crops in developed countries?

The US has rapidly adopted GM corn, soybeans, cotton, canola and sugarbeet. Over the past 40 years there has been a steady increase in corn yield from about five tonnes/ha in 1965 to more than nine tonnes/ha in 2005. These gains are attributed to hybrids, irrigation, nitrogen fertiliser, conservation tillage, IPM and, notably, the recent gains are attributed to Bt corn – a genetically modified organism (GMO). Thus the big gains were first made by conventional methods of intensification but GM has made a contribution as well. The future will be interesting – when there will have to be reductions in nitrogen fertiliser and irrigation.

### Precision agriculture

Global fertiliser input is expected to soar to over 320 MT from the current 120 MT. Nitrogen and phosphorus will both be critical and their conservation will be a matter of great concern.

Nitrogen, for instance, is poorly utilised resulting in eutrophication and greenhouse gas emissions. There is intense research on how to use nitrogen more efficiently, including advances in precision agriculture. One way in which GM may help is in the more efficient use of nitrogen by the plant, as has been shown for a GM canola which has an extra gene for amino acid metabolism.

This is still in the experimental phase but field trial

# What's aquatic biodiversity got to do with it?

Although we are tempted to hope that aquaculture can solve the problems of overfishing and save wild fisheries, this is a false hope, no matter how alluring.



By Meryl Williams

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**A**quatic biodiversity provides one of humanity's most important food resources. Most of the world's oceans and all inland waters are fished, providing protein and micro-nutrient rich food.

Driven by a growing global population, demand for fish is rising and adding to the pressures on the supply side – overfishing, inefficient aquaculture, climate change, acidification and deoxygenation of oceans, pollution from chemicals and dumping of rubbish, disruptions to nutrient, carbon and water cycles.

The export value of world trade in fish, some US\$63 billion in 2003, is more than the combined value of net exports of rice, coffee, sugar and tea. Fishing is also a vital and valuable source of employment and income in both the developed and developing world.

About 30 million fishers make a living directly from the sea and an additional 200 million are dependent on fisheries related activities and industries. Most of these and the one billion people who rely on fish as their main source of animal protein live in developing countries.

Fishing has, over millennia, become a vital part of human life. We take eating fish for granted. For many the popular image of fishing focuses on the people involved, and the dangers in getting fish to the plate, such as in the Discovery Channel documentary series *Deadliest Catch*, now shown in 150 countries.

Sustainability debates do not generate such wide spread attention. Yet, a more compelling drama is played out each day in fisheries around the world – the daily struggle of fish workers, many of whom are women, to earn enough to live. Most of the people relying on fishing are labourers on other people's boats or in processing factories. Few of them have job and resource security and most face declining resources and declining aquatic biodiversity.

Many fisheries are still engaged in a 'race to fish' approach, with catches often determined by the size of the boat and illegal fishing practices, rather than sustainable management approaches. These fishers are eager to meet

the rising demand for fish in the hope of a better life.

The challenge is two-fold, ensuring that aquatic resources continue to contribute to food security and people's livelihoods, while not compromising aquatic biodiversity. The successful management of fish production requires an integrated approach and a watchful eye on biodiversity.

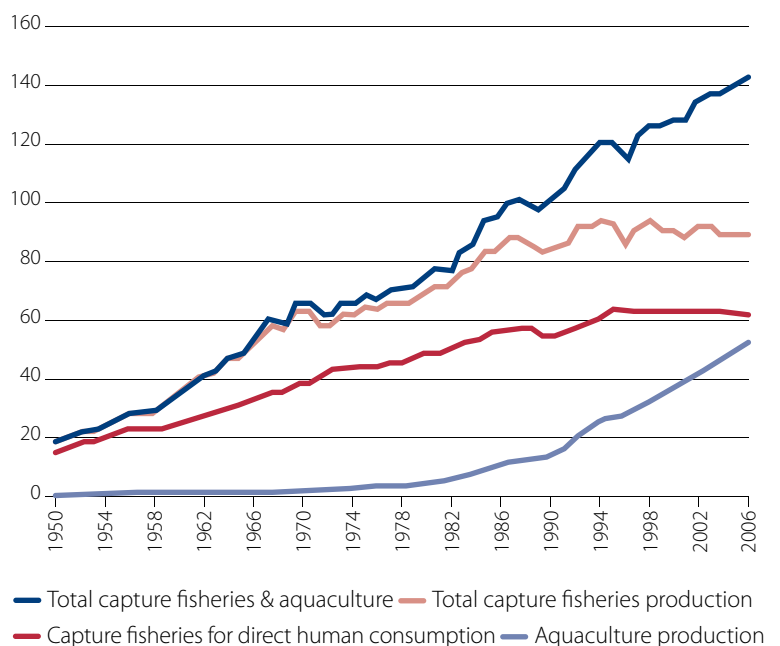
## Sustainable catches

Although we are tempted to hope that aquaculture can solve the problems of overfishing and save wild fisheries, this is a false hope, no matter how alluring. Instead we must deliver sustainable catches, and productive aquaculture.

Aquaculture is the key to future increased fish pro-

Figure 1 World fisheries and aquaculture production 1950 to 2008

All production statistics are in millions of tonnes and exclude aquatic plants and mammals



SOURCE: FAO

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*"At the end of the STELR project, students were surveyed and they loved the practical experiments on biofuel, energy transfer, solar cells and wind turbines and said they would not change anything about the project because it was fun. That is a huge vote of confidence for the project because when students are having fun they are engaged and they are learning."*

*– Louise Macfarlane, Box Hill Senior Secondary College, Victoria*

*"I'm blown away with STELR... you're doing a fantastic job."*

*– Matthew Rapley, Science Teacher,  
Caroline Chisholm College,  
New South Wales*

 **ATSE**  
**STELR**

duction. At most, capture fisheries may hold their own – although a more likely scenario is that catches will be reduced to achieve sustainability.

Today almost half of all fish eaten are farmed (Figure 1). This is a revolution in fish production but also a great challenge from to aquatic biodiversity at genetic, species and ecosystem levels.

The world's fish catch is biodiverse. Thousands of species are taken, of which approximately 2000 fish, crustacean, mollusc, echinoderm (marine invertebrates) and aquatic plant species or species groups are reported by name in FAO statistics but 10 million tonnes are landed as unnamed marine fish. More than 5,000 species are probably harvested.

Fishing compromises genetic diversity in several ways. Fishing typically targets one or several species, eventually removing some genetic stocks from the species. Fishing is usually focused on larger fish and when these are removed, a stock's reproductive capacity is decreased and it is prone to larger fluctuations in abundance.

Preferences for larger, valuable fish species reduce their abundance and promote abundance of other smaller species. Species diversity can be further diminished by incidental killing of non-target species such as marine mammals, sea turtles and sharks. Fishing also reduces the diversity of ecosystems and habitats.

Farming fish also challenges biodiversity and sustainability. Aquaculture utilises and affects species in different ways to fishing. In many cases cultured species are still collected from the wild at some stage in their life cycle because captive breeding has not yet been achieved. Culturing can involve growing out larvae through to fattening juveniles or taking adults for breeding. These unimproved varieties may or may not grow well or even survive capture and growout, thus wasting natural resources.

If local species are not available for culture, then another tactic is to introduce exotic species. Depending on the situation, this may be highly successful – or highly risky because the exotic species can become established invasive species, wrecking other forms of havoc on aquatic biodiversity.

Aquaculture is at a crossroads. It can continue to utilise available species sourced from the world's waterways and oceans, or it can narrow its focus and domesticate fewer species – but not too few. The first road will place increased pressure on fisheries worldwide, as biodiversity is tapped in an indiscriminate and inefficient way. The second road, while longer and more challenging, is also the more sustainable, as the genetic resources of a smaller number of species are used to build reliable systems for domestication, aiding the preservation of species in the wild.

**Table 1 Species choice criteria for aquaculture**

<b>Biology</b>	<ul style="list-style-type: none"> <li>- life-cycle closed</li> <li>- feed available</li> <li>- behaviour permits handling, confinement</li> <li>- disease resistant</li> <li>- large size and good growth rate</li> </ul>
<b>Economics</b>	<ul style="list-style-type: none"> <li>- marketable</li> <li>- potentially profitable</li> </ul>
<b>Culture system and environment</b>	<ul style="list-style-type: none"> <li>- feasible farming system</li> <li>- sites available</li> <li>- minimal or positive environmental impact, including on biodiversity</li> </ul>

Taking this second road towards domestication will be highly dependent for success on international agricultural research. Without the steadying hand of research, the choices of species to domesticate may be made for us, as overfishing and inefficient aquaculture reduce biodiversity.

### Hit-and-miss

So far, aquaculture has proven to be a hit-and-miss affair. Some species defy all attempts at culturing, others can be grown out after being captured and some can be raised from the larval stage. Presently, FAO reports aquaculture production from 348 different species and species groups. Less than 20 per cent of these species have been domesticated but most of those for which over one million tonnes are produced annually have been domesticated and their breeds improved.

The goal of all future aquaculture activities, and research, must be full domestication of selected species. A careful selection of species must be based on a set of comprehensive criteria (Table 1). Research must be used to define, test, develop and prove criteria for selecting suitable species.

Suitable species will be those for which the lifecycle can be closed in captivity. Feed must be available and affordable and preferably from non-fish sources. The selected species must have the ability to grow to market size in reasonable time and a tolerance to confinement and handling.

Economically viable culture species require a combination of marketability and profitability. From a food security perspective, some species must be available to smallholder aquaculture producers in the developing world. Achieving this result for smallholders must also cater to issues such as space, environmental management, available finances and assets along with training and education. All of these factors need to be present in species selected for domestication.

The improvement of farm breeds to increase efficiency depends on biodiversity at species and genetic levels. The selection of species must be carried out in conjunction with

the preservation of their genetic variability. To do otherwise is to limit the potential for breeding improved fish strains.

With these sorts of challenges in mind, the Australian Centre for International Agricultural Research (ACIAR) has designed and supported fisheries research since 1984. This research has a dual focus – managing wild fisheries through innovative management approaches and better utilisation of existing harvests, in concert with improved aquaculture through the development of productive and sustainable aquatic farming systems.

As an example, the WorldFish Center, in partnership with ACIAR, is applying this dual approach to sea cucumbers, focusing on viable culturing and restocking of depleted resources. This project, active in the Philippines, Vietnam and Australia, builds on past research that developed technologies for culturing ‘sandfish’ (*Holothuria scabra*) in hatcheries and for releasing in the wild. In many areas where sea cucumber has been overfished the culture technologies can be used to replenish selected sandfish populations.

In the Philippines restocking of sandfish into marine reserves is building up a critical mass of spawning adults. The research will help to speed stock recovery, generate income and conserve wild breeding stocks.

In another case, ACIAR’s support has helped in defining the basic taxonomy of the four Indo-Pacific mud crab species (*Scylla* spp) and developing technology for hatchery and nursery production of crablets with improved productivity in growout. Guidelines for the design of pens for farming crabs were developed. When farmers were

provided with appropriate crablet species and equipment, the growth of the crablets was rapid, with relative conformity in size and a viable survival rate compared to stocking ponds with wild seedstock.

Despite these successes, aquatic biodiversity faces huge conservation challenges because much of it needs to be conserved in-situ in water bodies threatened by myriad human actions such as dams and land reclamation for ports and cities. The challenge must be addressed on several fronts – sustainable management of wild resources, developing domestication systems for selected species and strategic and integrated policy interventions.

Whichever way we look at sustaining fish production, protecting and wisely using aquatic biodiversity lies at the core and research provides many of the answers. ◀

*I gratefully acknowledge the assistance of Warren Page of ACIAR in preparing the presentation for the 2010 Crawford Fund Conference on which this article was based.*

**DR MERYL WILLIAMS** FTSE Chairs the Australian Centre for International Agricultural Research and was previously Chair of the ACIAR Board of Management. She was inaugural Executive Officer of the CGIAR Alliance Office, formed in 2004 by the 15 international agricultural research centres of the Consultative Group on International Agricultural Research (CGIAR). Before this, she was Director General of WorldFish Centre and, earlier, Director of the Australian Institute of Marine Science (AIMS). She was a member of the AIMS Council from 1989 until June 1997.

#### ◀ FROM PAGE 14

results indicate that it may be possible to obtain the same yield with much less nitrogen.

What has been our experience in Australia – a developed country with GM crops? There was no increase in yield of cotton, as expected. But there were reductions in the level of active ingredients applied – 44 per cent with first-generation Bt cotton and an 85 per cent reduction with the second-generation Bt cotton, called Bollgard.

In terms of sprays per season, for Ingard cotton, spraying for *Helicoverpa* (a genus of moth which is a major agricultural pest) was reduced from more than nine to less than four sprays, while sprays for other pests remained unchanged at a little more than two per season. When Bollgard II cotton came

on the scene, sprays were reduced from more than eight to less than one for *Helicoverpa*, although spraying for other pests increased from one to over two. Cumulatively, the total insecticide sprays were reduced from more than nine to less than three.

This has led to better survival of beneficial insects which in turn helps control secondary pests. Bt cotton fields are now considered to be “living crops” not “biological deserts” and they could be the foundation for a long-term integrated system of pest control.

In conclusion, GM crops can and should be part of our global managed ecosystem. They can increase yield and so spare land for the natural ecosystem, increase income and therefore help reduce poverty and reduce

inputs for the protection of soils and water.

To do their part in long-term intensification of food, feed and fibre production to satisfy human needs and wants we will need enlightened leadership to drive new regulatory regimes as well as political and social changes. ◀

**DR TJ HIGGINS** FTSE is an Honorary Fellow at CSIRO Plant Industry. He works on protecting food legumes from insect damage, researching the application of gene technology for plant improvement. His current research is focused on international agriculture with particular emphasis on West Africa and India and he has a special interest in public awareness of science. He is a Fellow of the Australian Academy of Science as well as ATSE.

# More science, better integration to meet the food challenge

As every human is a net consumer of food, balancing the needs and merits of nutrition, bio-energy, the environment and livelihoods are global concerns.



By Kadambot Siddique

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**M**aintaining adequate global food supplies at a time of rapidly rising population, significant economic growth, increasing food and stock-feed demand, changing climate, declining natural resources, trade liberalisation and regional disturbances is a critical issue for mankind.

To meet this life threatening challenge, we must adopt scientifically sound and sustainable agricultural practices.

Science plays a major role in feeding the world, as clearly demonstrated by the green revolution post-World War II. However, future food security challenges will increasingly require a multi-disciplinary approach, involving environmental, economic, social and political solutions.

World leaders increasingly realise that feeding the world with diminishing resources is a massive task and greater cooperation between countries, governments and scientific disciplines is required. While the need to have food on their plates is shared by all consumers, the more affluent are now demanding their food should also be clean, green and ethically and sustainably produced.

Alarmingly, this is happening as the stockpile of wheat has dropped to its lowest level since 1980 – sufficient to feed the world for just 12 weeks. Food prices are soaring worldwide, while crude oil prices have doubled shipping and fertiliser costs. The UN's Food and Agriculture Organization (FAO) estimates that by 2050, grain output has to rise 50 per cent and meat output has to double.

Population growth, rising incomes, the declining rate of agricultural productivity trends, climate change and the increased use of grain and sugar cane for biofuel production are leading to a competitive surge in food commodity demand. This is occurring in an environment where land and water constraints will limit agricultural production growth. Total urban population will double, changing diets as well as overall demand, because urbanites tend to eat more meat products.

As every human is a net consumer of food, balancing the needs and merits of nutrition, bio-energy, the environ-



A great selection of fresh fruit on sale in Malaysia.

ment and livelihoods are global concerns. For these reasons, integrating whole aspects of agriculture and the food industry is important in the future.

I see five major trends in the global agriculture and food industry.

**1 Food production must increase substantially** by the mid 21st century to feed a world population projected to increase from 6.8 billion to 9 billion. The challenge is to double world food production output by 2050, while using less land, far less water and fewer nutrients, while watching the 'hovering cloud' of climate variability and change.

**2 Economic development is increasing faster than expected** in most countries. With economic growth comes a rapidly changing food preference, increasing purchasing power and greater demand for high standards of food quality. About 40 per cent of the increase in world grain production now comes from increase in yields and 60 per cent comes from allocating more land under cultivation. However, increased future food production must come from shrinking land, water and other natural resources, meaning increased productivity per unit of land.

**3 Impact of agriculture on the environment and our natural resources** is exemplified in the emerging global shortage of water for urban consumption, industrial use

and agricultural purposes. The world's two billion farmers, as guardians of much of what is left of the natural landscape, hold the fate of thousands of threatened species and the world's remaining forests in their hands. Agriculture currently uses 75 per cent of the world's fresh water and its runoff has degraded the earth's major rivers, estuaries and even seas.

**4 Escalating fossil fuel price and the growing popularity of biofuels** is driving demand for grain crops (corn and oil seeds) and sugar cane. Increasing fossil fuel prices pose a major risk to agriculture production and transportation costs, leading to increased price volatility. This presents a serious issue since it takes over arable land and diverts resources from food production. By 2020 we're likely to burn 400 million tonnes of grain a year just to keep our cars on the road – equal to the world rice crop. Billions of subsidy dollars have been poured into developing sugar and grain-based ethanol and biodiesel to help wean rich economies from their addiction to fossil fuels, the overwhelming source of human-made global warming. As soaring prices for staples bring more of the planet's most vulnerable people face-to-face with starvation, the image of first generation biofuels has changed from climate saviour to misguided 'experiment'.

