Annual Report 2009 – 2010

biosecurity built on science







Our vision...

...is to be a world leader in the generation, development and delivery of plant biosecurity science and education.

Our mission...

...is to foster scientific collaboration and engage stakeholders to deliver plant biosecurity technologies that will reduce risk to, and ensure sustainability of, Australia's plant industries.

Cooperative Research Centre for National Plant Biosecurity

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Executive Summary

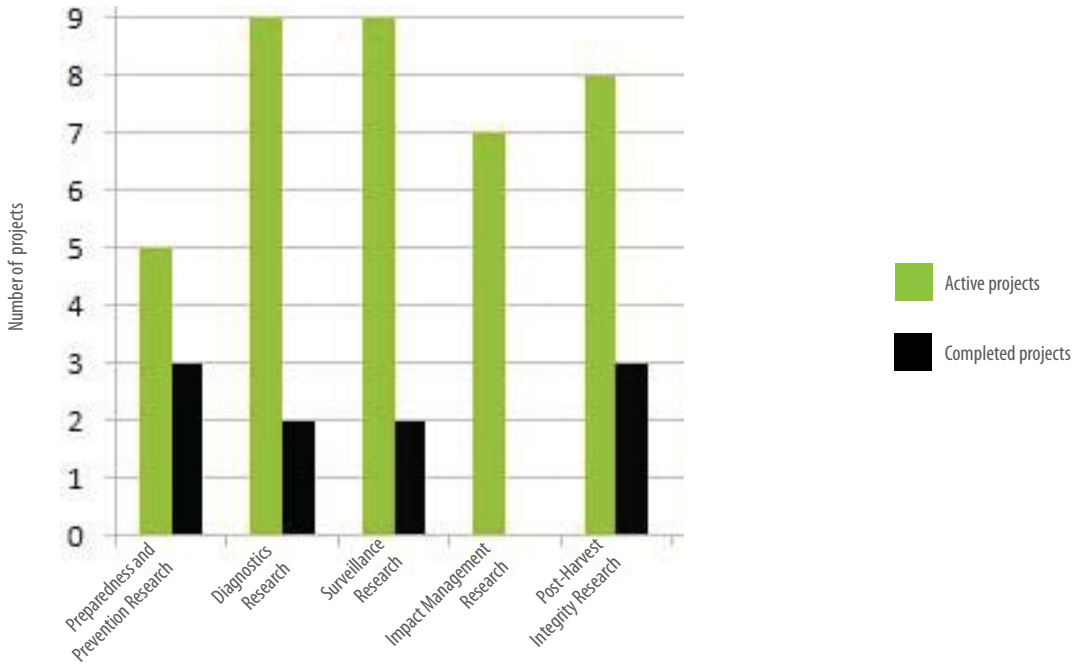
Achievements and activities of the CRC in relation to research, commercialisation/utilisation and education outcomes for the reporting period

We have witnessed a very successful reporting period as a result of the maturity of our research projects over our seven year term. A number of projects reached and achieved their final milestones, which delivered outputs to various end-users.

With a portfolio comprising a high number of successful projects, it is a challenge to single out just a few in a short summary. The section on our research programs provides greater detail of many of the key achievements for the reporting period. However for the purposes of reporting, we have singled out a number of projects which are having impact, or have the ability to impact Australia's biosecurity system.

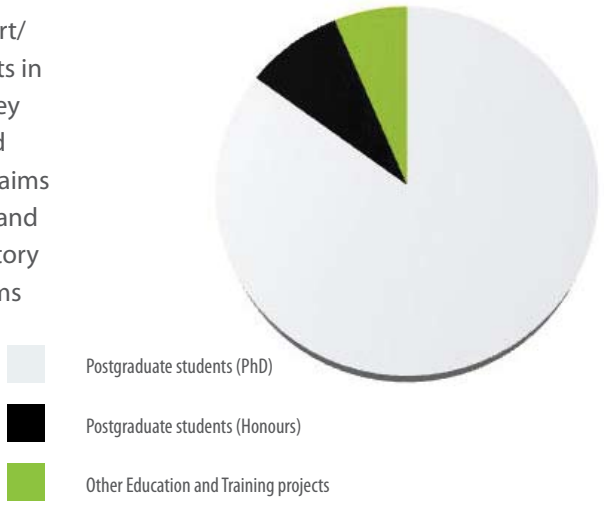
Recognising the maturity of projects arising from our research portfolio has also seen a significant increase in delivery and subsequent adoption of research outputs. Five strategic frameworks form the basis to prioritise delivery and adoption activities across the organisation and are themed on our five research programs: *Biosecurity Risk, Diagnostics*, *Area Freedom*, *Response and Stored Grains Biosecurity*. The first three areas were the main focus of delivery throughout the reporting period. Many projects in the *Response* theme had second phase project proposals approved and will see greater delivery to end-users in the coming financial year. The *Stored Grains Biosecurity* theme delivered a number of outputs, however, as this program is only in its third year (as a result of our 2007 supplementary bid) many outputs will be delivered in the 2010–11 financial year.

