EXCELLENCE

GROUP OF EIGHT
AUSTRALIA

IN INDIA

collaborative research from Group of Eight (Go8) and Indian researchers
Foreword from the Minister

Senator the Hon. Simon Birmingham

This publication celebrates the rich and diverse research ties that exist between Australia and India. *Excellence in India* highlights the strength of the collaboration between our two countries and recognises the accomplishments of our researchers.

The collaborative research in the five key areas of agriculture, water, clean energy, infrastructure, health and medicine acknowledges the shared challenges both countries face. The work documented in this book demonstrates that learning together is a sure way to address our mutual challenges.

In India we have found an ideal partner and we will always welcome collaborative arrangements with India’s best and brightest researchers and students.

Collaborative education and research underpins Australia’s strong relationship with India. And there are many more opportunities for us to work together; to deepen our research links with an important trading partner.

We are proud of our reputation for undertaking high quality research. We want to establish partnerships with countries that share the same goals. In India we have found an ideal partner and we will always welcome collaborative arrangements with India’s best and brightest researchers and students.
Collaborative education and research underpins Australia’s strong relationship with India. And there are many more opportunities for us to work together; to deepen our research links with an important trading partner.

Collaborating with other countries is valuable for Australia. When researchers and students travel to, and from, Australia to share knowledge and learn from each other, they generate scientific and commercial benefits for both countries. These bilateral links create networks that not only resolve joint challenges but they also build cultural understanding and mutual respect among peers.

I extend my congratulations to the Australian and Indian researchers responsible for these compelling research activities. They are excellent ambassadors for Australia and India. They have blazed a trail of research excellence that I am sure will be followed by subsequent generations.

My congratulations also to the Group of Eight for creating this wonderful publication. It demonstrates the rich and valuable research that is benefiting both our countries.

**Senator the Hon. Simon Birmingham**
Minister of Education and Training
I am delighted that Australia’s elite Go8 group of universities has taken this important initiative to document success stories in scientific collaboration between some of the finest educational institutions in India and Australia.

Over the past few years, we have seen a transformational shift in India’s relations with Australia. We have moved beyond traditional references to cricket, curry and the commonwealth and our conversations now encompass defence and security, trade and investment, river basins and water management, agriculture and animal husbandry, smart cities and urban development, culture and tourism, and of course, education and research.

Confluence, a Festival of India in Australia included 72 events that spanned seven cities over a three month period and is being regarded as one of the largest festivals that any country has organised in Australia.

The educational sector represents one of the most dynamic segments of our growing relationship with Australia and while we often mention the presence of 60,000 Indian students in Australia as the key metric, I personally regard the growth in joint PhD degrees and the quality and spread of joint research projects as an even more important element.

The studies in this publication seek to address some of the challenges faced by India and other developing countries in numerous fields ranging from the environment and climate change to healthcare and agriculture. One of the studies looks into the novel aspect of control of insects by the crop plant itself and thus restricts the usage of pesticides. Another study explores...
We have moved beyond traditional references to cricket, curry and the commonwealth and our conversations now encompass defence and security, trade and investment, river basins and water management, agriculture and animal husbandry, smart cities and urban development, culture and tourism, and of course, education and research.

The possibility of chickpeas with stress-tolerant genetic makeup and has sought to uncover the mechanisms by which these chickpeas maintain higher yield when faced with soil salinity, drought, or heat. Yet others look at management of diabetes and hypertension, providing access to clean water, handling e-wastes. Many of these have the capacity to impact the lives of real people in ways that will bring out the best of our two societies. ‘Excellence in India’, I am sure, will have an equally profound impact on the Australian scholars and universities engaged in these projects.

My sincere compliments to Go8 and best wishes to all scholars and researchers involved in this impressive list of projects. May they inspire many others to follow suit.

Mr. Navdeep Suri
High Commissioner
The Group of Eight Universities (Go8) comprises of Australia’s leading research intensive universities. At the Go8 we are exceptionally proud of our high global rankings which are testament to the quality of the research we carry out.

In fact, all of our research - some $6 Billion each year - is classed as world class standard or above.

But the pride in our research is about far more than the global rankings it helps Go8 universities achieve.

Go8 universities are always keen to partner with overseas institutions and their researchers. The research examples we have selected to showcase “Excellence in India” are all Go8 research collaborations between our two countries.

Our pride is more about the worth of our research, its impact; the lives it helps save, the debilitating diseases it helps conquer, the living conditions it eases, the infrastructure it builds, the local economies it assists so ably around the world.

This publication is a proud window on some of the work that Go8 researchers have been carrying out, and through that work “Excellence in India”.

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The research examples we have selected to showcase “Excellence in India” are all Go8 research collaborations between our two countries.

The Go8 looks to a future of increased collaboration and ever stronger research results.

Vicki Thomson
CEO
Defending against diarrhoea with safe water

The gene search to help save children’s sight

Visually acceptable coastal barriers to deal with the storm surges of our changing climate

A fast-changing India seeks new rice production systems

Protecting wheat crops from rust

Biogas from bovines

Crop plants that defend themselves against their own insect pests

Kerala Diabetes Prevention Program

High average rainfall but fresh water shortage for Darjeeling

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Defending against diarrhoea with safe water

Diarrhoea is a leading cause of death and disease globally. Ninety per cent of diarrhoea-related deaths annually are due to unsafe water, inadequate sanitation and poor hygiene.