**5 Climate change and its impact on agriculture** have the potential to reduce productivity and output in agricultural industries in major producing countries, in the medium to long terms. Several analyses indicate future climate changes and associated declines in agricultural productivity and global economic activity may affect global production of key commodities. For example, global wheat, rice, beef, dairy and sugar production could decline by two to six per cent by 2030 and five to 11 per cent by 2050. The agricultural sector must maintain strong productivity growth to cope with the pressures emerging from climate change and variability. Agriculture occupies 40 per cent of the world's free land surface and is responsible for 30 per cent of global greenhouse emissions.

More world-class scientists must be trained in agronomy/farming systems, environmental science, genetics, biotechnology and plant breeding. By instituting international agricultural training initiatives we can positively address the global food crisis.

Australia's engagement in international agricultural research and education, through ATSE, AusAID, ACIAR, universities, government departments, Crawford Fund and NGOs, has imparted knowledge and skills and delivered sustainable technologies for local conditions.

An example is 'Seeds of Life', a project in partnership with the Ministry of Agriculture and Fisheries East Timor, funded by ACIAR and AusAID and which commenced in 2005 with the goal of improving food security for East

Timor by improved crop varieties and technologies – critical for the country's independence and economic development.

The project has already released new varieties of cassava, a staple food in East Timor, which yield up to 65 per cent more than traditional varieties.

Australia's involvement with Iraq, through the project, 'Development of conservation cropping in the dry lands of northern Iraq', in partnership with ICARDA and supported by ACIAR and AusAID and training of young Iraqi agricultural scientists at Australian universities, is another example of Australia's strategic involvement in war-torn countries.

According to ACIAR CEO, Dr Nick Austin, "agricultural science can be a catalyst for lifting many of the world's estimated 1.4 billion poor people from poverty".

Addressing the annual ABARE Conference, he said in the past 50 years, agricultural R&D had been pivotal in lifting gross world food production by 138 per cent, from 1.84 billion tonnes to 4.38 billion tonnes.

At the moment, it's closer to a nightmare, for those going to sleep at night with an empty stomach – and this is unpalatable to caring, thinking human beings with the capacity to make the changes necessary for everyone to be adequately fed and cared for. We simply can't claim global food security when one in seven people today still does not have access to sufficient food, and an equal number are over-fed.

Many of our global problems, such as food, water and energy shortages and climate change, are related and it's clear we can no longer take a linear path to a solution. I believe appropriately funded and strategic R&D has the capacity to drive agriculture and, in turn, global food production, to the point where food security can be more a reality than a dream.

Strong political leadership and social planning are also equally necessary to achieve these desired outcomes.

Australia has contributed significantly through joint education and training initiatives in developing the next generation of scientists, agriculturalists and farmers – the people the world will depend on to solve the greatest challenge of human history – food security in the 21st century. ◀

**WINTHROP PROFESSOR KADAMBOT SIDDIQUE FTSE is Chair in Agriculture and Director of the University of Western Australia's Institute of Agriculture and Associate Dean Research, Faculty of Natural and Agricultural Sciences, UWA. He has developed and commercially released several grain legume varieties that have superior yield, quality and disease resistance. Professor Siddique is recognised for his contribution to Australian and international agriculture, particularly innovative research and leadership in production agronomy, farming systems, crop physiology, germplasm development and breeding of grain legumes and cereal crops of benefit to the grains industry in Australia and overseas.**

# Sustainable Food Systems – toward food for all

## CAETS Symposium Statement

A symposium in conjunction with the June 2010 Annual Meeting of the International Council of Academies of Engineering and Technological Sciences (CAETS) in Copenhagen focused on how to achieve a sustainable global food system, which allows increased food production while reducing poverty and hunger and over-exploitation of natural resources. It was noted that past advances in food production, obtained in part by over-exploitation of natural resources, as more land was brought into agriculture and new fish stocks were exploited, must be avoided. Achieving sustainable management of natural resources while meeting increasing future food demands was recognised as the key to success.

The conference rejected the notion that efforts to assure food security for all must necessarily be at the expense of the environment. It noted that – while the continuing need to develop new technologies, particularly in recognition of the vulnerability of food security to global climate change, should not be underestimated – some of the solutions to achieve a sustainable food system were available through regional adaptation and utilisation of technologies already developed. Progress toward food security could be facilitated today by adoption of economically and politically feasible government interventions, for example, to provide access to available technologies to indigent farmers.

**A**chieving a sustainable world food system will require reform of the food production system, modernising the food processing chain, and implementation of policy and market reforms and appropriate economic incentives, according to a CAETS statement on Sustainable Food Systems.

The CAETS meeting agreed the world could produce more food and ensure it was used more efficiently and equitably. But this would require food system stakeholders to focus on solving the central problems associated with securing a sustainable food system – to secure access to plentiful energy at an economical cost through improvements in energy efficiency and use of modern technologies throughout the whole value chain from farm to fork.

It suggested that the scaling up and further advancement of innovative approaches already under development would contribute greatly to achieving a sustainable food system and success would be facilitated if society, industry, public organisations and politicians cooperated to reform and rethink the food system. On one hand, the scientific and engineering challenges associated with securing a sustainable food system were immense, but the opportunities to succeed and meet the challenge were also great.

The CAETS academies committed themselves to help meet the challenge of securing a sustainable food system for the benefit of the world's population. To achieve these goals, the CAETS Council recommended seven actions.

## 1 Use available technologies

CAETS noted that conventional farming was becoming significantly more sustainable. Modern genetic techniques and better understanding of crop physiology allowed for a more directed approach to selection across multiple traits. The speed and costs at which genomes could now be sequenced or re-sequenced meant these techniques could be more easily applied, in combination with more traditional plant breeding technologies, to develop varieties of crop species that would yield well in challenging environments. A continuous and vigorous science-based search to increase productivity, especially focused on the needs of small farms in the developing world, was necessary to secure food for all. Genetic modification should be pursued according to international protocols and the outcomes should neither be available to only the privileged nor automatically dismissed as unsafe. Both public and private investment in research should be expanded to assure productivity increases that are compatible with sustainable management of natural resources and reduced release of green house gases. New alliances must be forged between businesses, society, organisations and government.

CAETS recommends expanded public and private investments in agricultural research and technology transfer to enhance productivity, assure sustainable management of natural resources, and prepare for climate change on small farms in developing countries; that full advantage should be taken of

## Letters to the Editor

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emerging technologies to develop new crop varieties with full respect for biodiversity, the environment, and health; that these technologies should be made available to the small farmers who need them at prices which allow for a free choice among different options; and that essential weather, climate and other environmental information be more widely available to the farming community.

## 2 Save energy

The meeting saw the food industry was highly dependent on energy for food preservation, safe and convenient packaging, storage and distribution, with half of all energy end-use consumption being used to change raw materials into products (process use) through heating, dehydration, refrigeration, machine drives and electro-chemical processes, among others. There were numerous opportunities for food engineers and agricultural scientists to contribute to energy efficiency throughout the food chain.

**CAETS recommends** efforts to enhance energy efficiency in the food industry through voluntary process analysis and improvement and adoption of effective governmental energy policies; that future energy efficiency studies should focus on improving existing plants and developing more energy-efficient food processing and post-harvest storage and distribution technologies; and improved education of consumers in handling and preserving food to minimise food spoilage and waste.

## 3 Expand aquaculture

The global catch of wild fish had been at about the same level for the past two decades, the symposium agreed. Half the fish stocks were fully exploited and more than one third was overexploited. The production of fish by aquaculture needed to double during the next 30 years to compensate for a growing population. Negative environmental impacts from overfishing and use of damaging fishing techniques in marine areas and coral reefs must be discontinued.

# PEAK PHOSPHORUS THREATENS AUSTRALIAN AGRICULTURE

The diminishing world reserves of phosphate rock – a non-renewable mined resource used for manufacturing phosphorus fertiliser – could threaten the long-term future of Australian agriculture.

Dr Eric Craswell, from the Fenner School on Environment and Society, Australian National University, told the recent 19th World Congress of Soil Science in Brisbane that the reason mined phosphate rocks were so critical to food production is that there was no substitute for phosphorus.

Australia, with its phosphorus-deficient soils, was more vulnerable than many other countries to the world supply of mined phosphorus running out.

“Phosphorus cannot be synthesised or manufactured in a laboratory and without sufficient phosphorus we cannot grow crops,” Dr Craswell said. “A recent estimate suggests that global production of phosphorus fertilisers will peak in 2033 and will be one third of that peak level by the end of the 21st century. Irrespective of when the peak occurs, exploitation of a non-renewable resource such as phosphate rock will peak and prices will

increase as it becomes scarcer.”

Dr Craswell said further research was needed to improve the efficiency of phosphorus fertiliser manufacture and application, improve phosphorus recycling, and boost the efficiency with which crops utilise phosphorus from the soil.

## UTS research

Recent work by University of Technology Sydney researchers shows that future scarcity of phosphorus will be a major threat to food security and a potential source of conflict.

Presenting this research at the Australian Fertiliser Industry Conference 2010. Professor Stuart White, Director of the Institute for Sustainable futures at UTS, said that unless further attention was paid to the issue, the world risks a global ‘hard landing’ as demand outstrips production in less than 25 years.

The research was conducted as part of a CSIRO-university collaboration and concludes that the world resources of phosphate rock, concentrated in Western Sahara and in China, will not be sufficient to keep up with growing demand as a result of changing diets, increasing population and increasing biofuels production.

“We will need to dramatically improve the efficiency of use of phosphorous if we are to have a ‘soft landing’ to avoid significant fertiliser and food price volatility,” Professor White said.

“This means many things: eating smarter, fertilising smarter, growing crops smarter, recycling nutrients and reducing waste at every point in the cycle of fertiliser use.

“Globally, changing diets is one of the biggest issues. The planet can’t afford us all to eat like Australians and Americans, with high consumption of animal products which use more than two and half times more phosphorous for the same output as plant-based products.

“In Australia, where the majority of food is exported, the answer lies in improving the efficiency of the use of phosphorous in agriculture, getting greater yield from stored phosphorous in soils and reducing application. This is the focus of much of the current research, and while there are promising signs, there is a long way to go.

“In cities, capturing and reusing human waste, especially urine, can help in completing the nutrient cycle.”

CAETS recommends that marine aquaculture should be improved and expanded, taking into account the use of responsible farming; that fish caught at sea must be human food; and that stock selection be improved, large scale production technologies be adopted and aquaculture in open seas and larger inland bodies be developed.

#### 4 Improve packaging and distribution

Packaging's key was to protect a product throughout a chain of logistics, so that it reached the consumer in a good state, the meeting said. Regardless of material, packaging contributed to sustainability in terms of minimising food waste, but different sustainability aspects must be considered. In developing countries inadequate packaging and distribution resulted in a very high percentage of all food produced never reaching the final consumer, compared with very low losses in developed countries. Investment in infrastructure to facilitate effective and efficient domestic food markets, transportation and access to farm inputs, especially in the developing world, should be expanded.

CAETS recommends development of better packaging from renewable and sustainable sources worldwide to reduce dependency on fossil resources and reduce food waste and, thus, to reduce environmental impacts associated with food production and distribution.

#### 5 Focus on agro-ecological methods

Agriculture could be intensified through agro-ecological methods using biological and technical knowledge in order to make more effective use of locally available resources and processes. This included the management of soil fertility, water use and innovative methods for recycling of organic matter and nutrients from farms, food processors and from society. Contributions from engineers were needed to develop automation and robotic technologies for improved observation and management of crop and livestock health, for control of weeds, reduction of soil compaction and harvest and post-harvest technologies for mixed cropping systems.

CAETS recommends use of agro-ecological methods as elements in an overall strategy for intensification of food systems based on increased input of biological knowledge and innovative technologies which can improve building of soil fertility, nutrient recycling, water utilisation and pest management in synergy with maintenance of biodiversity and ecosystem services; and that knowledge intensive, eco-functional intensification practices should be adapted to local conditions and local farmers' skills.

#### 6 Take political action

Inadequate policies, institutions, and rural infrastructure led to food systems that did not function efficiently,

CAETS said. The prospects for assuring food for all depended, in part, on how governments managed this challenge. Governments should give high priority to rural and agricultural development, infrastructure improvements and enhanced education to advance their level of food self-sufficiency, while preserving their own food culture. Long term growth required increases in productivity, which involved not only sound markets and property rights regimes, effective and constructive regulation, and appropriately skilled human resources, but also addressed market and information failures, provided public goods, and improved coordination and the diffusion of knowledge and best practices. Competition for land use between food production and biomass for energy use must be avoided.

CAETS recommends that developed and developing countries, international organisations and associations and political unions adopt policy reforms needed to support technical research and financial efforts to secure food for all; and that enlightened governance structures and policies, both locally and globally, are necessary for a more efficient and effective global food system.

#### 7 Establish values on ecosystem services

The symposium noted food production had important negative externalities, namely effects on the environment or economy that were not reflected in the cost of food. These included the release of greenhouse gases and losses of ecosystem services, which had direct economic repercussions that were systematically underestimated. Future food demands could be met at reasonable prices if environmental externalities were internalised in decisions related to the food system. Many threats to biodiversity and ecosystem services could be addressed through robust regulatory frameworks that established environmental standards and liability regimes.

In order to secure the future sustainability of the food system,

CAETS recommends political action and government incentives to capture the cost of environmental impacts in the cost of food; and that the resulting revenues should be captured by government and invested to repair damage to natural resources, moving the food system closer to sustainability. ◀



Grass roots  
agriculture  
– a Lao  
vegetable  
market.

# Food security – the science communication conundrum

GM crops are certainly not a golden bullet – but they are a valuable tool which will assist in sustainably increasing food production – and this is supported by good science

An Australian GM canola crop.



By Paula Fitzgerald

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**N**umerous science-based agencies have declared that more food will need to be produced on less land to support a growing population. Food security appears to be the next catchphrase chasing the fame of ‘clean and green’ and ‘climate change’, yet the ongoing challenge for the scientific community is to define such terms and convey their meaning, prior to the words being swept up in the public arena and carried away.

The ongoing debate about genetically modified (GM) crops provides a good example of this situation. Despite these crops being grown, traded and consumed around the world for 14 years, some states of Australia continue to ban their commercial production, denying farmers the opportunity to access new plant varieties.

In March, during a Western Australian Parliamentary debate about GM canola the topics of cane toads, our ‘clean green image’, consumer opinion, agricultural exports, choice, weeds, agronomics, corporate agriculture, grain handling and logistics, drought, and safety were all raised. None of these is unique to GM crops yet they were portrayed as being exclusively linked.

One could argue that this would not have occurred if deci-

sion makers and their constituents were aware that agricultural science underpins our existence with the production of safe, affordable food via R&D investment, use of new technology, supply chain management, stewardship – and that Australian farmers make business decisions which are economically and environmentally sustainable – and the list goes on.

In contrast to this reality, a number of decision makers – and some in the media over the past 18 months – have suggested that farmers are blindly being wooed by technology and are engaging in risky business and dangerous food production that will cause havoc. Not to mention the ‘gushing’ romance with organic farming.

Recently, the Permaculture Research Institute of Australia, in an article entitled “Ten reasons to go organic ... beyond being trendy”, noted that “If you eat meat or dairy products, going organic has never been more essential to safeguard you and your families’ health. Intensively farmed dairy cows and farm animals are fed a dangerous cocktail of antibiotics, growth promoting drugs, anti-parasite drugs and many other medicines on a daily basis. These drugs are passed on directly to the consumers of their meat and dairy produce which must be a contributing factor to meat-relat-

ed diseases like coronaries and high blood pressure”.

The article made no reference to science, data or evidence but the author happily inferred that all non-organic food produced by agriculture and consumed for decades is unsafe.

In October 2009, Standards Australia created a new industry standard for the organic sector – Standard AS 6000-2009. According to the *Law Society Journal*, the Standard defines organic as, “The application of agricultural and processing practices that emphasise:

- the use of renewable resources;
- conservation of energy, soil and water;
- recognition of livestock welfare needs; and
- environmental maintenance and enhancement”.

One cannot help but think that this list matches the underlying aims of all agricultural production in Australia, including organic. But those in the organic sector continue to reject GM crops.

Three university-based studies examined the potential of GM herbicide tolerant canola in Australian farming systems, prior to its commercialisation, with conclusions as follows:

- Charles Sturt University – “GM canola delivered superior weed control, higher yields and oil quality and better profits when compared to current common canola varieties grown under conventional weed management systems” (A five-year study completed in 2007);
- Melbourne University – “An extra 225,000 hectares of canola could be grown using conservation farming practices; 640 tonnes less triazine herbicide would be used pa; average canola yields would increase from 1.17t/ha to 1.28t/ha – with an increase in production of 295,000 tonnes pa; wheat production would increase by 64,000 tonnes on the additional canola area” (2007); and
- Curtin University – “Our analysis found that the profitability of GM canola was equal or superior to other systems of canola. We also found that the estimated environmental impact of GM canola was less than half of that of triazine tolerant canola – currently the most widely used system in WA” (2010).

The uptake of GM canola in Australia this year by farmers has been strong. It was anticipated that around 30,000 hectares would be planted in Western Australia yet almost 73,000 hectares went in the ground. In Victoria, GM canola plantings account for 14 per cent of the entire State’s canola crop (Table 1).