Figure 1: Number of CRCNPB research projects during 2009–10



Our Education and Training Program continues its goal of enhancing the awareness, knowledge and skill of industry personnel, and supply of trained scientists involved in the supply chain and import/export pathways. The first enrolments of students in the *National Plant Biosecurity Curriculum* was a key achievement and highlight of our Education and Training Program. The postgraduate curriculum aims to develop students' ability to analyse, evaluate and synthesis information from scientific and regulatory sources, and apply effective solutions to problems with changing contexts.

Figure 2. Number of Education and Training projects in 2009–10 (total 47)



National Plant Biosecurity Postgraduate Curriculum

- Increasing Australia's plant biosecurity capacity.
- First enrolments in 2009-10.
- Enrolments came from state and federal government employees.
- Positive feedback received from attendees.
- Five universities involved in delivery and administration.
- Assistance from federal government through a Collaborative and Structural Reform Grant.
- Support from Department of Agriculture, Fisheries and Forestry.

Plant Biosecurity Program

Providing the grains industry with a strategy to manage phosphine resistance

To provide strategic guidance to manage insect resistance to phosphine, we also developed a paper, *Strategy to manage resistance to phosphine in the Australian grain industry*. This paper was a collaborative effort between many of our Participant organisations as an initiative of the National Working Party on Grain Protection. The strategy was developed in consultation with Australia's grain industry to ensure that practical and commercial constraints inherent to this industry were accommodated without loss of the resistance management aim. The strategy applies to all sectors and is consistent with current best practice integrated pest management. The strategy is voluntary and success will depend on industry commitment and widespread compliance. Where successful, these strategies will limit the spread and impact of resistance but not eradicate it.

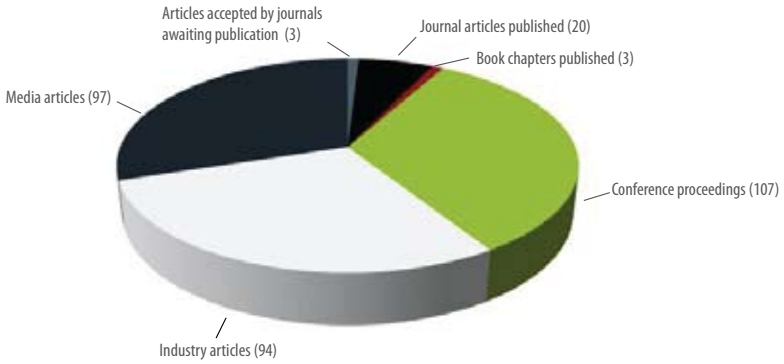
Russian Wheat Aphid *(Diuraphis noxia)*

- Causes significant damage to cereal crops.
- Australia is the only major wheat growing country free of RWA.
- CRCNPB research contributed to first peer reviewed paper (in *PLOSBiology*) that compared the genetics of global invasive RWA populations.
- CRCNPB co-organised and sponsored an international scientific RWA workshop in Singapore.
- PhD candidate won 'Best Student Poster' at Global Biosecurity 2010.

Our researchers are encouraged to publish their scientific discoveries by submitting manuscripts to peer reviewed journals and we are pleased to see an increase in the number of journal articles published. We have also had a strong presence at industry related conferences and continue to publish industry articles to disseminate knowledge to key plant industries and government agencies. In addition to this, there were a number of manuscripts submitted to journals which are waiting for acceptance.

In order to raise awareness to growers, the backbone of Australia's plant industries, we also undertook a targeted media campaign which resulted in a number of published articles in rural newspapers.