In India, diarrhoea is the third most common cause of death in children under five, killing an estimated 300,000 children each year.

To reduce the high incidence of diarrhoea in India, cost-effective and sustainable interventions are crucial. One such intervention is Riverbank Filtration (RBF). RBF is a low-cost technology which uses a natural, auto-regenerative purification process. It can substantially reduce contaminant levels to improve drinking water quality.

This project investigates the effect of improved water quality via piped RBF water supply to four rural communities in Karnataka, India.

To date, 2371 households have been recruited for the study. All have received hygiene awareness and household water storage education, and completed the first (baseline) of six health and water-usage surveys.

RBF wells have been constructed in all four villages and a piped distribution system is currently being installed in each village. Health and water-usage data will be collected following completion of pipework and supply of river water to the villages. This is scheduled for November 2016.

The remaining four surveys will be administered quarterly during 2017 as each village is progressively supplied with RBF-treated water. The project is scheduled for completion at the end of December 2017.

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Project outcomes will quantify the incremental health benefits of filtering water, over and above those health benefits that result from increasing water quantity and providing hygiene education. Together with a cost evaluation, the project will allow the Indian Government and non-government agencies to evaluate the merits of addressing different aspects of water supply and intervention strategies to reduce diarrhoea and other diseases.
Preventing childhood blindness in India from primary congenital glaucoma (PCG) led to a joint research project between Australia and India which has been further progressed by the University of Western Australia (UWA).

PCG is a severe genetic disorder where the affected child carries two mutated copies of the responsible gene, one inherited from each healthy carrier parent. Onset of the disease is in the first months of life; surgical treatment is of limited success and the disorder commonly leads to childhood blindness.

Although globally relatively rare, PCG incidence appears to be higher in some parts of India at one in every 3000 live births and exceedingly high in some Roma/gypsy populations – at one in 250 births in Slovakia.

The best approach to PCG prevention is genetic testing, however that requires knowledge of the molecular basis of the disease. To date this has been problematic as the disease has a diversity of genetic mutations that account for only a small proportion of cases. The genetic basis of the remaining cases is still to be identified.

The overall aim of the research project was to contribute to understanding PCG genetics based on the common history of the two affected populations in the study. At the outset, there was one single gene (CYP1B1) known to be involved. It accounts for just a fraction of cases globally and for 30 per cent in gypsies and 20 per cent in Indians.

During the project, a second PCG gene (LTBP2) was discovered which harbored an ancestral gypsy mutation shared with patients from the Indian subcontinent (Pakistan). It was shown to be responsible for another 30 per cent of gypsy PCG cases but only a very minor proportion of patients in India.

A third novel gene, TEK, which was recently identified in a large international study in which UWA was also involved, revealed a different pattern of inheritance, (a single TEK mutation can cause PCG), plus variable severity and a large proportion of cases with unilateral glaucoma.

The research indicates that the molecular basis of primary congenital glaucoma requires an individualised approach to each patient and family. The rapid development of new genetic technologies will make this possible in the foreseeable future.

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Visually acceptable coastal barriers to deal with the storm surges of our changing climate

With storms, storm surges and other extreme weather events predicted to increase with global warming and sea level rise, more effective ways of protecting coastal infrastructure are required that do not affect the visual amenity of coastal areas.

Australian and Indian researchers are working together to better understand and advance the design of the more visually acceptable, and, importantly, less expensive porous barrier breakwaters that could reduce the effects of these weather and ocean events that are so problematic to both countries.

This project is using experimental wave tank modeling in Mumbai and computational modeling in Melbourne to predict the forces on porous barriers of different wave types.

Under normal coastal conditions, porous barrier breakwaters can be suitable. Their use is effective where some transmission of wave energy through a breakwater is acceptable, or even desirable. This is common in marinas, within a larger harbor area to allow the passage of some wave energy and water volume so that water quality is maintained or in channels where bow waves from ships can interfere with navigation if completely reflected from solid channel barriers.

Currently the hydrodynamic characteristics of porous barriers are not understood for waves that are typical of coastal area shallow water. This project is using experimental wave tank modeling in Mumbai and computational modeling in Melbourne to predict the forces on porous barriers of different wave types.

The effect of barrier porosity, thickness and how far it has been submerged are of particular importance.

The data is providing important information on the techniques for measurements of “cnoidal waves” that are the most common form of shallow water wave that impacts coastlines.
Recent work has also shown that an effective barrier can be made using a number of different porous plates, appropriately spaced. This could mean the possibility of a barrier that has different transmission properties depending on which side the wave approaches from; at the same time as ensuring environmental flows to maintain water eco-systems.

This research project will feed into structure design guidelines and inform engineers when these structures could be used and in what way. Where they can be used the benefits are obvious as they cost less, are more visually acceptable and can be moved/removed more easily.

**Figure:** Computer simulation of a solitary wave impact on a porous barrier, showing partial reflection and partial transmission of the wave. The total wave energy is dissipated during the impact.