Farmers are voting with their feet. They want better weed control. They want access to the latest plant varieties. They want to utilise the most environmentally friendly inputs and systems. They want to trial new plant science in their own farming systems.

In 2009, 134 million hectares of GM crops were grown

around the world by 14 million farmers in 25 countries, representing an 80-fold increase since GM crops were first commercialised in 1996. Of the four top GM crops:

- more than 75 per cent of the 90 million hectares of soy grown was GM;
- GM cotton accounted for almost half of the 33 million hectares of cotton grown in the world;
- GM corn accounted for 25 per cent of the 158 million hectares of global corn; and
- GM canola accounted for more than 20 per cent of the 31 million hectares of canola.

GM crops are certainly not a golden bullet – but they are a valuable tool which will assist in sustainably increasing food production – and this is supported by good science.

As we strive to deliver more sustainable production and food security, the bigger, broader challenge is convincing consumers and decision makers about the legitimacy and veracity of what our science delivers. All our good work can be unravelled by scepticism, ideology and commercial interest. ◀

**MS PAULA FITZGERALD is the Executive Director of Agrifood Awareness Australia (AFAA) a position she has held for a decade. AFAA’s role has grown considerably from a gene technology communication/education/information knowledge hub, to now working across agriculture supply chains to coordinate gene technology communication, issues and media management and position statements. Paula has published numerous articles on biotechnology, engaged in media debates and been and invited speaker at more than 300 science, industry and public conferences and events both nationally and internationally. Most recently, she was the Australian coordinator for a GM Wheat Trilateral statement between Australia, Canada and the USA.**

**Table 1 GM canola adoption in Australia**

Year	State	Canola area	GM canola	% GM
2008	NSW	195,000	4,700	2.4
	Victoria	185,000	4,900	2.7
	<b>Subtotal</b>	<b>380,000</b>	<b>9,600</b>	<b>2.5</b>
2009	NSW	234,000	13,600	5.8
	Victoria	227,000	27,600	12.2
	<b>Subtotal</b>	<b>461,000</b>	<b>41,200</b>	<b>8.9</b>
2010	NSW	315,000*	24,000**	7.6
	Victoria	260,000*	36,500**	14
	WA	875,000*	72,800**	8.3
	<b>Subtotal</b>	<b>1,450,000</b>	<b>133,300</b>	<b>9</b>
<b>TOTAL</b>		<b>2,291,000</b>	<b>184,100</b>	<b>8</b>

\* Australian Oilseed Federation industry estimates at 10/09/10

\*\* Monsanto GM canola planting figures at 22/06/10

# FARM LABOUR SHORTAGES SET TO WORSEN



**Grape harvesting, where people are the key.**

Australian agriculture faces a current labour shortage of at least 96,000 full-time workers and 10,000 part-time workers, and future projections of labour supply and demand for the sector show no signs of this shortage being reduced over the next decade unless action is taken on a number of fronts.

This is the key finding arising from a new Research Report 'Towards a Better Understanding of Current and Future Human Resource Needs of Australian Agriculture',

released by the Australian Farm Institute.

The research concluded that if the sector continues on a business-as-usual course over the next decade, the current shortage of available labour will continue to worsen, driving up labour costs and limiting future growth in the sector.

Competing demand for regional labour supplies from the mining sector, and the generally poor perceptions of careers in agriculture are major negative factors which reduce the number of new entrants seeking careers in the sector.

A further factor which discouraged new entrants from entering the sector was the lack of defined career paths, and the indifferent attitude employers in the sector towards helping employees undertake additional education or training.

Executive Director of the Institute, Mick Keogh, explained that the research, jointly funded by Horticulture Australia, Agrifood Skills Australia and the Institute, involved a detailed examination of labour demand and supply statistics for the agriculture sector, an industry survey, and the development of future labour and demand supply scenarios over the next decade.

"Given the reliance that many agricultural businesses now have on technology and complex management systems, there is an obvious need for a better educated and trained workforce, which will also help the sector to maintain productivity growth in the future," Mr. Keogh said.

"A key issue that emerged from the research was the poor quality of statistics that are available to the industry which would help in future workforce planning.

"It is very difficult for the sector to develop comprehensive programs to improve labour supply, when the available employment and training data is so poor," Mr. Keogh said.

## Farmers' property rights "under siege"

Amid converging government, environmental and mining encroachment on their ability to farm, Australia's farmers feel frustrated and disempowered – and are demanding answers.

"Australia's farmers have had a gut-full," said National Farmers' Federation (NFF) President David Crombie – "be it Federal and State governments conspiring to do farmers out of legitimate land use without proper compensation, miners usurping land and water rights at will or environmentalists telling us what we can and can't do on our land.

"What we want is certainty over future land use and compensation for travesties committed in the past. Full and adequate

compensation must be provided where property rights are compulsorily acquired by governments or where farmers are required to undertake management practices above and beyond their normal duty of care.

"Australian farmers are justifiably proud of their sound environmental management. In fact, 94 per cent of farmers practice natural resource management as a matter-of-course, recognising that the preservation of their natural resources is vital for their future livelihoods.

"At a time when food and fibre production is more important than ever, farmers are increasingly uncertain about our future and our rights as landholders. The property rights

of farmers must be respected in relation to government decisions affecting land and water entitlements to give us confidence to invest in and run farm businesses.

"The desire for governments to regulate environmental outcomes must be viewed in this context. Too often we are seeing the emergence of governments assuming a property right, while leaving the title with the owner.

"Enough is enough," he said. "Whether it is in relation to rights surrounding carbon credits, water, natural resource management or mining's interaction with farming resources, this imbalance must be urgently corrected."

# ELECTRON BEAM FOOD DECONTAMINATION

A collaborative agreement between CSIRO and two German organisations is providing Australian food companies with access to a new processing technology that uses low-energy electron beams rather than heat or chemicals to decontaminate food.

The agreement – with the Fraunhofer Institute for Electron Beam and Plasma Technology and a service company, EVONTA-Service GmbH – aims to further scientific research into ‘low-energy electron beam processing’.

The first food producer to have benefitted from the collaboration is Stahmann Farms,

Australia’s largest grower, processor and exporter of pecan nuts and a major processor of macadamias. Product manager Paul Deeth said Stahmann Farms approached CSIRO for help to meet strict new overseas food safety guidelines.

“This is an emerging technology that uses electrons to decontaminate the surfaces of foods like powders and fresh produce,” says CSIRO scientist, Dr Kai Knoerzer. “It helps retain foods’ fresh flavour, odour and nutrients, which can be damaged by traditional heat treatment or by applying chemicals.”



IMAGE: CSIRO

**Electron beam technology uses electrons rather than heat or chemicals to decontaminate food surfaces, such as pecan nuts.**

## Fertilisers keep half the world alive

Almost 50 per cent of the world’s population would not be alive today were it not for an invention to capture atmospheric nitrogen and turn it into synthetic nitrogen fertilisers, an international fertiliser expert told the recent 19th World Congress of Soil Science in Brisbane. Dr Luc Maene, Director General of the International Fertilizer Industry Association, said that without the invention of synthetic nitrogen fertilisers, today’s world population would be much lower, as crops would be far less productive.

Dr Maene said further population growth would also be reliant on increasing crop productivity through increased fertiliser use, especially in Africa where crop productivity was low and the population was increasing.

“We are monitoring trends in fertiliser consumption around the world and providing that information to our members so that we can balance fertiliser supply and demand,” he said.

“We need to increase the use of fertilisers in some developing countries so that they can increase food production. And we also need to increase fertiliser efficiencies for sustainable production and to reduce environmental impacts.”

Dr Maene said food nutrition was also vital and he predicted the addition of micro-nutrients to fertilisers would be an effective way to prevent human health problems associated with nutrient deficiencies.

## Too much focus on the environment?

Is it time irrigators got as much say as the environment when it comes to regulation of our waterways? This will be one of the key questions debated by academics and irrigators at the Australian Farm Institute’s Agriculture Roundtable Conference in Sydney on 10 and 11 November.

Participants will include:

■ Danny O’Brien – CEO of the National Irrigators’ Council;

■ Professor Richard Kingsford – Director, Australian Wetlands and Rivers Centre, School of Biological, Earth and Environmental Sciences of the University of NSW;

■ David Anthony – Managing Director and CEO, Auscott Ltd; and

■ Dr Arlene Harriss-Buchan – Healthy Rivers Campaign Coordinator, Australian Conservation Foundation.

## Water quality sensor wins ICT Award

A smart sensor network that is monitoring the quality of drinking water in south-east Queensland has earned CSIRO one of the Australian ICT industry’s highest accolades – the Australian Information Industry Association’s 2010 iAward for research and development.

CSIRO and Seqwater have developed Australia’s largest integrated intelligent wireless sensor network, which is monitoring Lake Wivenhoe and its catchment, which supplies the majority of the region’s drinking water as part of the SEQ Water Grid.

The network consists of 120 nodes, 45 of them floating, and measures water temperature through the water column. Another 70 are land-based and collect stock movement and weather data, spread across the catchment. An autonomous solar-powered catamaran, also developed by CSIRO,



PHOTO: CSIRO

**CSIRO’s autonomous catamaran and one of the floating nodes monitoring environmental conditions on Lake Wivenhoe.**

travels between the floating nodes gathering data and performing maintenance.

CSIRO Senior Research Scientist, Dr Matthew Dunbabin said the successful deployment and operation of this proof of concept network boded well for this platform technology, dubbed iSnet for integrated sensor network, to underpin the next generation of water quality monitoring systems.

# SHANGHAI EXPO A REAL SHOWCASE FOR ATSE

Australia-China Science and Technology Week in August, as part of the 2010 Shanghai World Expo, was extremely productive, with ATSE playing a strong role in an event which provided a focus to review cooperative arrangements and the key elements of vital international collaboration and science and technology linkage programs between China and Australia.

The principal events included:

- the celebration of 30 Years of Science and Technology Partnership between China and Australia;
- the launch of a major report of considerable bi-lateral interest;
- the conduct of three major International Workshops; and
- the signing of four bilateral MoUs.

China and Australia have enjoyed several decades of cooperation and research collaboration in the science and technology arena, underpinned by continuing exchanges of research and applications leaders, early and mid-career scientists and students. Australia's research community and Learned Academies have been at the forefront of this collaborative evolution, with substantial



Professor Robin Batterham at the podium in Shanghai.

support for the Australian Government.

The attendance at the Australia-China Science and Technology Week reflected the importance of the event – Chief Scientist for Australia Professor Penny Sackett, the Deputy Secretary of the Department of Innovation, Industry, Science and Research Ms Patricia Kelly, the ATSE President Robin Batterham and

a large number of Fellows of the two Learned Academies, and numerous senior business executives, research community leaders and bureaucrats from both countries. The three major International Workshops conducted generated considerable interest and new understanding of the issues and opportunities by participants from both countries.

## NEW RESEARCH SHIP WAS KEY TO AUSTRALIA'S ANTARCTIC RESEARCH

Australia is widely recognised as an international leader in Southern Ocean science – and much of it rests on the introduction of the research vessel Aurora Australis in 1989, according to CSIRO Southern Ocean expert Dr Steve Rintoul.

Two decades ago, Australia had achieved little in Southern Ocean science, at least in terms of physics and biogeochemistry, but the arrival of the Aurora Australis marked the beginning of a new era in Australian Southern Ocean research, he told an Academy Symposium in Melbourne in September.

Dr Rintoul was one of the

speakers at 'Going South', ATSE's Phillip Law Commemorative Antarctic Science Symposium, which commemorated the career and contribution of the late Dr Phillip Law AC CBE FAA FTSE, a Foundation Fellow of the Academy, Director of the Australian Antarctic Division from 1949 to 1966, and a giant of Australian Antarctic exploration and science.

Australian scientists had contributed to a much deeper understanding of the fundamental role of the Southern Ocean in the planet's climate and biogeochemical cycles, Dr Rintoul said.

"While substantial progress has been made in recent years, significant gaps remain

in our understanding of the link between Southern Ocean processes and global climate, biogeochemical cycles and marine ecosystems."

The capacity of the oceans to moderate the pace of climate change was controlled strongly by the circulation of the Southern Ocean and, given the significance of the Southern Ocean to the Earth system, any change in the region would have impacts extending well beyond the high southern latitudes.

"To make further progress, and in particular to determine the nature, causes and consequences of Southern Ocean change,

## Impacts of Climate Change on Future Urban Societies

This two-day workshop, convened by Professor Michael Manton FTSE and Professor Yang Xin, sponsored by DIISR and the Shanghai Association for Science and Technology, linked more than 20 leading Chinese and Australian experts in architecture, town planning, water management, human health and climate science to explore the issues and impacts of climate change on urban environments.

## Nanotechnology Benefiting Society

This two-day workshop, convened by Professor Max Lu FTSE and Dr Calum Drummond FTSE, the Science and Technology Commission of Shanghai Municipality and the Shanghai Nanopromotion Centre, linked 14 top scientists from both countries to discuss nanomedicine, nanomaterials for clean energy, nanotechnology for quantum computers and computational molecular tools in a stimulating and meaningful atmosphere. Participants from both sides noted the quality of the presentations and the calibre of the speakers.

## Biotechnology Improving Food Production, Food Quality and Human Health

The third two-day workshop, convened by Dr

Jim Peacock AC FRS FAA FTSE and Professor John Shine AO FAA and the Chinese Academy of Sciences, featured high-quality presentations from nine Chinese and Australian speakers covering biotechnology in food production and nutrition and also in medical science, particularly in the area of no-infectious disease. The workshop demonstrated that the time was ripe for a synergistic bilateral relationship in biotechnology – targeting improved food quality which, in turn, could make a major contribution to public health problems in both developing and developed regions of the world.

## Other highlights

### 30 Years of Science and Technology Partnership celebrated

The Australian Government and the Chinese Ministry of Science and Technology (MOST) hosted a successful high-level reception at the Australian Pavilion to mark 30 years of bi-lateral partnership in Science and Technology between China and Australia.

### Major Report launched

Chief Scientist for Australia Professor Penny Sackett launched the ATSE Report Climate Change and the Urban Environment,

which enjoyed good news media pick-up in Australia

### Four MoUs signed

- China-Australia Automotive Research Alliance (Participants – CSIRO, China Automotive Engineering Research Institute, Tongji University Shanghai and the CRC for Advanced Automotive Technology)
- CSIRO MoU with Eastern China University of Science and Technology
- Australian National Measurement Institute and Chinese National Institute of Metrology
- Australia-China Joint Venture on Nanoscience and Nanotechnology (participants – CSIRO, University of Queensland, Shanghai Municipal Government's Science and Technology Commission)

The Australian and Chinese participants agreed that the events, interactions and outcomes of the Australia-China Science and Technology Week were outstanding. The personal interface and understanding developed between high-level delegates from both sides illustrated the value of international collaboration and science and technology linkage programs.

sustained observations are essential."

Dr Rintoul said Australia was playing a leading role in the development of international plans for a sustained Southern Ocean Observing System.

Going South presenters included key Australian figures in Antarctic research and science, including:

- Professor Ian Simmonds, Professor of Atmospheric and Oceanic Sciences in the School of Earth Sciences, University of Melbourne;
- Dr Tas van Ommen, Principal Research Scientist with the Australian Antarctic Division in the field of glaciology;
- Dr Donna Roberts, a postdoctoral fellow with the ocean acidification team at the Antarctic Climate & Ecosystems Cooperative Research Centre (ACE CRC);



**Dr John Gunn, Chief Scientist, Australian Antarctic Division, addresses the Going South audience.**

- Professor Mark Hindell, head of the Marine Predator Unit of the Institute of Marine and Antarctic, University of Tasmania;
- Professor Marilyn Ball, Australian National University, an eco-physiologist who has studied the vulnerability of Antarctic mosses to freezing injury with climate warming;
- Dr Tony Worby, Acting Program Leader of

the Ice, Oceans, Atmosphere and Climate program, Australian Antarctic Division;

- Dr John Gunn, Chief Scientist, Australian Antarctic Division; and
- Professor Patrick Quilty, former Chief Scientist with the Australian Antarctic Division and now Honorary Research Professor at the University of Tasmania.

# MORE FRESH SCIENTISTS

Tasty weeds, bright black holes, Antarctic ice and reversing shoulder joints – these are among the research interests of 16 of Australia's top young scientists who were recently named as Australia's Fresh Scientists for 2010.

Their research was presented for the first time in public through Fresh Science, a national program sponsored by the

Australian Government that identifies and publicises new and interesting research being done by early-career scientists around the country.

Now in its 13th year, Fresh Science is designed to:

- enhance reporting of Australian science;
- highlight and encourage debate on the

role of science in Australian society; and  
■ provide role models for the next generation of Australian scientists.

*Focus 163* showcased the work of five of the 2010 Awardees. This edition takes a look at the work of a further six of the 2010 Fresh Scientists.

Details of all winners at [freshscience.org.au](http://freshscience.org.au).

