



NSW DEPARTMENT OF
PRIMARY INDUSTRIES

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Science and Research Division

Developing integrated research and innovative solutions

Nature and scope of activities

The Science and Research Division undertakes strategic science and research that underpins the growth, sustainability and biosecurity of primary industries in NSW.

The division comprises seven branches:

- Systems Research
- Production Research
- Health Sciences, Strategic Alliances and Evaluation
- Resources Research
- Rural Innovation
- Research Operations
- Science Strategy

Major outcomes achieved

Strong economic performance of primary industries

Alliances (State Plan P6, E3)

NSW DPI seeks alliances with universities and industry bodies to integrate research and develop innovative solutions to pressing problems facing primary industries.

In 2007–08 a full-time, co-funded director, Professor Bob Martin, was appointed at the Primary Industries Innovation Centre, which links the department with the University of New England at Armidale. The centre is focusing on climate change mitigation opportunities for primary industries through the newly established National Centre for Rural Greenhouse Gas Research and will undertake research to pave the way for agriculture and forestry to participate in an emissions trading scheme. To date it has attracted over \$3.6 million in external funding.

At the EH Graham Centre for Agricultural Innovation, an alliance between NSW DPI and Charles Sturt University, the research team is directing their efforts to the challenges and opportunities currently facing dryland and irrigated agriculture in adapting to climate change. Projects dealing with such topics as stubble management, forage conservation, animal parasites, and weed management aim to improve risk management and increase productivity.

Mixed farming systems (State Plan P6, E4)

NSW DPI took part in the national Grain & Graze program that aims to lift profitability and improve biodiversity in mixed farming systems.

As the managing agent we led a series of sub-projects in the Central West/Lachlan region on innovative farming systems with, as project partners, the two local catchment management authorities and three producer organisations. The projects concerned:

- research on pasture cropping and alley farming with old man saltbush
- evaluation of the economic and biodiversity implications of different landscape designs with a view to informing catchment policy on incentive funding
- development of a novel 'whole farm' model for optimising forage supplies in livestock enterprises.

After project completion, we published a series of case studies and fact sheets and conducted training sessions for more than 4000 producers.

The final report on the national program is being prepared.

Market access for citrus (State Plan P1, P6)

Collaborative research by NSW DPI and Agriculture WA on the effectiveness of cold disinfestation at 2 and 3 degrees Celsius has opened market access for Australian citrus in Japan. While importation of 1 degree Celsius-treated citrus into Japan has been allowed since 1996, the new temperatures are easier to maintain and keep the fruit's quality and pest-free status intact. Acceptance of the new disinfestation conditions has the potential to expand annual trade valued at \$18.5 million. NSW DPI will

submit the research data to other countries where Australia is seeking to export citrus, such as China, Taiwan and Korea.

In another project to improve market access, a team from NSW DPI, the South Australian Research and Development Institute and CSIRO recently identified factors contributing to the incidence of post-harvest rind breakdown in navel oranges, a problem that has periodically impacted on returns to growers. The factors identified included both seasonal conditions and on-farm management of tree health and irrigation. As noted in the project findings, there are simple methods already available for improving fruit quality and marketability.

Appropriate access to and wise management of natural resources

National Centre for Rural Greenhouse Gas Research

(State Plan E3, E4)

In February Minister for Primary Industries Ian Macdonald launched the National Centre for Rural Greenhouse Gas Research, which is located within the previously mentioned Primary Industries Innovation Centre at Armidale. The Centre's work will bolster the State's capacity to identify ways to reduce greenhouse gases and have national and international applications.

Researchers at the centre are currently pursuing a number of projects, including:

- long-term regional trials to estimate changes in soil carbon levels under different management practices such as cropping and pasture farming systems. The results will guide NSW farmers in adopting practices that will increase the soil carbon level of their farms and improve farming sustainability. Information from the trials will also be critical if agriculture is brought into the Carbon Pollution Reduction Scheme after 2015
- investigations into the environmental and agronomic benefits of biochar, which locks carbon in soil for potentially hundreds of years and provides significant benefits to soil health. Testing is in progress in over 150 small-scale field plots in northern NSW and there are plans to expand to other areas of the State. Both ABC television and CNN featured stories on NSW DPI's biochar research in 2007–08
- research on reducing methane emissions from ruminant livestock. NSW DPI is increasing scientific and community understanding of methane emissions from ruminants and how these can be minimised. Research has focused on reducing emissions by elimination of protozoa from the rumen environment and genetic improvement of livestock for both lower methane output and improved feed use efficiency.

In February Minister Macdonald also released the Science and Research Division discussion paper, Climate Change Research Priorities for NSW Primary Industries (www.dpi.nsw.gov.au/research/topics/climate-change/discussion-paper). It presents a plain English overview of climate change, its likely impacts, options to mitigate emissions and, importantly, outlines the key research gaps NSW DPI will address over the next few years.