**RESEARCHERS**

**Prof. Murray Rudman**
Monash University

**Prof. Balaji Ramakrishnan**
Indian Institute of Technology Bombay
A fast-changing India seeks new rice production systems

Rice is the staple food of India

In India’s Indo-Gangetic plains (a 225 million hectare fertile plain that covers most of the north and east of India), it is sown traditionally and principally by hand-transplanting in fields that have been puddled (wet cultivation), but puddling degrades soil structure and requires a large amount of water and energy.

A fast-changing India has been affecting the continued use of this traditional method which worked well for many years when farm labour was abundant and relatively cheap. However, farm labour in India has been moving to work in industry where wages and work conditions are superior.

A joint India Australia research project has been underway to develop rice production systems that conserve India’s labour, energy and water. Direct seeded rice (DSR) which has been used in many countries for rice production was considered one useful alternative.

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Rice farmers have been financially squeezed by matching the rapidly rising labour costs and they are also coping with a rapidly declining ground water table as a result of over-exploitation of underground aquifers. This is impacting the sustainability of irrigated agriculture on the plains.

Machine transplanted rice (MTR) was another production system that was investigated in-depth. Both DSR and MTR systems were found to produce equivalent rice yields to the traditional puddling method and at a much lower production cost. With DSR it was possible to reduce irrigation by 25 per cent without reducing yield.
As expected, weeds that would have been suppressed by puddling, infested rice crops when different methods were used.
But there was another problem to solve.

As expected, weeds that would have been suppressed by puddling, infested rice crops when different methods were used. The research project identified several new herbicides which would provide effective weed control, and registered them with local authorities for use.

The first phase of the research project was able to develop a complete production package for DSR on the plains. The follow-up three-year extension phase has been used to train Indian research personnel on DSR. The project team also undertook a multi-year survey to document farmer experiences with DSR. Farmers supported previous research, reporting the similar yield potential of DSR and PTR and large savings in labour and water in DSR.

Many farmers are continuing to adopt DSR in this region. As a result of the project Punjab government 2015 statistics showed that DSR was being used on 160,000 hectares of local farms.
They can decimate global wheat production, so the three rusts of wheat are among the world’s most feared plant pathogens.

Rust epidemics, particularly stripe (yellow) rust which is the most damaging world-wide, have extended their footprint in recent years into warmer areas where historically rust was not problematic. This has been caused by an unprecedented adaptation of the stripe rust pathogen to warmer temperatures and a general ability of the pathogen to cause more disease more quickly.

Crop control of rust is achieved by either fungicides or genetic resistance. Using gene technology is by far the most economical and environmentally sound approach, and has been the focus of a collaborative research program between Australian and Indian scientists.

Indian and Australian researchers have been working collaboratively to uncover ways to broaden stem rust resistance, and are now focussing on stripe rust resistance. These efforts have already resulted in new stem rust resistance genes being identified, one of which is effective against a broad range of rust strains.

Rust resistance genes have now been transferred to two Australian and two Indian wheat backgrounds. The research is a critical step in assisting to future proof a key component of food supply in both countries.
LEAD RESEARCHERS

Prof. Robert Park
University of Sydney

Dr. Vinod Prabhu
Indian Agricultural Research Institute
Biogas from bovines

The search for available, cheap and environmentally acceptable fuels for use in developing countries has led Australian and Indian researchers to focus on India’s large bovine population – specifically the manure those bovines generate.

The manure produced is capable of providing biogas - a mix of methane and carbon dioxide - for use in villages for heating and cooking. But importantly the biogas can also be converted to enable its sale for direct delivery into natural gas pipelines. This is done by removing the carbon dioxide to produce high quality methane.

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A research project was undertaken between the University of Melbourne’s Clean Energy Laboratory and the CSIR’s Indian Institute of Petroleum (IIP) to develop a cheap and easy-to-operate technology for enriching biogas so that it can be sold into the pipelines.

A technology was developed (called CO2VSA). It enriches a 50/50 mixture of carbon dioxide and methane into a plus 99 per cent methane purity. It uses absorbent materials (acting like porous sponges) to soak up the carbon dioxide from the mixture, releasing pure methane. A pressure reduction then allows the captured carbon dioxide to be released and used for other purposes (eg greenhouses).

The absorbent materials are then ready for re-use. The materials were developed at the University of Melbourne and the process was developed at the CSIR Indian Institute of Petroleum. The process is cheap to build and easy-to-operate.

It has strong potential for use in India and other developing countries. In the next phase of the project which is currently underway, the Indian Institute of Petroleum is building a bio-digester to produce biogas and a CO2VSA unit to enrich the biogas and pipe it to the cafeteria at IIP for use in their cookers.
LEAD INVESTIGATORS

Prof. Paul Webley
University of Melbourne

Mr Bal Mukund Shukla
Indian Institute of Petroleum
Crop plants that defend themselves against their own insect pests

As part of the global movement to remove toxic sprayed insecticides from the agro-environment, Australia/India research is now taking caterpillar resistant cabbage and cauliflower plants that its team has developed, forward toward commercialisation in India.