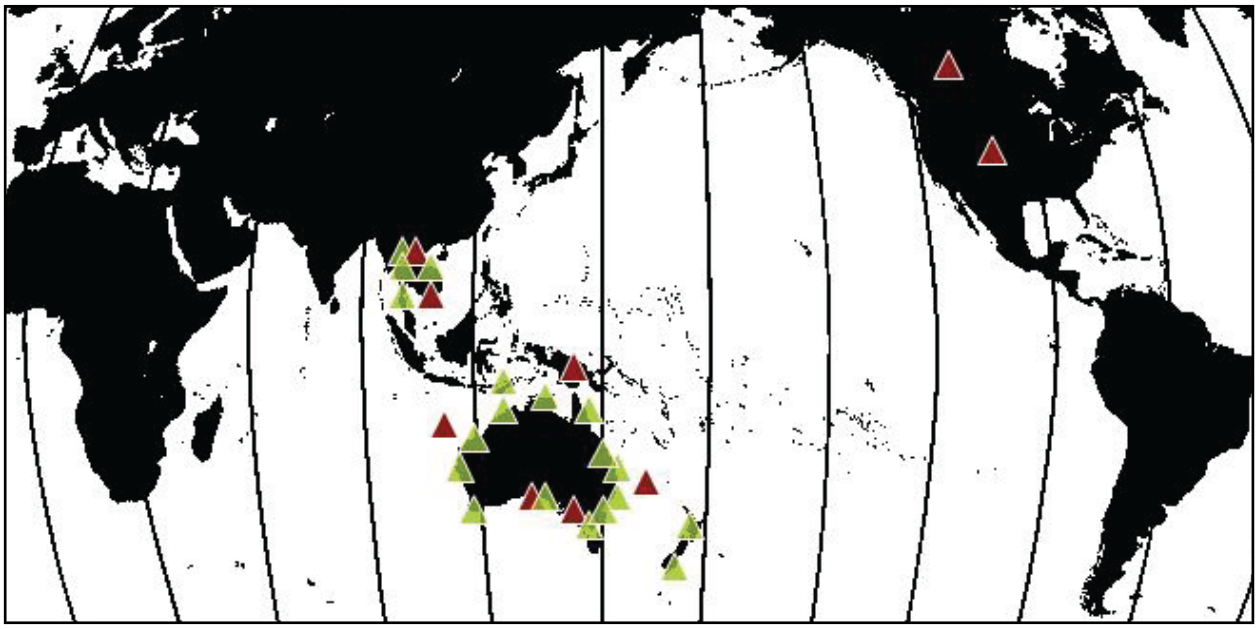
Figure 3. Publication of research activities by type



National Diagnostic Database/Digital Diagnostics

- Australia now has over 30 camera-connected microscopes.
- Experts are able to be reached anywhere there is internet access.
- Changing Australia's ability to accurately and quickly diagnose plant pests.
- Extended to Vietnam, Singapore, East Timor and Laos during the reporting period.
- Building Australia's pre-border surveillance activities.

Figure 4. Remote Microscope Network



▲ Deployed remote microscopes ▲ Future remote microscope locations

Risks, opportunities and responses to the above

The projects discussed in the previous section provide us with many opportunities. Most importantly is the opportunity to change biosecurity practice by offering end-users solutions to biosecurity issues. The ongoing success of the work in digital diagnostics not only strengthens Australia's diagnostic network, but also assists other countries to accurately diagnose pests, and thereby increasing our pre-border biosecurity intelligence.

Russian wheat aphid (RWA) is a high priority pest for Australia's grain industry. Our continued research to understand the virulence of this pest will provide the Australian grain industry with information to improve the level of preparedness for potential incursions into Australia, and develop a strategy for Australian wheat breeders to achieve sustainable and stable resistance to RWA, reducing the need for insecticides.

As indicated in the section below, *Context and major developments during the year*, the rapidly changing nature of the grains industry, particularly following changes to marketing legislation, deregulation of domestic markets and changes to export marketing arrangements provides us with an opportunity to highlight the importance of scientifically proven biosecurity solutions to help Australia maintain its export market access. Continued sustainability and competitive advantage in premium markets requires that industry guarantee a 'nil tolerance' of live insects in all grain leaving the country. While the deregulated grain industry does not affect our ability to do our research, industry is more aware than ever before of the need for sound biosecurity practices across the supply chain.