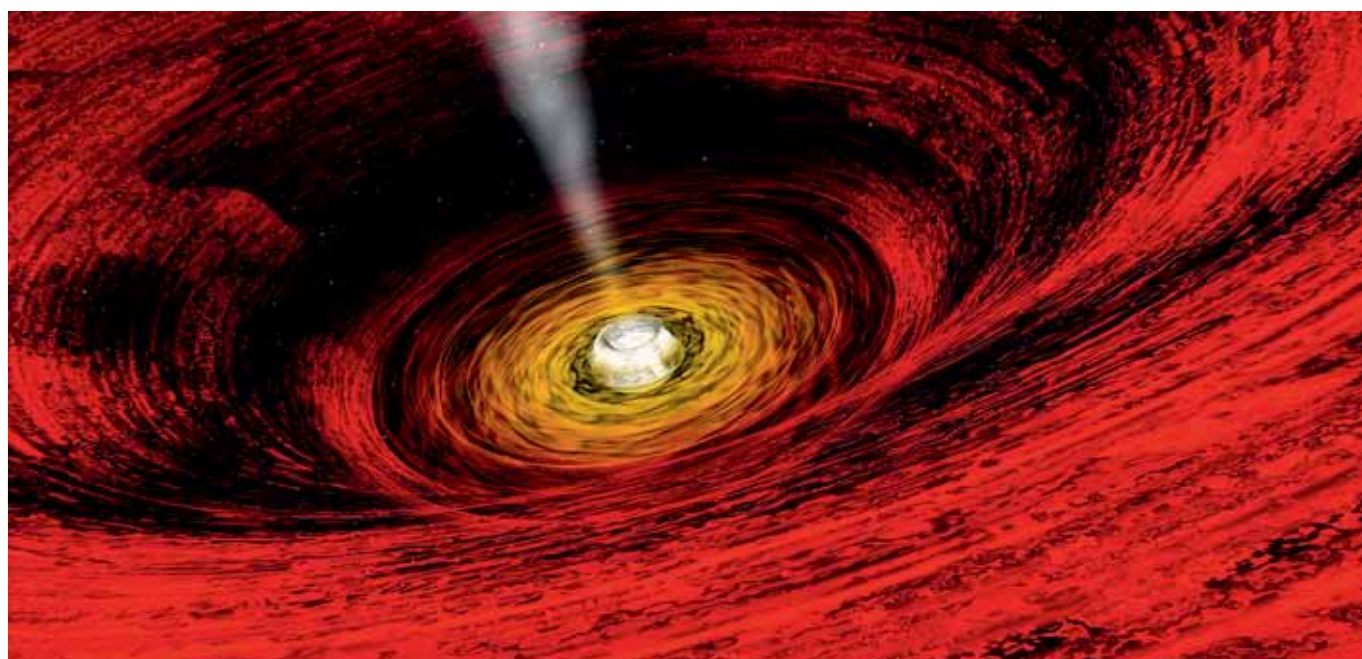


IMAGE: APRIL HOPART, NASA/CXC

## How do black holes eat?

Using galaxies as cosmic telescopes has helped reveal the diets of the black holes at the heart of every galaxy.

Anglo-Australian Observatory Astronomer David Floyd has been able to observe matter falling into a super-massive black hole – one of the Universe's brightest objects.

It's the first time scientists have been able to probe so close to a supermassive black hole, a region inaccessible to telescopes until now.

Material in the immediate vicinity of a black hole undergoes extreme compression and superheating. The result is a quasar, which emits so much energy as visible light that it can outshine the galaxy in which it is located by many thousands of times.

"The problem is that the regions emitting these huge amounts of light are so small and their distance from Earth so mind-bogglingly far, that it has been impossible to observe

them directly, and therefore to understand the part they play in the evolution of the Universe," David says.

"Conditions in a quasar are so extreme that they push the laws of physics to breaking point and beyond. They are the particle accelerators of the Universe. They shape galaxies and drive the evolution of the Universe."

The research makes use of a technique known as gravitational microlensing, where the light from a quasar passes near or through another galaxy on its way to Earth. The intervening galaxy acts like a lens, enlarging and splitting the image of the quasar into several components, each of which can be analysed.

Using data from the 6.5-metre Magellan telescope in northern Chile and the NASA Hubble Space Telescope, David and his colleagues, Nick Bate and Rachel Webster,

**Artist's impression of material falling onto a black hole. The material is compressed, heating it and causing it to shine.**

have shown that about 99 per cent of the visible light in the quasar with which they have been working is produced in a region just a thousand times larger than the black hole itself.

This is so tiny in astronomical terms that it would take a telescope with a lens 100 kilometres across to observe directly, he says.

"It is exciting that we can study these extreme objects at all," David says. "This technique heralds a new era in exploring black holes. It can probe regions just a few times larger than the black hole at the centre of the quasar in a matter of minutes, rather than decades. And these early results are just a taste of what's to come."



PHOTO: JAN LIESER

**About to fly, East Antarctica, 2007.**

can be  $-50^{\circ}\text{C}$ , the sea water under the ice is at about  $-1.8^{\circ}\text{C}$  – and the ice acts as insulation preventing the sea water from losing heat. And the heat of that sea water ultimately drives global currents and climate systems.

There was strong evidence that there had been massive sea ice loss in the Arctic, Natalia said, but at present we lacked similar information about the Antarctic. In particular, the thickness and variability of Antarctic sea ice and snow cover were poorly understood.

Radar is a particularly good way of making the measurements as it not only penetrates snow and ice, but the reflected signal also provides information about internal structure. In the Arctic, satellite readings can be checked against those from submarines under the polar ice cap, but Antarctica is a neutral, weapon-free zone, meaning no submarine data.

In a collaboration with the University of Kansas, Natalia has taken radar designed there, and used by NASA in fixed-wing aircraft – and modified it for operation in helicopters. It has taken her two years to develop a system robust enough to function accurately in such an unstable environment.

## Testing Antarctic snow depth from a chopper

Young Tasmanian electrical engineer Natalia Galin has turned US technology into a robust helicopter-borne radar system that can accurately measure the thickness of snow on polar sea ice. Her work will improve NASA's satellite measurements of what's happening to the Antarctic sea ice, and will contribute to more accurate climate models.

When the world's climate scientists measure the thickness of snow on polar sea ice in future using satellite radar, the accuracy of their results is likely to depend on Natalia's work at the University of Tasmania's Institute for Marine and Antarctic Science, where she is now completing a PhD.

Natalia has been modifying, programming and operating specialised radar equipment in a helicopter off Antarctica to provide accurate readings of snow thickness which will be used to calibrate satellite remote sensing.

"Thickness estimates are considered the Holy Grail of the sea ice world. We can only measure directly how much of the ice is floating. And if we get that measurement wrong, we multiply the error of the estimating the thickness of what's below the water by eight to nine times," she said.

That's important because the polar regions play a key role in the Earth's climate system. In winter, when the air temperature

## Insulin that doesn't need a fridge or a needle?

A young Monash University chemist and her colleagues have successfully strengthened insulin's chemical structure without affecting its activity. Their new insulin won't require refrigeration.

They have just filed a series of patents with the support of their long-term commercial partner, Circadian Technologies, which is now negotiating with pharma companies to start the long process of getting the invention out of the laboratory and to people with diabetes.

At the same time they're using their new knowledge to develop a form of insulin that could be delivered by pill.

The poor stability of existing forms of insulin complicates the management of diabetes, a condition that affects 1.7 million Australians.

"Like milk, insulin formulations need to be kept cold," Bianca says. "At temperatures above  $4^{\circ}\text{C}$ , insulin starts to degrade and eventually

becomes inactive. So supplying insulin in areas where fridges are scarce or difficult to maintain presents a real challenge."

The instability of insulin is closely related to its chemical structure, Bianca says. "Insulin is constructed from two different protein chains which are joined together by unstable disulfide bonds. Using a series of chemical reactions, we have been able to replace the unstable bonds with stronger, carbon-based bridges.

This replacement does not change the natural activity of insulin, but it does appear to significantly enhance its stability."

These so-called 'dicarba insulins' are stable at room temperature. And, Bianca says, storage at higher temperatures

for several years has not resulted in degradation or loss of activity.

The new insulins may also provide much-needed insight into how the molecule works.

"Insulin acts like a key in a lock at its receptor," she says. "When insulin binds to the receptor the lock opens and allows sugar to be taken up into cells from the blood. But insulin is known to change shape inside the 'lock' (the receptor), and its final shape is currently unknown.

"If we had that information, we might be able to design smaller, less complex, non-protein mimics of insulin."

Such molecules could one day become the basis of treatments taken in pill form, eliminating the need for injections.



Bianca van Lierop



David Ackland with his arm-testing device.

function, for which there are very few effective treatments.

"These new implants increase the leverage of the muscles surrounding the shoulder, and thereby reduce the force required to move the arm. This lowers muscle stresses during everyday tasks such as lifting and pushing, and it also substantially increases the range of motion of the joint."

After designing and building his own shoulder-testing equipment, David worked with orthopaedic surgeons from Melbourne's Epworth Hospital who implanted eight of these artificial joints into the shoulders of donated human cadavers. During testing, the shoulders were manipulated to simulate common arm motions, while the properties of the muscles and joints were measured.

Data from this study is not only helping surgeons to understand the clinical and biomechanical benefits of the shoulder reconstruction, but also has suggested ways in which surgeons can minimise postoperative failure and specific strategies for rehabilitation.

David hopes that his research will lead to further improvements in the design of a range of joint replacements for the human body.

## Joint reversal eases arthritis

A shoulder-joint implant, with the ball and socket on the opposite bones from nature, can significantly improve the quality of life of patients with severe arthritis and tendon tears, says medical engineer David Ackland from the University of Melbourne.

In a search for a more effective replacement joint, David and his colleagues looked at the counterintuitive 'reverse' implant, which was designed and manufactured in the

US by Zimmer, Inc. Their tests on the Zimmer implant showed that it stabilised the joint and increased the range of movement of arthritic shoulders.

Arthritis and problems to do with muscles, joints and bones disable more people more severely than any other medical conditions, David says.

"Many arthritis sufferers have to cope with chronic and debilitating pain and loss of joint

## Cling wrap captures carbon dioxide

High tech cling wraps that 'sieve out' carbon dioxide from waste gases can help save the world, says Melbourne University chemical engineer Colin Scholes, who developed the technology.

The membranes can be fitted to existing chimneys where they capture CO<sub>2</sub> for removal and storage. They are already being tested on brown coal power stations in Victoria's La Trobe valley.

"The membrane material is specifically designed to separate CO<sub>2</sub> from other molecules," he says.

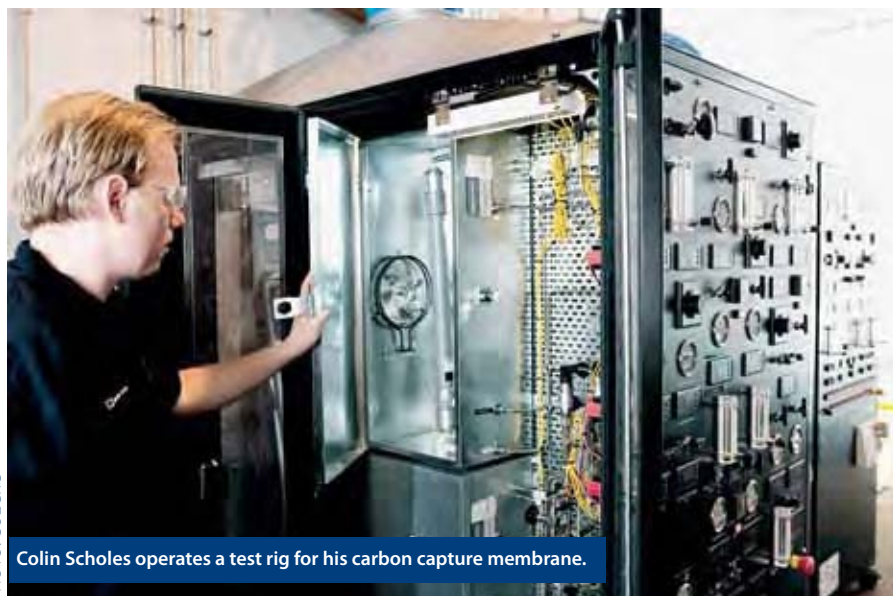
"It acts like a filter and is much more efficient than existing technology. We are hoping these membranes will become an important part of a carbon capture and storage strategy which will cut emissions from power stations by up to 90 per cent."

Not only are the new membranes efficient, they are also relatively cheap to produce.

"Carbon capture and storage is currently very expensive. Reducing the cost of trapping the CO<sub>2</sub> will make it much more affordable. And cheaper systems mean power generators

can put them in place much sooner."

Another crucial aspect of the membrane has been its toughness – a power station chimney is not a friendly environment.



Colin Scholes operates a test rig for his carbon capture membrane.

## Add fertiliser to fight weeds

Feeding weeds fertiliser sounds like exactly the wrong way to get rid of them, but Jennifer Firm of CSIRO Sustainable Ecosystems in Queensland has been doing just that – to control African lovegrass, an invasive species of rangelands in every Australian state. Her method works by making the weed tastier to grazing animals, which illustrates the need to be smarter in dealing with weeds, Jennifer says.

Australia spends about \$1.4 billion a year controlling weeds, yet most continue to spread. For decades, Jennifer says, the methods used against weeds have centred on killing the invaders with herbicides, slashing and bulldozers. "But these measures create harsh disturbances, the very conditions that favour invasive species," she says.

"Consequently, one weed may be removed from an area only to have the same or another one take its place. I found a better approach was to determine what environmental conditions were favourable to invasive species, and then change them to favour the growth of more desirable native species."

In her work on African lovegrass, Jennifer evaluated 24 different ways of controlling it in

a large field experiment. Then she monitored the abundance of lovegrass and native species over multiple growing seasons.

"I found a key reason why the lovegrass dominated was that it is unpalatable to grazing animals such as cattle and kangaroos.



Jennifer Firm took detailed measurements across 192 plots.

So the most effective control measure was to keep grazing but make lovegrass 'tastier' using a low application rate of fertiliser. This method decreased lovegrass abundance without using herbicides and labour-intensive slashing," Jennifer says.

In addition, the native grasses became more abundant because they were grazed less and had access to more nutrients in the soil. In turn, that meant the abundance of another weed, Mayne's pest, was kept at low levels because of increased competition from the natives.

"At first these findings appeared counterintuitive to me," Jennifer says, "because grazing and fertilisers generally don't favour Australian native plants. This strategy worked because lovegrass responded very quickly to the added nutrients but grazing pressure kept it from producing seed.

"The recommendation from this study is not to use fertiliser and grazing for all invasive species. Instead my findings point to a need for a broader approach where we understand how the invasives grow, what the natives need and then change the conditions to return our native species."

"Trials with real flue gas have been essential for the development of material robust enough to handle industrial conditions," Colin says.

"Fossil fuels currently supply 85 per cent of the world's energy," says Colin, one of the founders of the Australian chapter of Scientists without Borders.

"So despite the urgent need to reduce levels of carbon dioxide in the atmosphere, the International Energy Agency predicts fossil fuels will continue to be heavily used for many years to come.

"Carbon capture and storage will be an important part of the portfolio of solutions to address climate change including energy efficiency, less carbon-intensive fuels, natural carbon sinks and renewable energy."

Colin's work is supported by the Cooperative Research Centre for Greenhouse Gas Technologies where he is a research fellow.

## CARBON CAPTURE PROJECTS EXTENDED

Extra funding of \$855,000 in has been announced for two CO<sub>2</sub> capture projects developed by the Cooperative Research Centre for Greenhouse Gas Technologies (CO2CRC). The projects were two of five to receive funding from Brown Coal Innovation Australia (BCIA).

The CO2CRC/HRL Mulgrave Capture Project is researching pre-combustion carbon capture from a stream of syngas at HRL Developments Pty Ltd research gasifier.

The CO2CRC H3 Capture Project is investigating ways to improve post-combustion carbon capture from Hazelwood power station as part of the Latrobe Valley post-combustion capture (LVPCC) project.

The projects are trialling three technologies – solvents, membranes and adsorbents – to find the most effective and economic for application to Victorian brown coal.

CCS, developed to capture CO<sub>2</sub> from large industrial sources and store it safely and permanently deep underground, is one of the key technologies being developed globally to deal with growing greenhouse gas emissions.

The International Energy Agency believes CCS will be responsible for as much as 19 per cent of the CO<sub>2</sub> emission reductions required to tackle the challenge posed by climate change.

# EDUCATION EXPORTS THREATENED BY POLICY MOVES: ATN

Economic output associated with Australia's third-largest export industry will shrink by as much as \$600 million in 2011 and by \$1.2 billion to 2012,



Professor Ross Milbourne

unless urgent action is taken to address pressing policy concerns, according to a new study.

The forecast reduction in the international education industry, which last year generated \$18 billion in exports (50 per cent more than tourism), will also see the loss of up to 9,000 jobs in 2012 across Australia, rising to a total loss of 19,000 jobs by 2012, as related sectors such as retail and hospitality are hit by the downturn.

The Australian Technology Network of Universities (ATN) has

released the first report to concentrate such analysis on the nation's universities, which in 2009 attracted 203,324 international students.

The report, *The Economic Implications of Fewer International Higher Education Students in Australia*, commissioned by ATN from the John Curtin Institute of Public Policy (JCIPP) at Curtin University shows that:

- higher education is the most significant part of the sector – with 32 per cent of the international student market it generates 57 per cent of the export revenue;
- international onshore education is now a billion-dollar industry in NSW and Victoria, generating value-added of about \$3 billion in each state and an overall economic impact of \$1.4 billion in Queensland;
- on average, each international student in higher education generates \$50,874 for Australia – 36 per cent of this is spent on fees and the remainder mainly on accommodation, food, restaurants and retail;
- for every two international students enrolled in an Australian university one extra job is created; and
- value-add from international university students in 2009 created an additional 102,387 jobs, 83,050 of these outside the education sector.