In addition to preparing the discussion paper, the division led development of a broader department-wide strategy to integrate research priorities with socio-economic evaluation, policy

development and training programs for key stakeholders. The strategy links to the State Plan and the national Climate Change Research Strategy for Primary industries.

BioFirst funds collaborative research (State Plan E3, P6)

Under the BioFirst scheme, NSW DPI signed a \$13.5 million collaborative research agreement with two other leading institutions in agricultural biotechnology — the Australian Centre for Plant Functional Genomics and CSIRO Plant Industries. Together we will undertake pre-breeding research on the impact of climate change on wheat and, in particular, canola.

Regardless of how climate change affects current sowing-flowering-harvesting times, plant choice will be important. The research will give breeders a complete understanding of the biochemistry and genetics underpinning flowering, maturity, water use, rate of grain filling, tolerances to heat and frost stresses. It will also increase understanding of the interactions between climate change effects and their influence on grain quality.

The final research theme under the collaborative agreement will be the development of a universal DNA barcode system to identify pests and diseases in Australia, which will improve management of changing agricultural ecosystems. The proposal is to extend and improve the DNA barcoding capacity developed at NSW DPI in recent proof-of-concept studies.

Fisheries resources (State Plan E4)

Staff of the division's Wild Fisheries Program completed the comprehensive report, *Status of Fisheries Resources in NSW 2006–07*. The publication, which is required under fisheries legislation, is the culmination of many individual scientific studies on important species and draws on the results of the commercial fisheries monitoring project. It is available both in electronic format from the NSW DPI website and in hard copy.

International publication on by-catch reduction (State Plan E4)

Boasting a NSW DPI editor and several NSW DPI contributors, the international publication *By-catch Reduction in the World's Fisheries* has a distinctly local flavour. The book, which was published by Springer, Germany covers successful work worldwide on reducing unwanted fish wastage. It should prove a valuable tool for fisheries professionals and lay people interested in this important subject.

Marine pests in Sydney estuaries (State Plan E4)

NSW DPI and the Sydney Metropolitan Catchment Management Authority are studying the likelihood that marine pests will invade Sydney estuaries. The study will identify the high-risk vectors for a suite of marine pests not yet in NSW, but with potential to establish here if they were to arrive, and determine the likelihood that these pests could spread to other NSW estuaries. The pilot risk assessment framework will help improve the design of future surveys and underpin surveillance arrangements.

Seagrass rehabilitation (State Plan E4)

A new three-year research program to develop methods for cultivating the seagrass *Posidonia australis* for small-scale rehabilitation has begun with funding from NSW DPI and the NSW Environmental Trust. *Posidonia australis* (also called strapweed) is susceptible to many human impacts, is slow

growing and has limited natural recruitment. Research will focus on ways of propagating and enhancing growth and survival rates, with the ultimate aim of growing the seagrass in small sandbags which can be deployed in estuaries to help rehabilitate damaged seagrass beds.

Reducing irrigation impacts on fish communities (State Plan E4)

Work recently completed by the Aquatic Ecosystems Unit has shown that each irrigation pump in the Murray-Darling Basin can extract fish at a daily rate likely to significantly impact on fish communities, especially in rivers that have substantial irrigation infrastructure.

NSW DPI will build on these results via a three-year project jointly funded with the Murray-Darling Basin Commission. The project aims to develop protective screens that prevent the extraction of native fish from main river systems. Close collaboration by researchers and irrigators will be essential to ensure sustainable outcomes for all concerned.

Rehabilitation of Moira Lake (State Plan E4)

Under the Murray Darling Basin Commission's 'The Living Murray' program, NSW DPI is investigating lateral fish movements in Moira Lake, a wetland adjacent to the Murray that has suffered immensely from river regulation. Our twelve month rehabilitation program will reinstate natural wetting to the site and guide environmental managers on how best to improve native fish diversity and control of alien species such as carp.

Water management (State Plan E1, E4)

Our ongoing research into efficient water use in the Murrumbidgee Catchment gained wider public recognition when it won the 2007 Eureka Prize for Water Research and Innovation. The research, undertaken by a team from CSIRO, NSW DPI and Charles Stuart University, is establishing a model for identifying water savings and efficient water management in catchments in Australia and overseas.



A research team which included NSW DPI irrigation engineer Saud Akbar (pictured on right) has won the Eureka Prize for Water Research and Innovation for research into water flows in the Murrumbidgee River catchment, the first global catchment assessment of any river in Australia.

River health (State Plan E4)

A comprehensive assessment of inland freshwater fish communities under the Sustainable Rivers Audit is providing important information for monitoring the health of NSW river ecosystems. The second round of sampling commenced in 2007–08 with surveys of the upper Murray and Darling rivers and will yield vital information for the state-wide Monitoring, Evaluation and Reporting Program.