The research team also aims to add aphid control for use in India in cabbage and cauliflower, and for canola pest control in Australia. A number of aphid species are major disease transmitters for crop plants in the Brassica family (which includes cabbage, cauliflower, brussel sprouts, canola, kale and broccoli).

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The technique involves putting short DNA sequences into plants which will generate RNA molecules. When the insect (aphid in this case) sucks the sap of the plant it picks up the complementary RNA, which binds to the aphid RNA (rather like a Velcro strip) in a process that inactivates the gene and either kills or incapacitates.

The most novel aspect of the ongoing research project has been to attempt control of the insect by the crop plant itself, using RNA interference (a process which turns off or silences vital genes in the insect pest) and to add this to the already developed biotechnology system for caterpillar control.

The team has identified multiple aphid gene targets for RNA interference. Both caterpillar and aphid control are major priorities in these crops in India and Australia and there is a great deal of preliminary interest from seed companies in taking any breeding lines developed, forward to eventual commercialisation.
LEAD RESEARCHERS

Prof. Prem L Bhalla
University of Melbourne

Dr. Raj Kamal Bhatnagar
International Centre for Genetic Engineering and Biotechnology
Diabetes affects more than 70 million people in India, so is a major public health problem.

The Kerala Diabetes Prevention Program (KDPP) is a successful community-based lifestyle intervention program for the prevention of diabetes in India.

In collaboration with the University of Melbourne, KDPP was implemented and comprehensively evaluated by a research team at the Sree Chitra Institute in Trivandrum, Kerala, India with support from an international expert advisory committee with experts from Finland, USA, UK, Australia and India.

The trial included more than 1,000 people aged 30–60 years who had been assessed as at high risk for developing diabetes in 60 rural communities in the Indian state of Kerala. These high-risk individuals were identified using a simple and low-cost screening tool. The 60 communities were randomly allocated to receive either KDPP or “usual care”.

The lifestyle intervention program was delivered by trained lay peer leaders for 12 months. The intervention involved increasing physical activity, promoting healthy diet, stopping tobacco use, reducing alcohol use, improving sleep and reducing stress; and the program was extensively culturally adapted from well-evaluated programs undertaken in high-income countries.

Factors relevant to development and implementation of diabetes prevention programs in resource-constrained settings, such as India, have been understudied. Therefore, the research’s purpose was to develop, implement and evaluate a scalable community-based model for the disease’s prevention.

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Those receiving the program also participated in more social activities such as yoga sessions, working in kitchen gardens and walking groups. Those in the control arm received education materials to prevent diabetes. After 12 and 24 months, the lifestyle intervention was able to reduce tobacco use and alcohol use, improve blood lipids and reduce diabetes incidence in those at highest risk as measured by blood glucose levels.

Given the successful implementation of this program, KDPP is now being more widely implemented in India.

In collaboration with the University of Melbourne, KDPP was implemented and comprehensively evaluated by a research team in Sree Chitra Institute in Trivandrum, Kerala, India.

LEAD RESEARCHERS

Prof. Brian Oldenburg
University of Melbourne

Prof. Kavumpurathu Thankappan
Sree Chitra Tirunal Institute for Medical Sciences and Technology

Excellence in India
Water crises are spreading across the length of South Asia at an alarming rate, and some of the pockets of stress include unexpected locations such as Darjeeling, West Bengal, where rainfall is plentiful. What is often left out of the picture is the high levels of water wastage that are all too common.

Dr. Georgina Drew of the University of Adelaide has been exploring the problems of post-colonial water management in the former British hill station. Darjeeling is now a rapidly growing township best known for its tea plantations. Despite its high average rainfall and abundant springs, fresh water is in short supply. Dr. Drew is primarily concerned with how water issues affect communities, the causes in a growing number of village collectives that self-organise to access and manage water - samaj.

The samaj have a distinct character based on the histories of colonial neglect that prompted villages throughout the Darjeeling region to solve socioeconomic problems independently of centralised systems. The research discussion overlaps the numerous resource pathways with the plethora of social and political organisations operating in Darjeeling to argue that to find a solution the municipalities would do well to harness the varied ways in which water flows through the township.

Integrated within larger questions of sustainable development in India’s urbanising townships, Dr. Drew’s research offers a glimpse into the possibilities for more holistic and equitable water management.

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Darjeeling has had a functional water supply system for 80 years but many people have been left out of this distribution system and forced to fend for themselves. This has resulted in a growing number of village collectives that self-organise to access and manage water – samaj.
Interview with Dr. Georgina Drew

For Dr. Georgina Drew of the School of Social Sciences at the University of Adelaide, her research in India on “the anthropology of water” is as much about her love affair with that nation and its people, as assisting a better understanding of the cultural and religious politics of water resource use and management there.

An American researcher currently based in South Australia, Dr. Drew was first invited to India in 2004. “I spent 10 months there initially,” she says. “I know some people find it overwhelming but I felt an immediate connection and was comfortable. It was so layered in history. People were very inviting which made the process all the more engaging. Now it is my research focus.”

“I have a focus too on how it affects the lives of women – women whose everyday lives are controlled by being left to shoulder the burden of finding water for their family while their husband works.”