Impediments to achievement of the CRC's objectives experienced during the year and strategies adopted to address these.

We have not experienced any impediments to achieving our objectives during the reporting period. We continue our focus on delivering project outcomes, especially as projects reach maturity. The number of final reports from projects is increasing and we will continue to ensure that research outcomes translate into impact for our end-users. In the coming financial year, we will continue to consult with industry to measure the impact of our research.

Awards, special commendations, CRC highlights

2009 Science Exchange

A highlight for the reporting period was our Science Exchange which was held in Queensland from 22 to 24 September. Over 160 people attended including researchers, PhD students, staff, Board, Participants Committee, industry and government representatives. The two-day event provided an opportunity for everyone to meet, network and discuss our research portfolio. The Science Exchange was preceded by a number of meetings including our annual PhD professional development workshop and Board meeting. The event also provided an opportunity for a number of other meetings including Grains Advisory Panel, Participants Committee, Board Nomination Committee, project meetings and a workshop on using statistics in a biosecurity context.

During the Science Exchange, 34 oral presentations from our research portfolio were given and 31 scientific posters presented. Researchers and students showcased their work under themes loosely based on the five delivery frameworks; *Biosecurity Risk, Diagnostic Platforms*, *Managing Area Freedom, Response Strategies* and *Post-Harvest Grains Resistance Management*. A dedicated networking function provided an opportunity to showcase the posters and other tangible exhibitions from our research portfolio including the remote microscope network and the modelling software used in our climate change project.

The nature of a cooperative research centre is to bring together organisations across the nation who have a requirement for research and development in a particular area. Australia's plant biosecurity community has been strengthened through the establishment of our CRC and the Science Exchange social activities are integral to fostering these relationships.

Recognising the significant impact and contribution our researchers and project teams make in developing scientific solutions to plant biosecurity issues, the organising committee decided that these should be acknowledged at a formal Science Exchange Awards Dinner.

Awards were presented to researchers and students at the annual Science Exchange

The Science Committee nominated a number of project teams for awards in key areas. A *Highest Impact Factor Publication Award* was presented to the project that published in the highest impact journal during the past two financial years, with acknowledgment of the CRC in the author affiliations. The winner of this award was the *Russian Wheat Aphid* project team for publishing in the *Proceedings of the National Academy of Sciences*, USA.

Three *Collaboration Awards* were presented to project teams who have displayed exemplary proficiency in the key tenet of the CRC; cooperation. These awards are exceptionally important to our research as they represent what can be achieved through effective collaboration and knowledge exchange.

The winners of the awards were:

- *Student Collaboration Award*: Ms Bobbie Hitchcock who is clarifying the taxonomy of the light brown apple moth group – Revision of the genus *Epiphyas*. Bobbie was chosen because of the approach she has taken in establishing and positioning herself to provide advice to international collaborators as well as staff within Australian National Insect Collection.
- *Research Project Collaboration Award*: Project team *Enhanced Risk Analysis Tools*, led by CSIRO's Dr David Cook. Throughout their project, this team has worked closely with industry and regulators and consulted extensively with key organisations to develop a tool that industry was able to use. This was done in a structured, open and transparent manner between a range of competing priorities.
- *International Collaboration Award*: Presented to Project Leader, Dr Gary Kong on behalf of two of his project teams (*National Diagnostic Database* and *Increasing Diagnostic Capacity in Thailand*). Both project teams have shown outstanding rapport in building and nurturing collaborative groups within Australia (and then network these to international linkages to benefit national and international biosecurity).

An *Innovation Award* was presented to project *Biosensor-based Detection of Grain Pests*, which is looking at novel biosensor-based technology to detect insect pests in stored grain. The award recognises creative and innovative thinking and applying new research techniques to plant biosecurity and originality in method application. These techniques may be entirely novel or existing ideas that are being applied in a plant biosecurity context for the first time.

Recognised for scientific outcomes that have caused a positive change in practice at the industry level, the *Impact on Industry Award* was presented to the project *Biosecurity Quarantine Model System*. This project team designed an integrated surveillance system for invertebrates, vertebrates and plants for the Gorgon gas project on Barrow Island. The design was developed to detect non-indigenous species on Barrow Island with an 80 percent statistical power. The design methodology developed by the Queensland University of Technology project team has been recognised both nationally and internationally.