Use of irrigation water and fertiliser in viticulture

(State Plan P6, E1, E4)

NSW DPI researchers developed strategies to optimise water and fertiliser use in vineyards following a three-year program that identified unnecessary irrigation or fertiliser applications, particularly in furrow-irrigated vineyards, and irrigation on already wet soils as major environmental management issues.

They found that scheduled irrigation based on soil water measurements delivered considerable water and nutrient savings. Based on average water and nitrogen inputs, the researchers identified potential water savings of one megalitre per hectare per year in furrow-irrigated vineyards and potential nitrogen savings of 28 kilograms per hectare per year generally.

NSW DPI has since produced guidelines for grape growers and other industry stakeholders on improved management of viticultural and environmental resources.

Safe, Healthy and biosecure industries

Equine influenza (State Plan S8, P1, P6)

Elizabeth Macarthur Agricultural Institute, NSW DPI's Centre of Excellence for Animal and Plant Health, demonstrated its credentials in the fight against equine influenza. The fast response of the Virology Laboratory at the institute enabled the Chief Veterinary Officer to establish measures to prevent spread of the disease Australia-wide. Testing not only saved the community an estimated \$540 million but also led to eradication of the virus within six months.

At the peak of the virus, the laboratory completed 2 500 real-time PCR (polymerase chain reaction) tests in a single day, using innovative methods and automated equipment unique in Australia. The daily turnaround rate was three to four times greater than that achieved during the 1999 outbreak of Newcastle disease on poultry farms in Mangrove Mountain. Over 131 000 samples were processed, with results usually available within 24 hours or, in urgent cases, three hours.

In achieving a rapid turnaround rate, the laboratory benefited from the department's recent \$2 million investment in a modern, networked laboratory information management system. This investment is critical to delivering effective laboratory support for an exotic disease event response.



At Elizabeth Macarthur Agriculture Institute 132 000 samples were tested for equine influenza by NSW DPI staff.

Upgrade of the Elizabeth Macarthur Agricultural Institute

(State Plan S8, P1, P6)

The NSW Government is to provide \$43.25 million for a significant upgrade of the entire Elizabeth Macarthur Agricultural Institute in order to meet increasing biosecurity standards and maintain response capability to deal with exotic disease incursions. Construction of a new plant biosecurity precinct and a high security wing under the upgrade will expand the institute's diagnostic capability and enable safe diagnosis and research on plant and animal diseases.

A strong voice for primary industries

Management of genetically modified food crops

(State Plan P6, E4)

In July the NSW Government appointed an independent panel to review the *Gene Technology (GM Crop Moratorium) Act 2003*, due to expire the following year. The panel consulted extensively with industry and the community.

Parliament subsequently passed amendments based on the panel's recommendations. These extend the Act until July 2011, place a blanket moratorium on the cultivation of GM food crops and establish a scheme for approving commercial cultivation of GM food plants under which the NSW Expert Committee on Gene Technology must assess applications against criteria in the amended legislation and the Minister for Primary Industries grant approval.

Following the first application under the new regime, the Minister for Primary Industries approved commercial cultivation of GM canola and approximately 5 000 hectares of GM canola was sown.

Excellence in people, innovation and service delivery

Our scientists received national and international recognition for their work over 2007–08 as the following honours demonstrate:

Dr Sandra McDougall, Industry Leader – Field Vegetables at Yanco, was named Bayer CropScience Researcher of the Year at the 2008 Australian Vegetable Industry Awards

Dr Steven Djordjevic won a fellowship to study at the Department of Microbial Pathogenicity, Helmholtz Centre for Infection Research, Braunschweig, Germany

Two publications by NSW DPI researchers — one by Dr Paul Arthur, Dr Robert Herd and Dr Peter Parnell and the other by Dr Paul Greenwood, were listed in 'the 50 most-frequently cited articles' in leading US publication the *Journal of Animal Science*. NSW DPI Chief Scientist Prof. Steve Kennelly was appointed Adjunct Professor of Macquarie University for his long-running association with this and other universities. He also received an Australia Day Award

Dr Rod Mailer received the Timothy L Mounts Award established by the American Oilseed Chemist Society to recognise research relating to the science, technology or applications of edible oils or derivatives in food products

James Neal, Research Agronomist at the Elizabeth Macarthur Agricultural Institute, won the Young Dairy Scientists Communication Award sponsored by the Australian Department of Agriculture, Fisheries and Forestry

Roy Lawrie was awarded an Honorary Doctorate from the University of Wollongong

Dr David Michalk was awarded the Dunhuang Award, the highest award presented to foreigners by the People's Government of Gansu Province, for his outstanding contribution to grassland rehabilitation and the substantial impact of his programs on development of sustainable livestock systems in China

Saud Akbar, irrigation engineer Richmond, along with members of CSIRO's Water for a Healthy Country flagship program, was awarded the CSIRO medal for 'research that has significantly advanced the sustainable management of Australia's water resources, specifically within the irrigation sector'

Dr Kevin Atkins, Principal Research Scientist, was awarded a Fellowship of the Association for Advancement of Animal Breeding and Genetics

Yin Chan was the author of two articles listed in the top 10 published articles in the decade to 2005 by the respected international journal Soil & Tillage Research

Dr Peter Kirkland was elected president of the World Association of Veterinary Laboratory Diagnosticians.