Dr. Drew’s work fits within the fields of environmental anthropology and the critical anthropology of development. Although her research began predominantly in India’s rural areas, she is now also working on projects in urban areas that are often bereft of basic access to clean and legal drinking water apart from an occasional and rationed truck delivery.

She is dealing with the anthropology of a plethora of issues and their effects – “there is no dearth of challenges,” she says. “The effects are widespread. There are droughts that can severely affect some 330 million people at any one time as was recorded in April 2016. That is a high number for those in western nations to get their heads around,” says Dr. Drew. There are several drivers of this distress – polluted rivers; a lack of clean ground water; depleted water tables meaning wells that are drying up; and a climate change effect that is ensuring a fast-changing pattern of monsoonal rains which now can fall in different areas and at different times to that which have been the historical norm.

“Too little or too much at once, and not where and when those rains are expected makes it much harder to store and manage those rains,” she says. “This means water wastage in a nation that cannot afford to lose any water.”
All these issues come with the overlay of irrigation problems for farmers that affect critical food supplies. These farmers have to work through how best to harvest water, often without much-needed infrastructure, in ways that can be sustainable for the long term. There is also the problem of interpreting, and addressing, the deleterious effects of large industry on the populous nation’s fragile water supply.

The effects of large industry on water supply in India is a complex area. “Multinationals come to India and they make huge investments. Their heavy machinery then uses huge amounts of water,” says Dr. Drew. “The Indian Government has now become much more interested in ensuring corporate social responsibility from those companies. India needs the industrial investment but it also needs to protect its people’s health and livelihoods. Water is all important.”

Dr. Drew says there are so many examples of what a lack of water, or difficulty sourcing water, is doing to families. “We know there is a high rate of farmer suicide when crops fail because of water issues. So many gender issues are created by water in this wonderful country,” says Dr. Drew. “I have a focus too on how it affects the lives of women – women whose everyday lives are controlled by being left to shoulder the burden of finding water for their family while their husband works.” As a result, they are unable to do anything else but source water. They are controlled by water needs – from a polluted river to a water truck they never know when to expect. That is the narrow scope of their lives. No opportunity to do anything else.

“Then in the mountains men leave their families to find work as contract labourers in the Gulf States. Their wives are left with every responsibility for their family. They do everything but plough. Water needs, food needs, walks of three and four hours to find fodder. It is a limiting and hard existence.”

Dr. Drew heads back to India in 2017 to advance a multi-year project on the cultural politics of urban rainwater harvesting. The project is funded by a fellowship from the Australian Research Council and it aims to identify the promise and pitfalls of rainwater collection and reuse in megacities such as New Delhi. Dr. Drew aims to use this research to inform, and improve, policy.

Dr. Georgina Drew
University of Adelaide

“India needs the industrial investment but it also needs to protect its people’s health and livelihoods. Water is all important.”
Researching the right drug to look after the baby during pregnancies complicated by gestational diabetes

Gestational diabetes (GDM) is a form of diabetes that occurs during pregnancy. It is a worldwide problem and predicates the subsequent development of glucose intolerance in affected women as well as in their child. This builds the pandemic of Type 2 diabetes (T2DM), with major impacts in the Indian subcontinent and Asia.

Treatment of women with GDM is based on restoring normal blood glucose levels. This has been shown in two large randomised trials from Australia and the USA, to improve pregnancy outcomes both for the woman and for her fetus. Research has been undertaken to identify if the oral drug metformin can be used instead of insulin in pregnant women. This is especially important for India – it’s far cheaper, easily available, and it can be taken easily by the patient and without requiring storage refrigeration.

Affected women, who do not respond to lifestyle changes in diet and exercise, are offered drug treatment. The naturally occurring hormone for glucose control is insulin, which has been available for many years. However, it remains relatively expensive, is given by injection and needs to be stored carefully in a cool environment.

Metformin is a well-established and effective treatment for those with T2DM, and with a good safety record. However, as a small molecule, it crosses the placenta, so that to use it during pregnancy demands careful assessment of the risks to the fetus, both in the short and the longer term.

However, as a small molecule, it crosses the placenta, so that to use it during pregnancy demands careful assessment of the risks to the fetus, both in the short and the longer term.
New Zealand and Australian researchers combined forces to carry out the Metformin in gestational diabetes (MiG) study and demonstrated metformin to be a safe and effective treatment, performing as well as insulin for pregnant women. It showed no serious fetal or maternal risks. There were no major differences at birth between the two groups of children.

Subsequent and ongoing follow-up studies of the children were performed in consultation and collaboration with researchers in India. No major differences have been shown to date in the growth or development at up to seven years of age of those exposed to Metformin, over and above what might be expected in children of mothers treated with insulin.

It appears, therefore, that Metformin has a reasonable safety record for use in pregnant women with gestational diabetes. The research data supports its use for treatment of women with GDM in income-poor countries such as India, as well as in indigenous communities and in rural Australia.
Understanding the Indian and Australian monsoons

The Indian and Australian monsoon systems affect approximately a quarter of the world’s population. So understanding the reasons for the large year-to-year variations in monsoon strengths is of major scientific and societal interest.