ATN Chair and UTS Vice-Chancellor Professor Ross Milbourne said the most immediate issue for government to address was the impact on the sector of policy in regards to student visa conditions, permanent residency issues and regulation of quality issues in the sector.

"Government must reconsider its policy settings. As outlined in the report, Higher Education – the largest economic and employment generator in the sector, with the least problems in terms of quality – is already suffering reduced enrolments and lower visa grants in what appears to be a case of significant collateral damage arising from policy measures aimed mainly at other sectors in a challenging international

environment," Professor Milbourne said. "We accept there have been serious issues related to international students that needed to be dealt with, but those did not relate to universities. Yet, the Government has made no differentiation in its crackdown on student entry requirements.

"By refusing to deal with university students in a separate category, we are about to see a massive economic fallout which will reverberate across the nation in the form of job losses in tourism, retail trade and hospitality – one we simply cannot afford. ATN contends that the damage has to be stemmed and that international students must be made welcome in our universities in growing not reducing numbers."

ATN has called for a new visa category to address this issue and that of the looming skills shortage in researchers, many of whom must be attracted from overseas. Economic modelling by JCIPP that examined three possible scenarios shows a 'best case' decline in enrolments of 10 per cent, with a worst case decline of 35 per cent in 2011.

"A key issue that must be addressed as part of an urgent policy rethink is the current student visa restrictions and timing and financial complexities that are driving international students away from attending our universities to study in the US and the UK," Professor Milbourne said.

## EDUCATION NOT DELIVERING OUR FUTURE INNOVATORS

Australia's formal education system is not yet fully geared to deliver the innovators we need and our innovators and entrepreneurs often achieve success in spite of their education, rather than because of it, says Dr Ruth Bridgstock.

Dr Bridgstock, of the ARC Centre of Excellence for Creative Industries and Innovation (CCI) at Queensland University of Technology, is researching the capabilities Australia's future graduates will require to meet the needs of a 21st century innovation economy, based on detailed study of successful innovators.

"Worldwide, every advanced country is moving to an innovation economy and we need to ensure that Australia produces enough innovators to keep ahead. At the moment, in my view, we are not educating sufficiently with this end in mind."

Dr Bridgstock says her studies of successful Australian innovators have identified key qualities that need to be developed – and which are not sufficiently addressed by traditional university courses. "These include the ability to build strong and diverse social networks, the ability to cross disciplines with ease, be 'digitally savvy', have a strong enterprise orientation, and the skill to channel one's passion into what one does and use it to take advantage of whatever comes along."

Today's university courses still tend to have a strong discipline focus and adopt a reductionist approach, she says. "Our educational history is all about becoming credentialled and very knowledgeable in a particular area. We need that, but we also need courses that allow creativity and an innovative spirit to flourish. Innovation is about following and capturing new possibilities, not just obeying the rules."



## NICTA WINS e-LEARNING AWARD

An online programming course for high school students, developed by NICTA and the University of Sydney, has won the e-learning category of the Australian Information Industry Association (AIIA) iAwards.

"We developed the embedded programming course to encourage students to develop software that can make an impact in the real world," said Dr John Judge, NICTA Senior Research Engineer, accepting the award on behalf of NICTA and the University of Sydney's National Computer Science School. "It is a great way for them to learn important programming skills and have fun at the same time."

NICTA says by inspiring students to learn about ICT in an exciting way, the course is helping solve a difficult and important problem in ICT – the supply of skilled IT professionals for the digital economy. The five-week course is one of three programming streams offered in the annual National Computer Science School Challenge.

## PUBLIC SUPPORT FOR UNIVERSITIES

A survey commissioned by Universities Australia on the attitudes of Australian voters towards universities found overwhelming support from the public for the role of universities in the economy and society.

"The core finding is that the overwhelming majority of respondents believe universities make a very important or important contribution to the economy (81 per cent), the environment (73 per cent), social opportunity (82 per cent) and our links with other countries (66 per cent)," said Dr Glenn Withers, Chief Executive of Universities Australia.

The majority of those surveyed thought the core functions of universities in educating Australian undergraduate students (86 per cent), postgraduate students (82 per cent), conducting pure (72 per cent) and applied (84 per cent) research are very important or important. A majority (58 per cent) of respondents believed the share of government expenditure on universities should be 50 per cent or more. The current level is 44 per cent.

(From left) Award sponsor John Maddock, of Innovation and Business Skills Australia, John Judge from NICTA and James Curran from the University of Sydney.

## MORE RESEARCH GRADUATES NEEDED TO OPTIMISE INNOVATION

Australia needs more well-trained research graduates to achieve the Government's vision of innovation as a key driver of national success, but urgent action is needed. This is a key point made in a submission by the Academy in response to the Department of Innovation, Industry, Science and Resources consultation paper on Australia's Research Workforce Strategy.

ATSE says urgent action is needed to ensure that the Government's plan for greater innovation in Australian enterprise is strongly supported by appropriately trained research graduates and better use of public and private sector research facilities. But it says this will not occur unless the national consciousness is raised and universities and industry cooperate significantly more than in the past.

ATSE believes – while acknowledging the alternate models in the consultation paper – that the greatest research career paths benefits are in schemes that encourage researchers to move freely between universities, industry and government laboratories and do not disadvantage them in promotion opportunities. ATSE broadly supports the opportunities that have been identified by Government to better support researchers at different stages of their careers, but sees a much stronger role for professional societies and Learned Academies in fostering career opportunities and providing career monitoring.

ATSE supports the Government's focus on innovation as a key driver of national success and says using higher degree research education to firmly embed a culture of innovation in the nation should be regarded as a key challenge to be faced over the next decade.

The consultation paper talks of maintaining the steady growth in researcher employment, but ATSE suggests there will be significantly increased demand. "Meeting this will require a re-think of current research training with a much closer involvement of industry and public-sector research organisations in the process," it says.

"ATSE strongly cautions against a 'one-size-fits-all' approach and proposes that the engineering, technology and applied science disciplines be grouped and examined to see if a collaborative research experience with industry or public sector laboratories would be desirable."

ATSE notes some progress on priority areas for action but says Government should take a lead role by engaging with universities and peak industry bodies.

The ATSE submission is available at [www.atse.org.au/resource-centre/ATSE-Policy-Statements---Submissions/Industry---Innovation---Research/](http://www.atse.org.au/resource-centre/ATSE-Policy-Statements---Submissions/Industry---Innovation---Research/)

# SOLAR DIESEL POWER IN NATION'S HOTTEST TOWN

Marble Bar, Western Australia's east Pilbara town often rated the nation's hottest, has become home to a world-first power station that combines renewable and traditional sources of generation.

Horizon Power's Pippunyah Solar Diesel Power Station incorporates a single axis tracking solar farm with diesel technology and a fly-wheel energy storage system.

WA Mines and Petroleum Minister Norman Moore said the station was powered by the biggest tracking solar farm in Australia, with 1350 panels, in a technology combination that was the first of its kind in the world and ensured a very high level of solar energy penetration and a reliable supply of power to the town.

Horizon Power managing director Rod Hayes said the business would focus on delivering the most reliable, safe, affordable and secure power generation, to even the most remote locations in its 2.3 million square kilometre service area.

The same solar-diesel hybrid generation model has been used to develop a 900-panel power station at Nullagine, 88 kilometres south of Marble Bar, which is under construction and expected to start supplying the town in October.

The project is supported by the Australian Government, through the Renewable Remote Power Generation Program, and implemented by WA's Office of Energy.

## WIND FARM 'LARGEST IN SOUTHERN HEMISPHERE'

A 140-turbine wind farm in south-west Victoria will be the biggest of its kind in the southern hemisphere. The \$1 billion project will be built by AGL Energy and Meridian Energy at Macarthur, south of Hamilton.

The Victorian Government says the wind farm, due to start operating in 2013, will create 400 direct jobs during the construction phase. It is planned to generate 420 megawatts of electricity, which is enough to power 220,000 homes.

## FIRST YEAR FOR ASI

The Australian Solar Institute (ASI) has completed its first year in its mission to proactively foster and support excellent research and development (R&D) in Australia to accelerate commercial deployment of photovoltaic and concentrating solar thermal technologies.

ASI invests in solar thermal and solar photovoltaic R&D to foster greater collaboration and between solar researchers in universities,

research institutions and industry and to help forge strong links with peak overseas solar research organisations. ASI has created a \$144 million portfolio of projects that has attracted \$87 million in external funding from domestic and international industry, research institutions and state governments.

## THE PAPARAZZI OF GEOPHYSICS

Winthrop Professor David Lumley, the Woodside-Chevron Chair in Petroleum Geoscience and CO<sub>2</sub> Sequestration at the University of WA, and Research Fellow Dr Jeffrey Shragge take what they describe as 'snapshots' of the Earth that cost about \$10 million each.

Images taken a year or even five years apart below the surface of either the ocean floor or land rock layers show the movement of fluids over time, including oil and gas, making it a valuable tool for pinpointing drilling locations and locating resources that have been bypassed. The technology was expensive, Professor Lumley said, "but when you consider the value of the projects – billions of dollars – it's worth it to the energy companies."

The pictures are at the core of time-lapse imaging, a form of seismic monitoring that was pioneered at Stanford University in the 1990s, while Professor Lumley was doing his PhD there.

He said the ability to use the technology to identify the best places underground in which to store CO<sub>2</sub> was also valued by the developers of the new offshore giant gas projects, including Chevron Australia's Gorgon fields. "The geochemistry of these fields means that the methane gas that is brought up will be mixed with a lot of natural CO<sub>2</sub>, which needs to be removed before it can be liquefied to form LNG and shipped to market.

"The companies don't want to simply vent the CO<sub>2</sub> into the atmosphere, so they are keen to investigate carbon sequestration, or injecting and storing it in deep rock formations where it originated."

"Carbon sequestration is one of the best opportunities we have to reduce the amount of CO<sub>2</sub> emissions going into the atmosphere."

Australia is the first nation in the world where commercial companies are able to lease offshore blocks to explore for carbon storage. The best place for CO<sub>2</sub> sequestration is in deep porous permeable rock with a big containment capacity where, over thousands of years, the CO<sub>2</sub> dissolves into salty water and then converts to minerals. But it must be secure so the CO<sub>2</sub> does not leak out.

"Looking for areas like this is almost the opposite of exploring for resources," Professor Lumley said. "We want to find the right storage volume that has nothing valuable in it."

Offshore, boats tow long cables with thousands of sensors and source arrays that discharge acoustic energy. The scattered energy is recorded and focused by supercomputers, giving a picture of what fluids are moving underground. On land, trucks with large vibrating pads are used to vibrate the surface of the earth. These waves go down through the earth and reverberate back to the surface, carrying information that is captured by sensors.



PHOTO: CSIRO

## VICTORIAN DIRECT MANUFACTURING CENTRE PLANNED

The new Victorian Direct Manufacturing Centre is planned to help the state's manufacturing industries become more environmentally friendly, productive and globally competitive. Established with the support of the Victorian Government, the consortium includes 10 Victorian companies, Swinburne University, Deakin University and CSIRO as research providers – and CSIRO is the lead agency.

Two leading overseas technology providers, Linde Gas and CGT (Cold Gas Technology GmbH), will also participate indirectly in the consortium, linking the Centre with other global developments in direct manufacturing.

"Direct manufacturing is a revolutionary concept where components are manufactured directly from powder, ribbon or wire in a layered manner, bypassing conventional processes such as casting, forging, rolling, cutting, machining, welding or drilling," says the Centre's Director, CSIRO's Dr Mahnaz Jahedi. "It offers dramatic savings in labour, time, materials, energy and other costs, and significant reductions in adverse environmental impacts."

Engineering company Frontline Australasia Pty Ltd has been appointed lead industry partner and Frontline's CEO, Kevin Hooper, will be the Chairman of the Centre's Board. Victoria's Department of Innovation, Industry and Regional Development is providing a \$3 million grant, which will be matched by the industry partners, with in-kind contributions from CSIRO and the universities.

## ENGINEERING SHORTFALL STILL HIGH

Engineers Australia says while all engineering disciplines have experienced fewer shortages than in the past, the shortages experienced by companies remain comparatively high.

No engineering discipline was in surplus and the biggest shortages were in the key mainstream disciplines of civil engineering, mechanical engineering, electrical engineering and structural engineering.

Releasing *The Engineering Profession – a statistical overview 2010*, the Chief Executive of Engineers Australia, Mr Peter Taylor, said the domestic supply of new engineering graduates had not been able to keep pace with increases in the demand for engineers for many years.

"For well over a decade the number of domestic engineering graduates flat-lined at around 5000 a year and it is only in the last few years that we have seen a modest increase to about 6000 per year.

"While the initiatives through Government policies to deal with shortages have increased the number of new fully funded engineering places in universities and TAFEs, and despite the immigration of suitably qualified engineers, the shortage of engineers remains an acute problem for Australia now and well into the future."

The report said in 2006–08 more than 70 per cent of companies reported experiencing engineer skill shortages during the preceding year. Even at the height of the GFC in 2009, 53 per cent of companies still reported they had experienced professional engineer skill shortages.

"With all indicators showing a return to robust economic expansion for Australia the long term, it remains very disturbing that there is no real end in sight to delivering an adequate engineering skills base across Australia to match demands for maintenance of existing infrastructure, increasing population and economic expansion," Mr Taylor said.

The full report is available at [www.engineersaustralia.org.au/statistical-overview](http://www.engineersaustralia.org.au/statistical-overview)

## ENGINE HEAT COULD DRIVE FUEL SAVINGS

A system being developed by researchers at Deakin University that uses wasted engine heat to reduce engine friction in motor vehicles has demonstrated fuel consumption reductions of more than seven per cent in preliminary testing.

"A typical car engine releases about a third of the energy bound in fuel as exhaust waste gas; about another third is lost through heat transfer into the environment," explained project leader Mr Frank Will from Deakin's School of Engineering. "Our system recovers and redirects some of this wasted heat and uses it to bring the engine oil up to its optimal operating temperature. This helps reduce friction in the engine, which has the potential to reduce fuel consumption.

"Preliminary testing of our system has demonstrated fuel savings of over 7 per cent, as well as significant reductions in exhaust emissions.

"One of the most important features of our system is that it doesn't have to heat all the oil in the sump, instead it heats the active oil in the engine lubrication system using an oil return bypass connected from the cylinder head directly to the oil pump, or oil pick-up tube. This bypass helps to increase the heat transfer from the combustion gas to the oil so the overall heat transfer process will be much more efficient."

Mr Will discussed the potential of this system with car manufacturers, investors, inventors, SMEs, and researchers at the Clean Vehicle Conference held at Deakin University's Geelong Campus in September, which focused on reducing carbon emissions.

# MOLECULAR SPONGES TO 'MOP UP' EMISSIONS

A University of Sydney researcher has been recognised for her groundbreaking work into capturing carbon emissions, which has the potential to significantly impact climate change.



Deanna D'Allessandro

Dr Deanna D'Allessandro, a postdoctoral fellow based in the School of Chemistry, was one of three female researchers to be awarded a L'Oréal Australia 2010 For Women in Science Fellowship.

Her research has investigated ways to capture and release carbon dioxide, hydrogen and other gases using molecular sponges.

During her time as a postdoctoral fellow at the University of California, Berkeley,

Dr D'Allessandro created chemical frameworks that could survive tough environmental conditions yet still capture carbon dioxide. Although not yet ready for commercial use, they are a step closer to cost-effective carbon capture.

Dr D'Allessandro believes, in time, she will be able to create molecular sponges that will mop up carbon dioxide, hydrogen, or in theory almost any gas, and then release it on cue.

She hopes to create more advanced molecular frameworks, the pores of which can be modified by different wavelengths of light. Her metal-organic frameworks could also have many other applications, such as hydrogen storage; gas separation; electrodes for sensors, and capacitors for electronic circuits.

## DEAKIN HOSTS CARBON FIBRE WHEEL RESEARCH

Deakin University is at the heart of development of a world-first advanced car wheel that is designed to improve driver safety and boost vehicle performance.

Research firm CFusion is developing the world's first single piece carbon fibre automotive wheel at Deakin's Proof of Concept facility at the Geelong Technology Park on the university's grounds, which will be shared between the university and industry to collaborate on technological projects.

Opening the facility, Victoria's Regional and Rural Development Minister Jacinta Allan said the CFusion wheel was made from a single

piece of carbon fibre and would improve car safety by decreasing braking distance, and enhance performance by allowing faster acceleration and better grip.

She said the Government would provide CFusion and Deakin University's Institute for Technology Research and Innovation (ITRI) with a \$100,000 grant to jointly develop the carbon fibre wheel, which had already been flagged for use in the Shelby 2010 Ultimate Aero, one of the world's fastest cars.

"The Proof of Concept facility will create 150 new jobs, but the technologies and solutions born out of it will lead to many more being created by the advanced companies marketing these solutions as products," Ms Allan said.

State Member for South Barwon, Michael Crutchfield, said Geelong was set to become the carbon fibre capital of the state, if not the nation, as Deakin University readied to build the \$28 million Australian Carbon Fibre Research (ACFR) facility.

## WORLD ROBOT CHALLENGE

A team led by the University of Western Australia is one of six international finalists in a challenge to develop the next generation of fully autonomous robots that could undertake dangerous missions in hostile environments.