During the Science Exchange, the Board Directors also contributed to the awards by nominating researchers for *Board Awards*. The *Best Student Poster Award* was awarded to Mr Alistair McTaggart while the B*est Scientific Poster Award* was presented to *Dr Mark Sosnowski*. The Board also nominated a *Best Oral Presentation Award* of which Dr Gary Kong was the recipient. Furthermore, delegates had the opportunity to nominate a researcher for a *People's Choice Award* for the best poster. This award was presented to PhD candidate Ms Rachel Powney.

The Awards Dinner was a highlight of the CRCNPB annual Science Exchange

Delegates listen to Dr Deb Hailstones discuss the Diagnostics Research Program

A poster and interactive session enabled researchers to learn about each other's work

Global Biosecurity Conference 2010
safeguarding agriculture and the environment

'The best part about the conference was the mix of animal and plant papers, excellent keynote speakers and the mix of scientific and strategy/regulatory papers.'
Conference delegate

'The highlight for me was the opportunity to network and be exposed to a range of issues facing biosecurity.'
Conference delegate

Global Biosecurity 2010: safeguarding agriculture and the environment

After more than two years of planning, the successful delivery of the *Global Biosecurity: safeguarding agriculture and the environment* international conference was realised this financial year. Held in Brisbane from 28 February to 3 March 2010, this inaugural conference was a world first in bringing together scientists, regulators and industry representatives who have an interest in agricultural (both plant and livestock) and environmental biosecurity.

The conference was a collaborative effort led by our CRC in partnership with the Australian Biosecurity Cooperative Research Centre for Emerging Infectious Disease and the Invasive Animals Cooperative Research Centre. This partnership demonstrated the true philosophy of cooperative research centres and their role in bringing together industry, universities and governments in a global context. The conference also reinforced Australia's position as world leaders in biosecurity research, education and application.

A total of 453 delegates attend the conference, coming from the following countries: Australia, Canada, Fiji, France, Guam (USA), Indonesia, Kenya, Kingdom of Saudi Arabia, Malaysia, Mozambique, Netherlands, New Zealand, Republic of Tajikistan, Russian Federation, Singapore, South Africa, Sweden, Switzerland, Taiwan, Tonga Islands, Uganda, United Kingdom, United States and Vietnam.

Over the two and half days, delegates had the opportunity to attend six plenary sessions given by international experts as well as the conference opening address from CSIRO chief executive, Dr Megan Clark. A total of 166 oral presentations were provided across four concurrent streams of *Biosecurity Drivers, Biosecurity Threats and Impacts*, *Biosecurity Knowledge* and Biosecurity Systems. In addition dedicated scientific poster sessions were held during the course of the program with Springer Publishing donating generous prizes for the best poster and best student poster.

Delegates were able to attend a number of networking opportunities to further collaborate with peers across the biosecurity community. These included a welcome reception and the official conference dinner themed 'Our Big Backyard'; a subliminal reflection of the privileged lifestyle and environment we enjoy in Australia as a result of good biosecurity practices. Written and verbal feedback from delegates indicated the conference was an overwhelming success. This success is reflective of the many hours of work which were dedicated by all who contributed and also the support received from conference sponsors.

A trade exhibition allowed delegates to learn more about organisations involved in biosecurity

CSIRO chief executive, Dr Megan Clark opened the conference

Over 453 delegates from across the globe attended the conference

Springer Publishing presented an award for best poster to PHA and AHA

The conference dinner was a highlight of the social program

Delegates enjoyed the conference dinner themed 'Our Big Backyard'

Context and major developments

A brief outline of the industry context in which the CRC operates (e.g. has there been a change in market conditions; have these changes impacted on the ability of the CRC to meet its objectives?)

As indicated in our *2008–09 Annual Report*, Australia's grain industry became deregulated in July 2008 to bring competition and transparency to the Australian export wheat industry. Accredited organisations are now allowed to freely export wheat from Australia.

While this legislative change does not directly affect us as a CRC or the ability to meet our objectives, it does increase biosecurity risks in the export market. Throughout the reporting period, we continued our support of the Grains Biosecurity Officers who work in each major grain growing state. This was in partnership with Plant Health Australia Ltd and the Grains Research and Development Corporation. Grains Biosecurity Officers work with the grains industry to raise awareness of potential biosecurity issues and risks. In a deregulated market, this is more critical than ever before. The ongoing research in our Post-Harvest Integrity Research Program is providing outputs which will help Australia maintain its reputation as an exporter of grain which is free from pests and diseases, and subsequently secure market access.