Teams of researchers from the University of New South Wales and the Indian Institute of Tropical Meteorology have worked together as part of an Australian Government funded ARC project to better understand and simulate monsoons using numerical models. Armed with this knowledge it should be possible to make more accurate forecasts of what the next monsoon season is likely to bring, and how monsoon characteristics might change in the future as the planet warms – information that would greatly benefit the planning of local farmers and other resource managers.

The first stage of the project examined the link between the Indian and Australian monsoons. Often a strong Indian monsoon is followed by a strong Australian monsoon six months later, which is subsequently followed by a weak Indian monsoon in the next year. This monsoonal see-saw is referred to as the Tropospheric Biennial Oscillation. Climate models were used to examine whether this behaviour could help predict the strength of the next monsoon, but it was found that while it could indeed help forewarn about the strength of the next Australian monsoon, it didn’t help in predicting the strength of the next Indian monsoon.

Further work looked at the effect of global warming on monsoon strengths. Multiple available climate models were evaluated and those that most realistically simulated monsoon systems were used. It was found that with continued rapid increases in greenhouse gas emissions the rainfall during both the Australian and Indian monsoons would generally increase by between five and 20% during the second half of the 21st century.
A major problem with the current generation of climate models is that they cannot resolve processes that occur on scales finer than a few hundred kilometres. This is a major limitation given that very detailed information at local scales is what is required.

The final part of the project involved the development of a new numerical model that will uniquely be able to simulate small-scale processes in both the atmosphere and the ocean. This is an important step forward as the development of the monsoon depends critically on what is happening in the ocean.

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LEAD RESEARCHERS

Dr. Alex Sen Gupta
UNSW

Dr. Ashok Karumuri
Indian Institute of Tropical Meteorology
Making small wind turbines more efficient will enable them to become a more viable alternative source of energy in areas of India where access to electricity remains a pipe dream.

The aerodynamic efficiency of small wind turbines has been lacking compared with large turbines and this has prevented them becoming a socio-economically valuable resource in developing countries where they could power small communities too remote for power grid extension.

Monash University’s IITB Research Academy in Mumbai has been researching how to overcome the fact that the blades of small wind turbines are inherently unsuited to extracting energy out of low wind speeds. The research tested two designs of aerofoils with four modifications each.

Preliminary tests helped choose the best aerofoil modifications and success has come by slow moving air over the aerofoils being actively moved from their surface - producing more energy. While the active removal of the slow moving air requires energy to be spent, the extra output from the turbine compensates for it.

The positive results indicate an overall aerodynamic output that can be increased by up to 40 per cent on the rotor. The modifications also decrease fatigue over the lifetime of the tower by 80 per cent under standard wind speeds. The significant decrease in tower fatigue means a much longer lifespan, an important cost saving.

The aerodynamic efficiency of small wind turbines has been lacking compared with large turbines and this has prevented them becoming a socio-economically valuable resource in developing countries where they could power small communities too remote for power grid extension.
This research success of increasing efficiency of airfoils will also positively impact other areas for the scientific community. It will contribute to aerodynamics, fluid dynamics, flow control and automatic control areas.

**RESEARCHER**

Jasvipul Singh Chawla  
(PhD project)

**SUPERVISORS**

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The positive results indicate an overall aerodynamic output that can be increased by up to 40 per cent on the rotor. The modifications also decrease fatigue over the lifetime of the tower by 80 per cent under standard wind speeds.
Stroke is one of the world’s leading causes of death and its incidence is rising rapidly in low and middle-income countries. In India stroke services are in their infancy, with few stroke units and virtually no neurologists outside major urban areas, therefore the majority of those with stroke have no access to rehabilitation.

To address this great need, an international collaboration of leading stroke researchers from the UK, India and Australia came together to design a low-cost rehabilitation program designed to be delivered by family caregivers.

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The NHMRC-funded ATTEND trial successfully recruited 1,250 patients (and their caregivers) in a multicentre randomised controlled trial across 14 sites in India. This makes it one of the largest rehabilitation trials ever completed for stroke.

Its results will have a major impact on the future design of stroke care in India and around the world.

The research capacity development of ATTEND has already had far-reaching consequences. Thirty-five full time staff in India were employed for the main phase of the trial, and the success of ATTEND has led to the development of a funded Indian stroke research network.

Australian funding ensured the clinical trial was completed to the highest methodological quality and it has forged important new academic links between the UK, India and Australia.
The research capacity development of ATTEND has already had far-reaching consequences. Thirty-five full time staff in India were employed for the main phase of the trial, and the success of ATTEND has led to the development of a funded Indian stroke research network.
Dealing with the scourge of e-waste – seeking a zero waste recycling approach

It is estimated that 20 to 50 million tonnes of e-waste are generated worldwide every year and e-wastes are growing three times faster than any other forms of urban waste.

In recent years, rapid urbanisation, a general improvement in living standards, increased consumption and the mentality of a “disposable living society” in first world nations has resulted in the generation of unprecedented amounts of waste.

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The generation of waste residues during recovery of precious metals from e-waste, the presence of hazardous lead, waste plastics, and secondary pollution caused by landfilling non-metallic residues are some of the problems associated with recycling e-waste.