The team, WAMBOT/MAGiCian, is up against five teams representing the USA, Turkey and Japan and has members from UWA, Edith Cowan University and Flinders University, Thales Australia (also the primary sponsor) and local industry.

The team is in the running for a US\$750,000 prize and opportunities for contracts with the US and Australian Departments of Defence with their vehicle prototypes and human-robot interfaces. The competition is organised by the Defence Science and Technology Organisation (DSTO) in Australia and the Research Development and Engineering Command in the US.

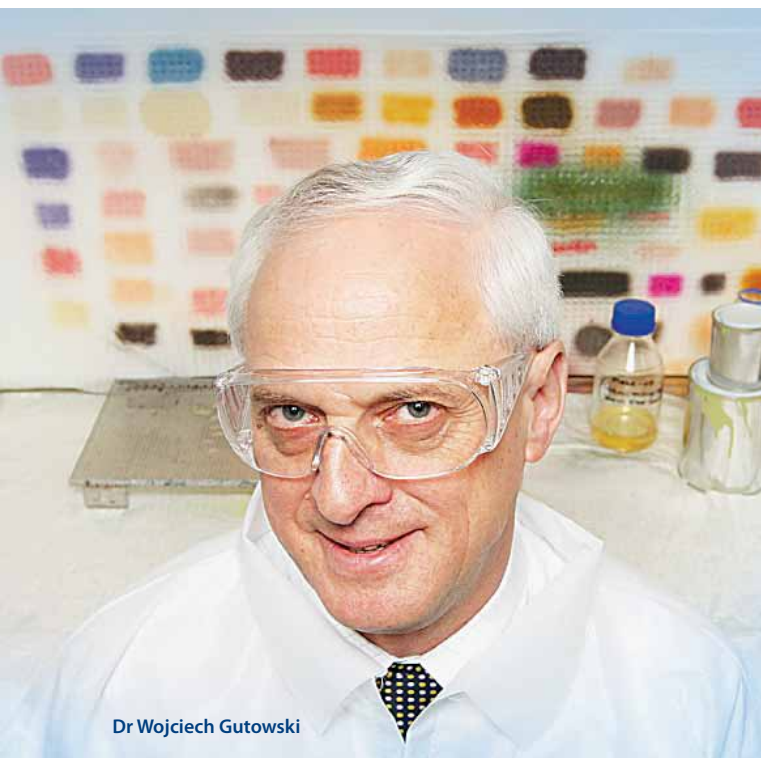
Australian and US officials visited all 12 short-listed teams, culled from an initial 23 from five countries, to evaluate their robots. The teams' robots performed a range of activities to demonstrate specific capabilities including the ability to operate autonomously and to map their surroundings digitally.

Australia's Acting Chief Defence Scientist Dr Warren Harch announced the six finalists, who will compete in the finals in Adelaide in November.

"The six successful teams displayed high levels of innovation and dexterity in completing their assigned tasks," Dr Harch said. "They now have a few more months to fine-tune their concepts for the grand final challenge when they will be required to field at least three robots and accomplish a complex task involving mapping and identification of threats while demonstrating a high level of autonomy between the robots.

"We want to move from the current paradigm of one man, one robot to one man and many robots," he added.

# PAINT SOLUTION WINS VICTORIA PRIZE



Dr Wojciech Gutowski

A world-first zero-waste technology that is set to save the Australian car industry at least \$100 million a year while becoming cleaner and greener has been recognised in the 2010 Victoria Prize and Fellowships.

The Governor of Victoria, Professor David de Kretser AC FAA FTSE, presented the 2010 Victoria Prize to Dr Wojciech 'Voytek' Gutowski in Melbourne in September.

Dr Gutowski, CSIRO Materials Science and Engineering Division Chief Research Scientist, is one of Australia's leading materials scientists and has played a pivotal role in developing new technologies that are transforming manufacturing industries around the world.

His work has addressed a problem faced by the car industry, which uses nearly 10 million litres of paint a year, with all solvents used in the process becoming airborne and 2.5 million litres of solids going to landfill.

Dr Gutowski and his team developed a breakthrough technology that completely eliminates waste and volatile solvent emissions from painting plastic surfaces. This technology is set to save the Australian car industry at least \$100 million a year while becoming cleaner and greener.

Now commercialised by Dulux, the technology is being adopted by CSA and Oz-Plastik and has reached pre-production trial stage with other Australian and international companies including major global furniture manufacturers.

In conjunction with the Victoria Prize, the Jack and Robert Smorgon Families Foundation awarded the \$100,000 Anne & Eric Smorgon

Memorial Award to the institute supporting the work of the Victoria Prize winner. Professor Callum Drummond FTSE, Chief of CSIRO Materials Science and Engineering, accepted the award on behalf of CSIRO.

Announced at the same time were the 2010 Victoria Fellowships:

- Ms Suzanne Ftouni – for tackling the issue of driver fatigue;
- Dr Mathew Hill – for development of metal organic frameworks;
- Dr Baohua Jia – for development of solar cells;
- Dr Michelle Ma – for early cancer cell detection;
- Ms Denise Miles – for development of Testes cancer tests; and
- Dr Sant-Rayn Pasrischa – for research into anaemia.

Dr Jia and Ms Ftouni also received the Australian French Science and Technology (AFAS) Fellowship. Dr Jia was also a recipient of the 2009 Australia China Young Scientist Exchange scheme run by ATSE.

*The \$50,000 Victoria Prize recognises exceptional achievement in science, engineering or technology. It is awarded annually to an individual whose scientific discovery or technological innovation has significantly advanced knowledge or has potential to lead a commercial outcome or other benefit to the community. The Victoria Fellowships encourage innovation and the commercial application of research among engineers, medical researchers and scientists in the early stages of their careers and provide six travel grants of up to \$18,000.*

## OLDER AUSSIES OFFLINE

Australia needs a national strategy to overcome the fears and uncertainty of older Australians about going online if broadband is to deliver its full value to the nation, says Dr Sandra Haukka, a Senior Research Fellow in the ARC Centre of Excellence for Creative Industries and Innovation (CCI) at Queensland University of Technology.

A CCI report, *The Internet in Australia*, has found that 98 per cent of young people aged 18 to 24 use the internet, compared with only 40 per cent of people aged 64 and over.

"People assume that older Australians are not interested in the internet because they don't know what it can do – but that's not true," Dr Haukka says.

"Our research shows they are very much aware of the benefits and many would like to use it if their concerns were addressed."

The main fears about internet use among older Australians were: lack of skills, concerns about security and viruses, lack of support, high costs, and not wanting to burden their friends or family by asking for help or advice, she says.

Survey participants were particularly interested in using the internet for general searching, communicating with friends and family, making bookings, looking up timetables, making cheap phone calls and researching health topics.

They were less interested in using the internet to access their medical and other records (Centrelink, bank accounts, investment funds), using social networking sites or managing their finances (banking, paying bills and investing online).



IMAGE: CSIRO

## WEIGHING PLANETS WITH RADIO SIGNALS

An international team of astronomers has developed a new way to weigh the planets in our Solar System using radio signals from the small spinning stars called pulsars.

Until now, astronomers have weighed planets by measuring the orbits of their moons or of spacecraft flying past them. That's because mass creates gravity, and a planet's gravitational pull determines the orbit of anything that goes around it, both the size of the orbit and how long it takes to complete.

The new method is based on corrections astronomers make to signals from pulsars – small spinning stars that deliver regular 'blips' of radio waves. These measurements of planet masses could feed into data needed for future space missions.

Data from a set of four pulsars have been used to weigh Mercury, Venus, Mars, Jupiter and Saturn with their moons and rings. Most of these data were recorded by CSIRO's Parkes Radio Telescope in eastern Australia, with some contributed by the Arecibo telescope in Puerto Rico and the Effelsberg telescope in Germany.

"This is first time anyone has weighed entire planetary systems – planets with their moons and rings," said team leader Dr David Champion from Germany's Max-Planck-Institut für Radioastronomie.

CASS scientist Dr George Hobbs said that, in the short term, spacecraft would continue to make the most accurate

measurements for individual planets. But the pulsar technique would be best for planets not being visited by spacecraft, and for measuring the combined masses of planets and their moons, he said.

## PHOENIX TARGETS BUSHFIRES

Phoenix RapidFire, a unique computer program that can predict the direction, speed and intensity of bushfires, will be a key tool for Victoria's bushfire response this summer.

Researchers at the University of Melbourne and the Bushfire CRC have designed the program, with the Victorian Government announcing funding of \$21.5 million to extend its use in Victoria.

Phoenix RapidFire is a fire simulation system that generates a coloured map of the state with a visual representation of the bushfire moving across the landscape. Environmental details such as height and slope of the land, vegetation type, road proximity and fire history of the area, are used in the program to help predict the fire's movement. The fire's impact is then estimated based on fire characteristics and the values and assets of the landscape, such as houses and agricultural areas.

Phoenix RapidFire is a Bushfire CRC project, led by Dr Kevin Tolhurst and Mr Derek Chong from the University of Melbourne. The program predicts the movement of fire and helps determine which communities need to be warned and where to send resources to minimise the impact.

"The program will provide detailed information on the spread of fires and is intended for use by fire agencies, land managers, town and land planners and policy makers," Dr Tolhurst says. "It's designed to show the progression of fire across an entire state, not just a local area, therefore firefighting resources can be most effectively allocated. The program should allow us to provide hours of warning of a fire approaching within just minutes of it being discovered."

## DEAKIN AND WUHAN LINK

Wuhan Iron and Steel (Group) Corporation (WISCO) – the seventh-largest steel-producing company business in the world – and Deakin University have signed a memorandum of understanding for science and technology innovation.

Director of Deakin's Institute for Technology Research and Innovation (ITRI) and ARC Laureate Fellow Professor Peter Hodgson, an expert on metal processing, said the signing brought together two dynamic forces – a major Chinese steel company with a high rate of technical development and Australian research expertise, particularly in steel processing, from ITRI.

He anticipated collaborative research projects in a range of areas related to new steel product and process developments. "Deakin is already conducting leading edge research on advanced high strength steels for the automotive industry and at a fundamental level is examining the development of novel steel properties through manipulation in structure at the atomic level."



Professor Mark Cassidy

## TRUST BACKS DEEP-WATER RESEARCH

The world's multi-billion dollar oil and gas industries should benefit from a new research project aimed at securing long-term, safer and cleaner forms of energy.

Winthrop Professor Mark Cassidy FTSE, Director of the University of Western Australia's Centre for Offshore Foundation Systems (COFS), said the centre's \$2.4 million program, supported by The Lloyd's Register Educational Trust (The LRET), would help provide solutions to the challenges of harnessing resources from beneath our oceans.

"We have signed an agreement with The LRET, an independent global charity that works to achieve advances in transportation, science, engineering and technology education, training and research for the public benefit," Professor Cassidy said.

UWA has committed \$1.2 million to the initiative, which will provide a Chair and Research Centre of Excellence in Offshore Foundation Systems, three assistant professor positions and a number of top-up PhD scholarships.

"The program means UWA will have a critical mass of researchers in deep-water engineering, renewable energy and risk assessment for oil and gas facilities," Professor Cassidy said. "It will allow COFS to engage more effectively with local and international oil, gas and renewable-energy industries – and with other universities in The LRET research network, such as the University of Southampton and the National University of Singapore's Centre for Offshore Research in Engineering."

## NEW OIL-FINDING TECHNIQUE

CSIRO scientists have developed a revolutionary technique for the rapid on-site detection and quantification of petroleum hydrocarbons (commonly derived from crude oil) in soil, silt, sediment or rock.

The technique, developed in collaboration with waste technology specialist Ziltek Pty Ltd, means that the presence of petroleum hydrocarbons can now be quantified simply by using a hand-held infrared spectrometer to take readings at the site of interest, without the need to take samples or perform any kind of processing.

The technique could be used for oil exploration purposes and could be particularly useful in assessing and monitoring contaminated sites such as coastal land following offshore oil spills and industrial sites planned for urban redevelopment.

The technique uses an infrared signal to detect the presence of petroleum hydrocarbons in samples. Current methods use sampling and processing techniques that are labour-intensive, time-consuming, require sensitive equipment and are not well suited to on-site analysis.

A significant portion of the time and financial costs involved in assessing and remediating contaminated sites is in monitoring and analysis. CSIRO says by decreasing analysis time and reducing costs this new technique could assist in the fast and effective identification of oil and other petroleum products in the environment, as well as treatment and protection of environmental assets threatened by petroleum contamination.

"The ability of this new technique to rapidly detect the presence of contaminants at the site has the potential to provide significant cost advantages, in terms of reduced testing costs and the avoidance of delays," says CSIRO scientist Sean Forrester. "Rapid analysis allows immediate measures to be undertaken to prevent further contamination or to limit contaminant spread."

**CSIRO's Sean Forrester uses the new technique to detect oil in soil.**



PHOTO: BEN DEARMAN, ZILTEK PTY

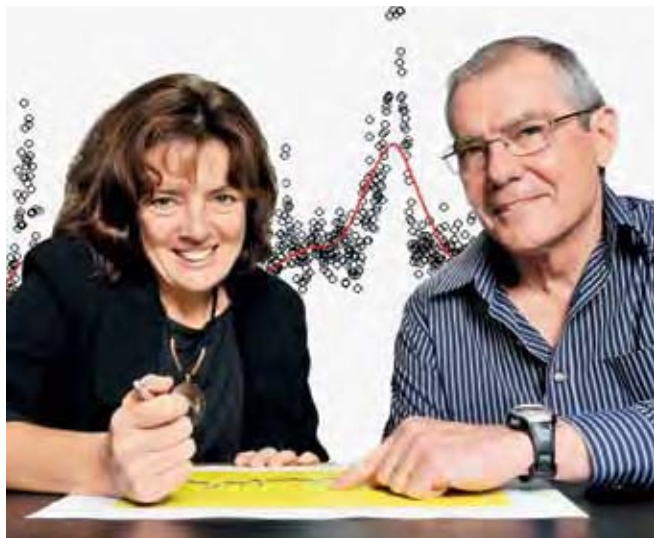


PHOTO: CHRISTAYLOR

## STATISTICS CAN DETECT DISEASES SOONER

New disease outbreak detection methods have been developed by CSIRO and NSW Health, which may enable health authorities to take action sooner to implement disease outbreak control measures.

"New methods developed by CSIRO statisticians have the potential to give an earlier-than-ever indication of whether a flu season is behaving normally or not," says CSIRO Mathematics, Informatics and Statistics' Chief, Dr Louise Ryan. "Diseases such as flu can spread quickly. The swine flu outbreak (Pandemic (H1N1) 2009) was, for example, threatening to overload intensive care services in Australian hospitals within weeks of being recognised in Mexico."

CSIRO says applying the model to e-Health data streams has the potential advantage of detecting not just the seasonal flu but new or rare events such as a new type of viral illness or an intentional outbreak like a bioterrorism attack. And it could allow health departments to predict the demographics and location of people most at risk. CSIRO is using the techniques to analyse flu data from other states and exploring the potential to build the statistical tools into hospital management software.

Dr Ryan said that e-Health technology provided huge amounts of data on hospital admissions, symptoms and locations that could be challenging to understand.

"We used archives of daily counts of emergency department visits from 12 NSW hospitals on seven different syndromes such as abdominal pain, influenza-like illness or respiratory conditions. We then adapted statistical control methods originally used to signal machinery failures in factories.

"We tested them on simulated health data and found we could detect an outbreak up to a day earlier than more conventional methods.

**Professor Louise Ryan, CSIRO Mathematics, Informatics and Statistics Chief and senior CSIRO scientist Dr Ross Sparks.**

"Our statistical tools answer the question: how do you know when you've got a disease outbreak unfolding? They tell us what the usual pattern would be of, say, winter flu. Then we can understand the variations that might signal something more serious."

Statistical surveillance methods developed by CSIRO have also been used in monitoring traffic incidents, pipeline breakages, and financial fraud.

## GETTING KIDS ACTIVE AT THE COMPUTER

CSIRO has developed computer software that aims to encourage children to be more active when playing computer games, by rewarding those who jump up and down.

Through the Preventative Health Flagship, CSIRO experts in information and communication technologies (ICT) took a game that is usually played sitting down and devised a way for players to earn extra points if they jump up and down. Designed as an add-on to popular computer games that do not ordinarily encourage physical activity, it works by exploiting the children's desire to win.

Dr Shlomo Berkovsky and his team developed the concept using the open source game 'Neverball' – where players have a certain amount of time to guide a ball through a maze – then shortened the time, so the only way an average player could complete the maze and go on to the next level of the game was by getting up and jumping around. Every jump earns a second of game time.

Modified and unmodified versions of the game were tested on 270 primary school children in Hobart and those playing the modified game jumped an average of 257 times in the 20 minutes they spent playing the game.

Dr Berkovsky said the trials showed children playing modified games spent 25 per cent of their gaming time being active, whereas those playing unmodified games were active for just three per cent of the time.



**A child fitted with an accelerometer trials a computer game designed to encourage movement.**

PHOTO: CSIRO

# Time for an Australian Hadron therapy facility



By John Boldeman and Richard Banati

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**H**adron therapy is a cancer treatment technique of unequalled precision, safety and efficiency – which has been used for more than 50 years – but it is not available in Australia.

This is despite the fact that Australia has been remarkably successful in installing world class scientific facilities at very modest cost.