A brief outline of the value of outcomes to date as compared to the expectations outlined in the *Commonwealth Agreement* or in your original funding application. The response should cover the following questions:

- **What were the expected monetary (economic) and non-monetary (such as social, environmental etc.) outcomes of the CRC?**
- **Is the value of outcomes matching the expectations and if not, what has led to the difference?**
- **How does the CRC intend to address any issues and maximise the value of outcomes over the remaining life of the CRC.**

In the *Commonwealth Agreement* it was noted that while pest incursions directly threaten the viability of Australia's plant industries the cost varies considerably depending on whether the pest spreads widely or if it can be contained in certain areas and, if so, whether area freedom status can be achieved and recognised.

In response, we have focused on building scientific capability and delivering impact within a biosecurity framework that comprises prevention, identification and detection, surveillance, impact management and post-harvest integrity. During the current year there has been strong progress in all areas and outcomes are being extended in line with end-user priorities and expectations.

A key achievement was the development and application of a self-organising map technique to predict invasive species. The work was peer reviewed and published in the *Journal of Applied Ecology,* and negotiations are progressing to deploy the technique for use by biosecurity practitioners. Complementary work to enhance risk analysis tools received significant support from both government and the horticultural industry for their approaches and contributions to long-standing plant biosecurity issues such as the importation of New Zealand apples.

Another achievement was the development of fumigation protocols for flat grain beetle, a recently emerged major insect threat of stored grain in Australia. The insect has recently developed high level resistance to phosphine (the only viable fumigant available for non-quarantine use) resulting in control failures with current dosage regimes. As there is no practical alternative to phosphine, control failures place at risk market access for Australian grain worth up to $7 billion in annual trade.

In addition to developing new phosphine fumigation protocols, an eradication strategy was developed in partnership with industry. An independent cost-benefit analysis of the research suggested that even if there are significant changes to key variables such

as costs of fumigation, probability of success and volumes of grain treated with contact insecticide, prolonging the life of phosphine through the development of new protocols will still result in substantial economic benefits.

Our remote microscope network has significantly increased the capacity to diagnose plant pests both in Australia and for our near neighbours. Diagnostic protocols being developed are used by the Australian Quarantine and Inspection Services (AQIS) in front-line biosecurity.

Our expertise is identified by international biosecurity agencies who have sought our skills in dealing with issues. In addition, our researchers and outputs from our research program were used as part of a plant emergency response by providing surveillance and diagnostic tools.

An explanation of any major developments or initiatives including:

- **Actions undertaken in relation to internal and/or external reviews, recommendations resulting from these reviews, strategies for implementing these recommendations and any resulting difficulties for the CRC anticipated by the Board; and**
- **Key events and changes of a substantial nature including key staff appointments and/or changes and purchases of major equipment.**

We are committed to science excellence and seek to undertake reviews of our science portfolio to ensure the science is of the highest standard and continues to address industry needs. During the reporting period we organised two independent reviews. The first review analysed our science portfolio. The review panel was asked to comment upon the quality and relevance of research being undertaken, to examine the impact of science undertaken and to make recommendations on areas of research that should be considered in a proposal for a new CRC. The second review examined our research of stored grain insect resistance. This research is part of our Post-Harvest Integrity Research Program which was established as a result of our successful supplementary bid in 2007.

Science Review

The science review was undertaken in the lead-up to, and during, the *Global Biosecurity 2010: safeguarding agriculture and the environment* conference. This provided maximum opportunity for the panel to meet face-to-face with interviewees and also listen to the many oral presentations from our project teams. The independent review was conducted by Dr Gordon Gordh, Principal Science Adviser from the United States Department of Agriculture, Mr Andrew Inglis, AM, Chair National Biosecurity Advisory Council and Biosecurity Australia's Plant Biosecurity Principal Scientist, Dr Bill Roberts.

Operating under three terms of reference the review involved extensive interviews with program leaders, management, participant organisation and industry representatives. The Review Panel made 18 recommendations under the terms of reference and additional comments on the structure and operation of the CRC. The panel concluded that the quality of science being undertaken was of a high standard, and represented a good mix of strategic and applied research relevant to the interests and expectations of stakeholders.