This is a novel approach to recover valuable materials from waste printed circuit boards (PCBs) - controlled pyrolysis of e-waste was carried out at high temperatures (750-1550 °C) in an argon atmosphere.

It was discovered that temperatures above 1350 °C were required to completely remove lead and other metals from e-waste and waste residue that was left behind was predominantly composed of carbon.

Further research was carried out on the use of this residue as a carbon source in ironmaking. It was found to be promising. This research has laid the foundations of a ‘Zero Waste’ approach for managing and recycling electronic waste.
LEAD RESEARCHERS

Prof. Veena Sahajwalla
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Prof. Barada Kanta Mishra
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Interview with Professor Veena Sahajwalla

Veena Sahajwalla was a child growing up in Mumbai when she first became enthralled with rubbish. Specifically how someone would pay for the small glass bottles she collected from the massive rubbish dumps and then cleaned. “The circle of rubbish,” she says. “Someone throws it away, someone else sees value and finds a way to re-use.”

That circle has stayed with her. Now Professor Veena Sahajwalla is based at UNSW Australia as Director of the Centre for Sustainable Materials Research and Technology (SMaRT@UNSW), and is a world-leading researcher specialising in “the circle of rubbish”. The Australian Research Council (ARC) is a great supporter of her research and in 2014 she was awarded a Laureate Fellowship.

“My worried but supportive parents would definitely have preferred me comfortable, studying medicine and living at home,” she says. “But I went to an IIT (Indian Institute of Technology) which was academically elite, the best for engineering, but also a great equaliser, attracting students from across society by not costing too much, and where I was constantly being asked as a girl ‘what are you doing here studying engineering?’ I loved it.

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The clever and inquisitive child grew up recognising, from her own childhood experiences, not only the potential for value in rubbish, but its astounding and unacceptable quantity and impact on a city of 18.4 million people that was also home to the largest dumpsite in Asia. She passed over the “more acceptable for a girl at that time” study of medicine, and instead left home to study engineering.

That first step away from home was also the start of a global journey that has ended in Sydney.

After a Masters attained in Canada, and a PhD from the University of Michigan, Veena was lured to Australia by a research position at CSIRO. She has stayed, enamoured by the Australian way of life, its embedded academic freedoms, a willingness to give academics the opportunity
“Waste has value,” she says. “You just have to find the best way to use it to help society.”
Australia and India share heat, drought and salinity

These shared crop stresses must be overcome to ensure premium crop harvests and one crop production impacted by such climatic stresses is chickpeas.

India is the world’s largest chickpea producer at almost nine million tonnes, while Australia is now the second largest producer at almost one million tonnes. India is also Australia’s largest chickpea export market. In the final quarter of 2015, some 80 per cent of Australia’s chickpea production was exported to India.

The collaborative research identified chickpeas with stress-tolerant genetic makeup and has sought to uncover the mechanisms by which these chickpeas maintain higher yield when faced with soil salinity, drought, or heat. Importantly, tolerance of combined stress factors such as drought together with heat, were also assessed.

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The shared climate stresses affecting chickpeas has led to collaborative research. Chickpea yields are being restricted by salinity and drought in Australia and India, and the intense heat of India is an added stress. Improved tolerance of these stresses is a priority for breeding programs. This is particularly relevant when in India chickpeas are often part of a staple diet. Chickpeas are also being consumed in higher quantities in Australia. Here they have been in commercial production since the 1970s.

Identifying those stress tolerant chickpeas will make future breeding easier, albeit within limits for salinity as chickpea is a relatively salt-sensitive species. The research outcomes also have potential benefits to future grain legume production in a changing climate.

In addition to the value of chickpea as a commodity, this legume fixes nitrogen and offers diversification in the cereal-dominated farming systems of both countries, with benefits to wheat crops that follow from residual nitrogen and disease and grass weed management.
LEAD RESEARCHERS

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Panjab University
There are significant barriers to the diagnosis and treatment of high blood pressure (hypertension) in both urban and rural India.

A joint Australia/India research project funded by Australia’s National Health and Medical Research Council (NHMRC) has been undertaken in three diverse rural regions of India to identify and explore the prevalence and awareness of these conditions and to develop appropriate treatment and control. It has also been identifying the barriers to control and developing intervention strategies at individual, health service delivery and policy levels.

Health system barriers to managing the disease were also investigated using focus groups and in-depth interviews. An audit of pharmacies at each site to capture availability and cost of medicines in the public and private sector was undertaken to identify opportunities for the inclusion of those in a proposed intervention plan.

At the end of the study’s second year, when most of the baseline surveys were complete, a low cost community-based group intervention that was culturally and economically appropriate for each setting was developed.

The baseline survey had some 14,000 participants from the three study regions who had their blood pressure (BP) measured, together with weight, height, and waist circumference in addition to risk factors, health care utilisation, current medication, socioeconomic position, diet, physical activity, smoking, other tobacco use and quality of life.

Content for the community intervention was driven by the already collected data. This had reflected poor knowledge of hypertension. The community also found it difficult to have their blood pressure monitored as distances to clinics were large.
The educational information developed for the communities was primarily visual imagery, both to ensure consistency of information at each site and to account for disparities in educational levels. Blood pressure was also measured at these meetings so that participants could keep a track of their blood pressure levels.