Three examples stand out:

- the Australian Synchrotron is an extremely high performance facility attracting world interest with a user community now exceeding all expectations;
- the recently installed research reactor, OPAL, is one of the three world-leading research reactors for neutron scattering research; and
- the tandem accelerator ANTARES, installed at ANSTO in the 1990s, continues to be a world leader in the application of charged particle beams.

Despite these great successes and others in radio astronomy and related areas, investment in Australian science and technology has been significantly less than that in comparable economies.

One initiative that is being pursued with vigour overseas is the construction and application of high energy particle accelerators for the treatment of cancer and related research. Already about 75,000 patients have been treated worldwide and new facilities are under construction in many countries. Australia is notable in the absence of such a facility.

The use of particle accelerators to produce high energy charged particles for the treatment of cancer is called Hadron therapy (sometimes ion or proton therapy). Studies in Europe and the US (Amaldi, ESOF 2004, Stockholm) reveal that approximately 3000 patients annually per 10 million population would benefit from Hadron therapy with – according to a UK study (National Radiotherapy Group, International Hospital Federation Reference Book 2007/2008) – 80 patients in this group having no feasible alternatives and at least 500 patients experiencing unequivocally superior dose distributions and reduced risk to vital organs.

## Particle beams

Hadron therapy is a cancer treatment technique of unequalled precision, safety and efficiency. It uses the specific properties of accelerated particles (protons and/or carbon ions – see Figure 1) to deliver a precisely calculated destructive energy (or radiation dose) at a specific depth (the Bragg Peak) in the body, strictly within the volume of the targeted tumour tissue.

This greatly increases the delivered dose to the tumour, while at the same time reducing collateral damage to healthy tissue, such as inducing secondary tumours through the radiation treatment itself, or growth abnormalities through the damage of healthy tissue in young patients.

The precision and efficacy of “surgery without scalpel” has its greatest benefits in children and high-risk patients with tumours close to vital organ structures, such as cancers of the eye, the brain, spinal cord (see Figure 2 – T. Haberer PTCOG 2009). Targeted to the appropriate patient group, hadron therapy is not only an incremental improvement, but essentially fully curative, without the higher risk of unwanted acute and long-term side effects associated with conventional radiotherapy with X-rays (photons). It

Figure 1 Hadron therapy uses accelerated particles to deliver a precisely calculated destructive energy (or radiation dose) at a specific depth (the Bragg Peak) in the body, strictly within the volume of the targeted tumour tissue

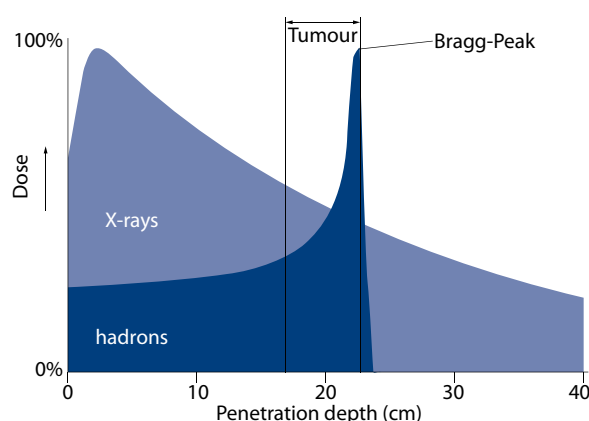
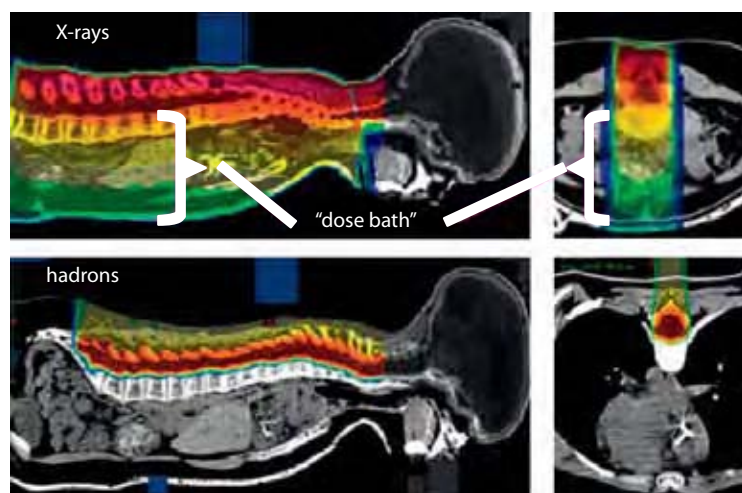


Figure 2 Medullblastoma: Target dose 32 Gy/GyE



In the above, treatment of medullblastoma the target dose is 32 Grays (Gy) or Gray equivalents (GyE). The unwanted dose to healthy tissue ("dose bath") with conventional X-rays is 22 Gy to bone marrow, 18 Gy to heart and 20 Gy to intestine. With hadrons, the dose is 1 GyE bone marrow, 0.5 GyE heart and 0.5 GyE intestine.

also substantially improves patient life style by reducing and sometimes eliminating side effects such as nausea.

The advantage that hadron therapy has over conventional radiotherapy can be summarised as:

- in the treatment process, the dose to healthy cells is reduced by factors between three and 10;
- because the hadron beams can be accurately steered by magnets and because of the small deviation of the hadron beam as it enters the human body it is possible to target tumours very close to critical organs;
- it is possible to kill tumours that are resistant to normal X-ray radiation;
- Hadron beams are more effective and the number of fractions (i.e. the number of times a patient needs to attend the facility) can be reduced; and
- side-effects, such as nausea and secondary tumor induction as a consequence of radiation exposure of normal tissue, are drastically minimised.

### Potential indications

Hadron Therapy has been used for more than 50 years and there is a great deal of information on where it is most appropriate. These include all solid paediatric tumours (medulloblastoma, retinoblastoma, other tumours of the central nervous system, sarcomas, Wilms tumour, etc.)

- chordomas and paraspinal chondrosarcomas;
- recurrent or intermediate meningiomas;
- pituitary adenomas;

- local recurrences of rhinopharyngeal carcinomas;
- other adult brain tumours;
- tumours of the nasal cavity or of the paranasal sinuses;
- bladder, lung, cervix, oesophagus, biliar tract, pancreas, head-and-neck district and prostate tumours;
- liver carcinomas;
- thyroid non-differentiated tumours;
- thymomas and thymus carcinomas;
- bone and soft tissues sarcomas;
- single metastases of the encephalon of the lung and liver;
- recurrent rectal cancer;
- neurinomas of the acoustic nerve; and
- macular degeneration of the retina.

### Capital and operating costs

The National Hadron Therapy Facility would be based on a versatile synchrotron accelerator capable of producing high-energy ion beams of both protons and carbon. The energy of the beams to be extracted from the facility would be variable. The requirements for both ion beams include:

- maximum penetration depth in the human body of approximately 32 cm;
- minimum penetration depth of 3.5 cm; and
- sufficient current to provide 2 grays of radiation to a targeted tumour in about 2 to 3 minutes.

To build the Australian Hadron Project it is proposed to adopt the same principles of construction that have proved successful in the past in building major infrastructure in Australia. The project would be divided into a number of specific components and international suppliers would be contracted to supply these specific components. Integration would be the responsibility of the host Australian institution. Approximately 60 per cent of the capital cost of the facility would be spent in Australia. Following preliminary planning, the facility could be constructed in about four years at a cost of \$150–\$180 million, with annual operating costs of about \$10 million.

### Value to Australia

The facility would introduce into Australia:

- the capability of treating 2000 to 3000 cancer patients each year with a special emphasis on children;
- a new level of high technology which could be exploited in developing new initiatives in energy production, high technology materials, scientific infrastructure;
- a world-class community in the study of the biological effects of radiation;
- advanced training and education in physics, chemistry, biotechnology and engineering;
- a high-level cross disciplinary research across almost all areas of scientific and technology development; and

■ retention and extension of an area of existing expertise, that is, accelerator sciences.

A preliminary physics design report (Boldeman *et al* ANSTO E/770) has been finalised and many references to international literature on the topic of Hadron therapy are available there as well as acknowledgement of numerous previous efforts within Australia to raise the capital cost of a facility. ◀

**PROFESSOR JOHN BOLDEMAN FTSE** is a Professor at the Institute of Nuclear Science at the University of Sydney, and a Researcher/Designer at ANSTO in Sydney. He held senior management roles

in both organisations and a personal chair at the University of Queensland. His roles in the establishment of two national icon projects – the ANTARES Tandem Accelerator and the Australian Synchrotron – were acknowledged with an ATSE Clunies Ross Lifetime Achievement Award in 2010.

**RICHARD BANATI** is Professor and Foundation Chair of Medical Radiation Sciences at the University of Sydney, Director of the Ramaciotti Centre for Brain Imaging at the Brain and Mind Research Institute (BMRI) and Distinguished Research Fellow at ANSTO. He has a long-standing interest in the role of non-neuronal (glial) cells in the progression of neurodegenerative and neoplastic brain disease.

# Herding Cats: success in the black arts

By Ian Rae

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It's hard to know what to make of this little book, which is in the tradition of F.M. Cornford's *Microcosmographica Academia* (1908, second edition 1922). There are lots of books like this directed to people in the business world, but only a few in scientific research.

The authors (Dr Geoff Garrett and Sir Graeme Davies) compiled their volume by first setting down the rudiments of 'guile and political acumen' under 12 headings, each a 'C'. Conflict, Committees, Credit, Change and Composure give you the flavour of the thing. Then they sought comments from about 50 vice-chancellors and executive directors, and assigned their responses relevant 'C' sections.

The practitioner contributions come straight from the scratching post, and include such well-worn observations as "people infer as much from what you don't say as they do from what you actually do say". Each of the 'C' sections is then rounded out with reflections from the authors and maybe a quotation or two.

The book concludes with a kind of glossary of the 'C's, a page on each of the authors, and a useful index. Garrett and Davies are scrupulous about referencing their sources – the likes of Cornford, Machiavelli, Santayana, and Churchill – while tactfully concealing the sources of the comments they elicited from the contemporary 'katz-zen meister'.

So, who is going to read this aggregated advice from two veteran authors? There is a danger that it will be dismissed as a feat of self-indulgence, a kind of hard-copy blog. It would be most useful, I believe, to those first assuming leadership

at the research group or faculty dean level. For someone nearer the top, who presumably got there by having at least facility with the black arts, if not mastery of them, it would be a useful refresher. And maybe those in the ranks would benefit from knowing what the boss thinks is going on.

In a parting reflection of my own, however, I note that Garrett and Davies, early in their book, quote an old Chinese saying (no reference, however): 'An evening across the table with a wise man is worth a month of study in books.' In its defence, the book is probably cheaper than a consultant. ◀

**PROFESSOR IAN RAE FTSE** is a former Technical Director of ATSE and Honorary Professorial Fellow, History and Philosophy of Science, University of Melbourne. He is member of the leadership group of ATSE's Climate Change Forum and former President of the Royal Australian Chemical Institute.

An academic for 13 years, **DR GEOFF GARRETT AO FTSE** has led two of the world's major national research institutions, CSIR in South Africa (1995-2000) and CSIRO in Australia (2001-2008), and is a former South African 'Engineer of the Year' (1999).

**SIR GRAEME DAVIES FEng FRSNZ** has led three major universities in the UK - Liverpool, Glasgow and, currently, London. A New Zealand-educated materials engineer, with 16 years as a distinguished academic at Cambridge University, he was instrumental in creating the Higher Education Funding Council for England as Chief Executive from 1991 until 1995.



*Herding Cats: Being advice to aspiring academic and research leaders* by Geoff Garrett and Graeme Davies (Triarchy Press, UK, 2010, 118pp, £15.00)

## John de Laeter was one of WA's most noted scientists

The science community has paid tribute to one of WA's most illustrious scientists, Emeritus Professor John de Laeter AO FTSE, who died in August, aged 77, after a long battle with illness.

Professor de Laeter, who joined the Academy in 1984, was inducted into the Western Australian Science Hall of Fame last year for research achievements that included measuring the atomic weight of 12 elements, mapping the geological age of WA rocks and finding ways to store nuclear

waste. He was awarded an ATSE Clunies Ross Lifetime Contribution Award in 2006.

An Emeritus Professor of Physics at Curtin University and a former

Curtin DVC (Research and Development) and Vice Chancellor, he became Head of the Department of Physics at the WA Institute of Technology (now Curtin University) aged 34.

Professor de Laeter played key roles in the establishment of Technology Park near Curtin University; the Science and Mathematics Education Centre at Curtin; and Perth's Scitech Discovery Centre, which has introduced science in an interesting way to many thousands of schoolchildren.

Colleagues at Curtin's Centre of Excellence in Mass Spectrometry, which

he established in 1997, have discovered the most ancient minerals found on Earth, at Jack Hills in WA, which they have identified as approximately 4.4 billion years old.

Professor De Laeter's own research produced many achievements in numerous fields of interest. He measured the atomic weight of 12 elements, mapped the geological ages of many regions of WA – data vital for the mining and petroleum industries – and his collaborative research into the Oklo Phenomenon in Gabon, a highly radioactive uranium deposit, demonstrated the capacity of the rock strata to contain radioactive material and hence store nuclear waste.

He also served as President of the WA Conservation and Environment Council for three years, was a long-serving Governor of the ATSE Clunies Ross Foundation and captained an Australian Veterans hockey team.

Curtin Vice-Chancellor Jeanette Hackett said Professor de Laeter was a giant of Australian science whose impact was felt worldwide.

## SA Division STEM Teacher Award

ATSE South Australian Division Chairman, Professor Mike Miller AO FTSE, recently presented the 2010 ATSE STEM Teacher Award

to Ms Deb Woodard-Knight of St John's Grammar School, in the Adelaide Hills suburb of Belair.

The award was made in recognition of her outstanding performance as the Head of Mathematics, Years 7 to 12, and the SA Certificate of Education Coordinator at the school. An ATSE cheque for \$2000 was presented to the school Principal, Ms Cheryl Bauer, for the school's STEM activities. The Award was in the form of a trophy and a plaque.

The SA Division award recognised excellence in the teaching of Science, Technology, Engineering and Mathematics (STEM) in South Australian secondary schools. The award was made in conjunction with the annual SA Science & Engineering Challenge. The Challenge was co-sponsored by ATSE SA Division and was attended by more than 50 secondary school teams.

The most successful schools in the May heats went on to compete in a Super-Challenge in August for the right to be invited to represent SA at the National Challenge in NSW later in the year.

The 2010 Science & Engineering Challenge involved more than 700 schools and 21,000 students in the state.



John de Laeter



Mike Miller and Deb Woodard-Knight

# Robot guru is NSW Scientist of the Year

Professor Hugh Durrant-Whyte FRS FAA FTSE, who heads the Australian Research Council Centre of Excellence for Autonomous Systems and the Australian Centre for Field Robotics at the University of Sydney, has been named the NSW Scientist of the Year, winning \$55,000 for his achievement.

Professor Aibing Yu FTSE, Scientia Professor in the School of Materials Science and Engineering at UNSW, was named winner of the Engineering, Mathematics and Computer Sciences Category.

The NSW Minister for Science and Medical Research, Jodi McKay, said Professor Durrant-Whyte had taken the world by storm, developing innovative robots for a wide range of applications.

"Professor Durrant-Whyte is a worthy winner of this year's award. He is a world leader in robotics and has helped develop autonomous solutions for a range of industries including mining, marine, military, aeronautics and agriculture," Ms McKay said. "He is literally leading a robotic revolution, not only for Australia but the world."

Professor Durrant-Whyte's team has spun out a number of companies, most recently Marathon Robotics, which has developed free-ranging robots, protected by armour plating, to train marksmen. The Marathon Robotics system recently attracted a \$57 million contract with the US Marines.

"He has also been involved in the development of underwater robots, flying weed-spraying drones and massive mining automation systems," Ms McKay said.

"Australia is the perfect place to develop and apply robotics," Professor Durrant-Whyte said. "Robotics works for things that are big and expensive and things you don't want to put people into – from mining to underwater exploration."

"Autonomous systems represent the next great step in the fusion of machines, computing, sensing and software to create

intelligent systems capable of interacting with the complexities of the real world."

Professor Durrant-Whyte said the rise of robots was set to have a huge impact on all areas of society and especially in Australia. "It's an exciting field and I liken it to the growth of the computer industry. One day, just like computers, there will be robots in every home."

Professor Yu – NSW Division secretary – is a world-leading scientist in particle/powder technology and process engineering. He has made many significant contributions and is recognised as an authority in the areas of particle packing, particulate and multiphase processing and simulation and modelling. He was named an ARC Federation Fellow in 2008.

## Graeme Clark wins Lister Medal

Australia's cochlear implant research pioneer, Professor Graeme Clark AC FRS FAA FTSE, has been awarded the prestigious Lister Medal – the most distinguished award in surgery – in recognition of his contributions to surgical science with the multi-channel cochlear implant. The Award was announced at a 75th birthday dinner for Professor Clark hosted at

the University of Melbourne.

"Professor Clark's pioneering research on the cochlear implant more than merits the prestigious Lister Medal," said Mr John Black,

President of the Royal College of Surgeons of England. "His vision, drive and initiative have transformed the lives of hundreds of thousands of people across the world, making him a very worthy recipient of one of the highest surgical accolades."

Professor Clark carried out his pioneering research at the University of Melbourne during the 1970s and the resulting cochlear implant became the first means of providing speech understanding to profoundly deaf children and adults. Today more than 200,000 cochlear implants have been performed in more than 100 countries.