Dr John Mullen, Research Leader Economics Research, and Leanne Orr, Project Officer (Economics), from Orange were awarded the prize for best article at the Conference of the Australian Agricultural and Resource Economics Society, held in Canberra in February for their paper entitled R&D: A Good investment for Australian Agriculture.

Significant issues

Succession planning

The division introduced measures to counter the impact of an ageing research workforce, including:

- actively promoting research careers to university students
- offering post-graduate scholarships to fill key gaps
- awarding summer scholarships for graduates and post-graduates to undertake work practice
- offering post-retirement fellowships to experienced senior staff to enable them to pass on skills and experience.

R&D contribution to productivity growth (State Plan P1, P6)

NSW DPI continued to analyse the contribution of research and development to productivity growth in Australian broadacre

agriculture, financed in part by the Australian Farm Institute. Based on our analysis, it is estimated that returns from public investment in agricultural research are in the range of 15 to 40 per cent per annum. This estimate is consistent with earlier analysis of investments by NSW DPI in areas such as the beef, sheep and weeds cooperative research centres.

We therefore advocate preservation of the current rate of total investment, irrespective of how the debate about the extent of public funding is resolved. For more details see www.dpi.nsw.gov.au/research/areas/health-science/economics-research/reports.

Future directions

The division has identified four over-arching priority areas for research — climate change, water management, food security and biosecurity. The aims within each of those areas are:

climate change

- better understand the likely impacts of climate change
- develop a capacity for the primary industries sector to adapt to climate change
- develop options for primary industries to mitigate emissions

water management

- develop water research priorities within an over-arching water action plan for NSW DPI
- develop techniques to use water more efficiently within dryland agricultural landscapes
- develop techniques to improve irrigation water use efficiency at the farm and system scale

food security

- on-farm management work with other divisions on promoting adoption of food security measures
- undertake economic modelling to inform industry about new and emerging productivity drivers
- improve tools

biosecurity

- develop common platforms for molecular diagnostics
- develop base germplasm rather than varieties
- develop cooperative approaches for gene discovery
- improve coordination across NSW DPI, including Forests NSW, on biosecurity matters
- adopt new technology for surveillance and diagnostics
- utilise smart technologies and databases for surveillance.

Divisional performance

Service Measures	Units	2005-06	2006-07	2007-08
New diagnostic tests and vaccines	no	5	8	8
New integrated pest control systems	no	6	8	8
Publication of research based innovations in scientific journals	no	1 237	1 200	1184
Samples processed by DPI laboratories	thou	265	350	483
Pre-commercial lines and varieties delivered for uptake by private breeding and seed companies	no	7	7	10
New innovations for horticulture, viticulture, aquaculture and animal production	no	35	39	39



Case study: NSW DPI at the forefront of greenhouse gas emission research

The response to climate change by governments all over the world has been to introduce carbon trading. One of the difficulties in successfully implementing a scheme is having the capacity and know-how to accurately measure the production (and reduction) of greenhouse gases.

For example, how much greenhouse gas does a dairy farm with 100 cows produce? What greenhouse gases are released when a forest is harvested?

In the livestock industries, a major NSW DPI study with the University of New England comparing new and conventional techniques for accurately measuring livestock methane emissions should prove integral to evaluating methane reduction strategies.

Not that our research is just about measuring gas. A Beef Cooperative Research Centre-supported project found that more efficient cattle eat less. This points the way for new research to establish a genetic trait for low methane livestock. High grain prices and the need for lower emissions have sparked interest in this research from the US cattle industry.

In forestry, NSW DPI scientists found that a high proportion of the carbon in solid forest products consumed in Australia can remain stored in the product for at least 100 years, regardless of whether the product is in use or discarded in landfill. These findings underscore forestry's role in any proposed carbon pollution reduction scheme.

A paper for the Garnaut climate change review prepared by NSW DPI demonstrates our capacity to support sound policy decisions. The paper found the total sequestration potential from pasture land, cropping land and rangelands was roughly equivalent to the total amount of greenhouse gas emitted from agriculture in NSW in 2005.

As Australia has around 26.5 million head of cattle and over 70 per cent of the land and water in NSW is under the stewardship of primary producers, this research can improve decision-making on greenhouse gas reduction and contribute to international debate about emissions trading.