Content included strategies to increase knowledge and understanding of the disease, promote healthy behaviour change and clinical interaction through goal setting. To deliver the intervention researchers trained Accredited Social Health Activists (ASHAs) about hypertension and about how to educate the population. Major administrative and health policy stakeholders were invited to contribute to the intervention’s development.

As expected, the project encountered differences in the prevalence of hypertension and barriers to its control across the three rural settings. There was also variation in both lifestyle factors and availability of goods and services, including health care services and food variety. We will be able to explore how the variability in lifestyle and services impacts on hypertension and associated health outcomes.

LEAD RESEARCHERS

Prof. Amanda Thrift
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Cotton – eco-friendly support against devastating pest

Cotton is the world’s most important fibre crop, with India the second largest, and Australia the sixth largest cotton producer.

Almost 20 per cent of all insecticide usage worldwide is on cotton and most of this on the attempted control of cotton bollworms which feed on the growing fruit buds, flowers and developing cotton bolls. But bollworms are now resistant to most chemical insecticides and increasingly resistant to genetically modified cotton.

It’s a scenario that threatens to devastate cotton production in both India and Australia. Already cotton crop losses in India due to bollworms are often more than half the yield, with annual losses estimated as USD$300–500 million.

Researchers are developing optimised versions of plant protease inhibitors (PPIs). PPIs are something plants themselves produce in an attempt to fight off bollworms. The aim is to produce PPIs that are more potent than those produced by the plants. By mimicking how cotton plant PPIs work, these optimised PPIs will starve developing bollworm larvae. These PPIs could be used as standalone bioinsecticides or genetically engineered into cotton.

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It is considered essential that a reliable bollworm control solution is found to help secure the future of India and Australia’s cotton industries. A joint research project is currently working on an eco-friendly alternative to the increasingly unreliable chemical insecticides.
LEAD RESEARCHERS

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In an extremely poor area of India – the eastern Gangetic Plains – goats have become the new “feminine asset”. They have been christened “rural women’s banks” and are being raised in very large numbers by women left behind in the remote villages as de facto heads of the household to look after the land, their children and the elderly.

In such poor areas it is the tradition for men to leave home to earn cash incomes, most often in the cities. This “out migration” and what is happening at home while the men are away has been a research project of the Australian National University’s Associate Professor Kuntala Lahiri-Dutt, a leading global expert in critical research on the length and breadth of gender and community livelihoods.

They have serious constraints. Married at an early age, 12 is not unusual, with little or no education their predicament means they have no access to the various schemes that state government ministries have for the improvement of agriculture. But those large numbers of goats being reared in their villages have become their beacon of hope.

The women of the Gangetic Plains have become a symbol of the feminisation of agriculture. They have been left to cope with the daily realities of working in an agriculture dependent on uncertain rainfall, rising input costs and the vagaries of the market in a global economy, and very few own the land they manage.

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Goats are also a symbol of the feminisation of agriculture in a nation where women are more likely to be engaged in agricultural work than men. (Women comprise some 33 per cent of cultivators [farmers with land] and nearly 47 per cent of the agricultural labourers.)
Goats are cheaper and easier than cows to raise and allow women a “critical little economic space” within which to manoeuvre their tiny financial resources and make independent household decisions. Women are buying goats either independently or on a profit-shared basis with other women. These goats can then be reared on limited land with little time or fodder inputs, and the decision to sell them off can be taken by women themselves.

The goat therefore is a symbol as well as a conceptual peg of rural women’s empowerment in the Gangetic Plain, with women reporting positively their feelings of empowerment that this independent process of decision-making and financial results has brought for them.

The growing body of research acknowledges that as farmers, agricultural workers and entrepreneurs women form the backbone of the rural economy in developing countries like India, and yet together with children remain one of the most vulnerable groups.

The research is funded by the Australian Research Council (ARC) and has enabled the Australian Centre for International Agricultural Research (ACIAR) to better understand what programs are required to assist.
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Mumbai to gain invaluable flood risk mapping

Floods are one of the world’s most frequent disasters and Mumbai is a severely flood-prone and densely populated “megacity”. There is an urgent need for effective flood risk management of which the initial step is flood risk mapping.

Australian and Indian researchers have worked together to develop a framework for urban flood risk mapping which has not previously been done in any comprehensive fashion. The study uses Mumbai as its site. It is the first such project to map an Indian “megacity”.

Flood risk maps are a key tool to guide policy development and mitigation planning. They look at hazards - the probability and severity; exposure - the land-use and soil type, and at vulnerability - the inability of the affected population to cope and its susceptibility to damage from the flood.

The mapping exercise is very data intensive; and particularly difficult when trying to generate maps for cities in data-poor developing and under developed countries. This study develops an overarching framework for urban flood risk mapping which has not previously been done in a comprehensive fashion. The framework involves hazard mapping the physical and engineering aspects of flood risk, and combining this with vulnerability mapping that considers the social aspects of flood risk, with both components being given equal importance.

This study is an effort to bridge the gap between various disciplines to create a comprehensive framework. It is a framework that can be then used for any urban region and can be extended to develop flood risk maps under changing climate.
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