"I am very honoured to receive such a prominent award on behalf of all of the researchers that are engaged in the fight against deafness," Professor Clark said. "We have achieved amazing success with the cochlear implant and have brought the world of sound to thousands of children and adults worldwide."

The Lister Medal is named after the English surgeon Joseph Lister (1827–1912), whose work on antiseptics established the basis of modern sterile surgery. The Medal selection is made by the Royal Society, The Royal College of Surgeons of England, the University of Glasgow, The Royal College of Surgeons in Ireland and The Royal College of Surgeons of Edinburgh.

Professor Clark joins the likes of many notables in medical history to receive the honour. He is the third Australian award recipient, with Howard Florey (the penicillin pioneer) and Sir Peter Morris (an expert in transplantation and vascular surgery) previously awarded the Lister Medal.



**Pictured at the Awards (from left) Professor John Boldeman, Professor Aibing Yu, Professor Susan Pond, Professor Rolf Prince.**



**Professor Graeme Clark**

# Green and Cantoni take out Eureka Prizes

Two ATSE Fellows have been honoured with wins in the 2010 Eureka Prizes – Scientia Professor Martin Green FTSE, University of New South Wales (UNSW), and Winthrop Professor Antonio Cantoni FTSE, University of Western Australia (UWA).

Professor Green, Executive Research Director of the ARC Photovoltaics Centre of Excellence at the UNSW, won his Eureka Prize in the Leadership in Science category as a Global Leader in Solar Cell Technology For his leadership and research on photovoltaics,

Professor Cantoni was one of a trio from the School of Electrical, Electronic and Computer Engineering at UWA which has become the first – in a mathematical innovation – to determine how to measure the margin of error inherent in systems tracking multiple targets, radically simplifying the required computation.

Presented annually by the Australian Museum, the Eureka Prizes reward excellence in the fields of scientific research and innovation, science leadership, school science and science journalism and communication.

The \$10,000 Eureka Prize for Leadership in Science was sponsored by CSIRO, and presented by CSIRO CEO Dr Megan Clark FTSE. The award citation said Professor Green – a 1994 ATSE Clunies Ross Award winner – was a shining light in the battle against climate change and global warming.

Over the past three decades he has led the international field in solar cell development, delivering cost-effective technology that has the ability to rival and ultimately replace human reliance on fossil fuels.

Professor Green is not only 'the father of photovoltaics', he is the global leader in solar cell technology. While many innovations

in alternative energy production remain experimental, Professor Green has had a real impact by taking this technology out of the laboratory and into the factory.

The work of the team involving Professor Cantoni won the \$10,000 Eureka Prize for Outstanding Science in Support of Defence or National Security, sponsored by the Defence Science and Technology Organisation (DSTO). It means scanning of Australia's seas, skies and land may become a lot simpler and more accurate and it is already transforming the technology behind large-scale surveillance.

Working with brothers, Professor Ba-Ngu Vo and Dr Ba-Tuong Vo, also from UWA, Professor Cantoni's trio is already transforming the technology behind large-scale surveillance and has shifted the paradigm for surveillance technology. It will quickly enhance the scope and accuracy of defence surveillance and has the potential for widespread use in the civilian world, the citation said.

For the first time, large-scale monitoring can now be done using standard off-the-shelf computers. Even using supercomputers, the current Australian tracking systems can follow only a few hundred targets at any one time, while the new approach will be capable of tracking thousands.

## Rob Lewis changes hats

Former South Australian Division Chair Professor Rob Lewis has taken up several new roles following his completion of 37 years' service with the SA Government, where his experience covered research, research management, public and private sector policy and governance, IP management and commercialisation.

He led the SA Research and Development Institute (SARDI) for 18 years, following 19 years with the SA Department of Fisheries in the role of Director of Fisheries.

He has established Science Without Bounds Pty Ltd and has taken up dual professorial positions at Adelaide and Flinders universities for a total of four days a week. He



PHOTO: 247 STUDIOS

Martin Green and Megan Clark

continues in a number of national Board and Committee positions. These include member of the SA Premier's Science and Research Council, Chairman of the A W Howard Memorial Trust Pty Ltd, Deputy Chair of the UniSA Institute for Sustainable Systems and Technologies and a director/member on the boards of the CRC for Molecular Plant Breeding, Molecular Plant Breeding (MPB) Pty Ltd, Australian Genome Research Facility Pty Ltd (Chair of the AGRF Audit Committee), UniSA Centre for Nutritional Physiology Advisory Board, Airborne Research Australia and Australian Grain Technologies Pty Ltd.

He chairs the PISC Fisheries and Aquaculture National Priorities Forum and is a member of the National Collaborative Research Infrastructure Scheme (NCRIS) Integrated Marine Observing System (IMOS) Advisory Board. He is an Honorary Fellow of SARDI.

## Paul Zimmet honoured

Professor Paul Zimmet AO FTSE, Director Emeritus and Director International Research, Baker IDI Heart and Diabetes Institute, has been elected to Honorary Membership of the European Association for the Study of Diabetes in recognition of his "Outstanding Contributions to Diabetes Research". This award, at the 46th General Assembly of the Association in Stockholm in September, was the first time an Australian was elected to the Honorary Membership, which is limited to 20 persons.

Professor Zimmet has also shared the Grand Hamdan International Award for Medical Sciences – the only Australian recognised in these awards, sponsored by the Deputy Ruler of Dubai, Sheik Hamdan bin Rashid Al-Maktoum, which recognise significant contributions to medical research.



Antonio Cantoni



Tanya Monro

## Tanya Monro named SA Scientist of the Year

Professor Tanya Monro FTSE has been jointly named – along with Professor Angel Lopez – as the 2010 South Australian Scientist of the Year.

SA Science and Information Economy Minister Jack Snelling said this year's judging panel was unable to separate the work of the joint winners, as both had made outstanding contributions in their fields.

"Professor Monro – the Director of the Institute for Photonics and Advanced Sensing – is a leading, internationally regarded physicist specialising in research into new optical fibres and how they can be applied in industries, such as defence, health, environmental monitoring and food and wine.

"Professor Lopez is a medically trained biomedical scientist who leads an elite group of 180 researchers at the Centre for Cancer Biology working to find new ways to prevent and treat the disease," Mr Snelling said.

Professor Monro is an ARC Federation Fellow who was elected to the Academy in 2009. She was one of three finalists in the 2010 Eureka Prizes Leadership in Science category, won by Professor Martin Green FTSE (see opposite).

She went to the University of Adelaide in early 2005 as the inaugural Chair of Photonics. From 1998 to 2004 she worked at the University of Southampton. She won the 2008 Prime Minister's Malcolm McIntosh

Prize for Physical Scientist of the Year and in 1998 won the Bragg Gold Medal, for the best physics PhD thesis in Australia.

## John Ralph honoured by Farm Institute

The Australian Farm Institute has launched an annual \$2500 essay competition to recognise the contribution of Mr John Ralph AC FAA FTSE, who was Chairman of the Institute from its founding until his recent retirement.

Topic for the 2010 essay, which closed in September, was 'The role of Australia's primary industries in buffering the Australian economy from external economic shocks.'

The winning essay and the best four other essays will be published in the November issue of the *Farm Policy Journal*.

Mr Ralph, an ATSE Fellow since 1996,



John Ralph

was the former Chairman of the Commonwealth Bank of Australia, former Deputy Chairman of Telstra Corporation and previous Chairman of the Business

Council of Australia and the Australian Mining Council.

Involved in farm enterprises in southern NSW, John Ralph has argued strongly for comprehensive and objective research as the basis for sound policy decision-making, particularly for the agriculture sector. To support this goal, the Australian Farm Institute was established in 2003.

## Aibing Yu wins Ian Wark Medal

Professor Aibing Yu, Federation Fellow and Scientia Professor, School of Materials Science and Engineering, University of NSW, was awarded the Academy of Science's 2010 Ian Wark Medal and delivered the 2010 Ian Wark Lecture in August at UNSW.

Professor Yu, who is NSW Division secretary, is acknowledged as a world-class researcher in the area of particle/powder

technology, especially particle packing, particulate and multiphase processing and the simulation and modelling of particulate systems.

His research has greatly expanded the scientific knowledge base and been applied extensively.

His work has brought significant economic benefits to the Australian and international minerals, metallurgical, chemical and materials industries, particularly in steel and coal.

## Fellows interviewed by Academy of Science

Two ATSE Fellows, Dr Jim Peacock AC FRS FAA FTSE and Dr Roy Woodall AO FAA FTSE, have been interviewed for the Australian Academy of Science's (AAS) 'Interviews with Australian scientists' project.

Their interviews are the latest in a series of discussions, including many with Fellows of both Academies, which are posted on the AAS website.

Over his career Dr Peacock has been a leader in introducing new molecular biological techniques to Australian plant science. In addition to his original research he has had extensive industry involvement through companies such as Gene Shears, GrainGene and the High Rainfall Zone Wheat Company. Dr Peacock has also been a fervent champion of science education in schools and public awareness of science.

Dr Woodall has made a significant impact on Australian mining exploration and science in his career with the Western Mining Corporation (WMC). He began working for WMC during his university summer 'holidays' and upon graduation accepted a position with WMC. Dr Woodall briefly left Australia to complete his Masters at the University of California, Berkeley. When he returned he rejoined WMC and went on to lead the teams which, among other things, made the remarkable discoveries of the Kambalda nickel field and Olympic Dam copper-gold-uranium deposit.

Transcripts at [www.science.org.au/scientists/index.html](http://www.science.org.au/scientists/index.html)

# Herding Cats launch a "home crowd" event

ATSE Fellow and former CEO of CSIRO Dr Geoff Garrett, played to a "home crowd" when he launched his recent book in Melbourne in August.

With Sir Graeme Davies, University of London Vice Chancellor, Dr Garrett has authored *Herding Cats: Being advice to aspiring academic and research leaders*, which addresses the "special challenge of leading and managing" in an academic or research institution.

The book was officially launched at the University of Melbourne by Vice Chancellor Professor Glyn Davies before Dr Garrett addressed a crowd of friends and colleagues that included a number of ATSE Fellows – Professor Robin Batterham, Peter Laver, Charles Allen, Professor Frank Larkins, Professor Richard Larkins, Dr Colin Adam, Dr Calum Drummond and Dr Ziggy Switkowski.

Fellows acknowledged in *Herding Cats* include Professors Michael Barber, Robin Batterham, Paul Greenfield, Peter Hoj, Richard Larkins, Gus Nossal, Alan Robson, Margaret Sheil and Doctors Ramesh Mashelkar, Graham Mitchell, Jim Peacock, Ron Sandland and Alex Zelinski.

*Herding Cats* is described as a "long-awaited guide for anyone grappling with such a challenge" and enjoys supportive comments from Fellows Professor Ramesh Mashelkar and Professor Sir Gus Nossal (see review, page 45).

## ATSE will host AusSMC Board meeting

ATSE will host the 30 November 2010 meeting of the Board of the Australian Science Media Centre (AusSMC) at the National Office in Melbourne, as part of its ongoing sponsorship of the centre.

Two Academy members serve on the Board – Dr Graham Mitchell AO FAA FTSE, Chief Scientist, Victoria (Deputy Chair) and Mr Graeme Liebelt FTSE, Managing Director and CEO, Orica.

There are nine Academy Fellows on the Centre's Science Advisory Panel:

- Professor Peter Andrews AO FTSE, Queensland Chief Scientist;
- Professor Snow Barlow FTSE, School of Agricultural and Food Systems, University of Melbourne;
- Professor Robin Batterham AO FREng FAA FTSE, President of ATSE;
- Professor Lyn Beazley FTSE, Chief Scientist of Western Australia;
- Professor Adrienne Clarke AC AAA FTSE, School of Botany, University of Melbourne;
- Dr Cathy Foley PSM FTSE, President, Federation of Australian Scientific and Technological Societies
- Emeritus Professor Ian Lowe AO FTSE School of Science, Griffith University and President, Australian Conservation Foundation;
- Emeritus Professor Nancy Millis AC MBE FAA FTSE, Department of Microbiology, University of Melbourne; and
- Sir Gustav Nossal AC CBE FRS FAA FTSE, Department of Pathology, University of Melbourne.

## Milestone steps in Cloud Computing

The ATSE Cloud Computing Working Group's summer internship program for graduate and undergraduate students was concluded in September, when prize-winning intern Jinhui Yao, from Sydney University, presented his internship report.

He presented his report as part of the Basser Seminar Series at the University of Sydney, discussing the research he did as an intern at CSIRO ICT Centre, Sydney, on accountability as a service in cloud computing – for which he won his \$1000 prize, presented at the seminar.

The Working Group called for internship proposals advocating novel applications of computing clouds, answering the question – how could a cloud platform be used to solve a previously intractable problem or to deliver services in a new and scalable way?

The internships were provided and supported by Australian National University/

NCI, Australian Research Collaboration Services (ARCS), CSIRO, IBM, Monash University and the University of Adelaide.

## Andrew Holmes on AAS Council

Professor Andrew Holmes AM FRS FAA FTSE, Laureate Professor of the School



Andrew Holmes

of Chemistry at Melbourne University, is the new Foreign Secretary of the Academy of Science and a member of AAS's Council Executive Committee.

He was a 2004 ARC Federation Fellow and inaugural VESKI Fellow at the Bio21 Institute and at CSIRO Molecular and Health Technologies. He has been an ATSE Fellow since 2006.

Professor Chennupati Jagadish FAA FTSE, ARC Federation Fellow and Distinguished Professor, Department of Electronic Materials Engineering, Research School of Physics and Engineering, Australian National University, is a new member of the Council (Physical Sciences). He joined ATSE in 2002.

Also joining the Council in Physical Sciences is Professor Yiu-Wing Mai AM FAA FTSE, University Chair, Professor in Mechanical Engineering and Director, Centre for Advanced Materials Technology, School of Aerospace, Mechanical and Mechatronic Engineering, University of Sydney. He has been a Fellow since 1992.

Professor Oliver Mayo FAA FTSE, Honorary Research Fellow, CSIRO Livestock Industries, South Australia – a Fellow since 1994 – remains on the Council and is a national committee member (history and philosophy of science).

ATSE Fellows on AAS national committees include Dr Errol McGarry FTSE and Dr Robedrt Watts FAA FTSE (Chemistry); Dr Neil Williams PSM FTSE (earth sciences); Professor Scott Sloan FTSE (mechanical sciences); Dr Cathy Foley FTSE and Professor John O'Connor FTSE (physics); Dr TJ Higgins FAA FTSE (plant and animal sciences); and Professor Michael Tobar FTSE (radio science).

# AUSTRALIA 2030

Photo: iStockphoto

## Meeting demands for effective infrastructure and services

**Theme:** PLANNING FOR THE FUTURE

The Seminar – organised by the Australian Academy of Technological Sciences and Engineering – will cover population changes, the economy, health, societal adaptability, energy, food, water, housing and infrastructure.

**Speakers:** Professor Ross Garnaut, The University of Melbourne and ANU

Mr David Murray, Chair, Future Fund Board of Guardians

Dr Shaun Larkin, Managing Director, HCF

Emeritus Professor Cliff Hooker, University of Newcastle

Mr John Howarth, Executive General Manager, Transmission Services, AEMO

Dr Geoffrey Annison, Deputy Chief Executive, Australian Food and Grocery Council

Mr Ross Young, Executive Director, Water Services Association of Australia

Ms Cate Collins, Head of Sustainability, Lend Lease Asia Pacific

Mr David Singleton, Chair, Global Infrastructure Executive, Arup Group

**Session chairs:** Professor Mary O’Kane, NSW Chief Scientist and Engineer  
Professor Robin Batterham, President, ATSE

**Date:** Thursday 11 November 2010 – 9.30am to 6.00pm

**Venue:** Industry and Investment NSW, 47th floor MLC Centre, Martin Place, Sydney

**Cost:** \$325 registration prior to 15 October 2010; \$365 registration after 15 October 2010;  
\$265 (ATSE Fellows)

**Register:** Contact ATSE on 03 9864 0900 or [events@atse.org.au](mailto:events@atse.org.au) for information.  
Online registration at [www.atse.org.au](http://www.atse.org.au)



# GLOBAL FOOD FUTURES

**UQ's Global Change Institute (GCI) is scoping programs of research and engagement that address the challenges of global food security.**

By 2050, globally there will be over 9 billion people to feed – requiring an additional 50–100% increase in current food production. Given the effects of climate change, water shortages, reduced availability of arable land, and the diversion of food crops to biofuels, biochemicals and bioenergy, food security is a firm priority on national and international agendas.

In September, the GCI held a public forum to give the community an opportunity to hear from international experts and participate in discussions.

This forum and subsequent workshop explored a range of issues relating to food security in a national, wider regional and global context, including climate change, distribution, natural resources, technologies, food systems, commodities markets and trade arrangements.

The GCI is working towards identifying ways to achieve a major alleviation of global hunger both now and into the future.

UQ consistently ranks among the world's top universities\* and attracts over 4000

people annually from around the world to pursue research higher degrees (RHD).

Be part of UQ's innovative research culture and apply for RHD admission and scholarship with just one form, any day of the year.

Visit [uq.edu.au/grad-school](http://uq.edu.au/grad-school) for detailed application advice.

*\*UQ has been named in the top 50 universities in the world for the fifth year running in the UK's 2009 Times Higher Education-QS World University Rankings.*