The panel also commented that the CRCNPB is staffed by enthusiastic and dedicated staff with a research program that is making a significant difference to plant biosecurity in Australia. They also commented on the research program, commenting that the resulting research is of a high quality and very relevant to industry, government and the community. In their report, they noted:

"The CRC is the only organisation providing a coherent, comprehensive national approach to plant biosecurity research in Australia".

The panel saw significant opportunities to transition the existing work of this CRC into a new CRC with an increased focus on delivering science to end-users. Management has accepted the recommendations and are using them to guide the science portfolio in a bid for another eight-year term.

Roush Review of Stored Grain Insect Resistance

Australia is a major grain exporter. To maintain competitive advantage in premium markets, it guarantees a 'nil tolerance' of live insects in all grain leaving the country. The most cost effective way to achieve this is to apply chemicals to the stored grains.

Currently phosphine is used as a fumigant on about 80% of grain. It is relatively cheap, easy to use, multi-commodity and considered virtually 'residue free'. Resistance to phosphine was first observed in the 1970s, and by the late 1990s, increased resistance levels and frequencies became a major concern to industry. There is currently no practical replacement for phosphine and the challenge for the grains industry and growers is to reduce or prevent the further spread of resistant biotypes of grain insect species with a management plan based on a sound understanding of the mechanisms of resistance.

In 2007, with a successful supplementary bid to the CRC Program, we forged a new alliance of industry, government, and science partners to develop better stored grain protection technology, training and safeguards. This alliance included three major Australian grain handling companies joining us as core Participants and resulted in our Post-Harvest Integrity Research Program.

Coming into the third year of this research, we decided to undertake a review of the strategic direction of the program, as well as review the research aims to ensure the potential benefits from the remaining investment are optimised. The review was undertaken by world authority on insecticide resistance Professor Rick Roush from the University of Melbourne, and Principal Scientist, Dr James Ridsdill-Smith.

The review operated under terms of reference and was strengthened by the submission of relevant peer-reviewed literature on resistance in insects. The review also involved meetings with key individuals across the grains industry and scientific community.

The final report from the review contained 11 recommendations and a further four comments on specific key projects. Management accepted all recommendations and are currently taking action to implement them.

Third Year Review

The status of the recommendations from the Third Year Review are provided at the end of this report.

Key events and changes

Throughout the reporting period, there were several changes to staff in the CRC, as follows:

- Ms Melanie Hay left the position of Education Officer in January 2010. As many of the activities for this position were met successfully during the financial year, the delivery role of the school education strategy will be integrated into the critical area of Delivery and Adoption.
- Ms Lauren Searson-Patrick left the position of Executive Assistant in February 2010 which was filled by Ms Angela Hagedorn from March 2010.

National Research Priorities

National research priority goal highlights

Our research is underpinned by the National Research Priority (NRP) of *Safeguarding Australia,* and in particular, *'Protecting Australia from invasive diseases and pests'.* As a cooperative research centre (with the Australian Government and most state governments as participants) we are able to give this priority a whole-of-government approach and integrate scientific solutions across agencies and jurisdictions to improve research and influence broader policy outcomes.

While our research addresses this particular NRP in relation to pests and diseases, our research can also be applied to *'Protecting Australia from terrorism and crime'.* In essence, bioterrorism is an additional pathway for plant pests and diseases to enter Australia and many project outputs provide tools and technologies to address any potential incursion from this risk.

Through our *Climate Change* project we are assisting to tackle the NRP of *Responding to climate change and variability.* This project team is modelling the effects of increasing temperature on the biology and distribution of pests and diseases and vectors, and collecting real-time data on host-pathogen/pest interactions from field experiments using wheat grown under elevated CO_2. Outcomes from this project will enable the development of adaptation plans for government and industry based on the above data. These adaptation plans will mitigate any increased risks posed by climate change to the biosecurity of Australian crops.

We are also addressing the NRP of *Frontier technologies for building and transforming Australian industries*. This is being achieved through several projects which are adapting existing genomic DNA nanotechnology for use in plant pathology. Another project will use insect pheromone receptors to develop biological recognition through a biosensor which will detect when and where grain insects are in stored grain.

Our work with the National Information and Communications Technology Australia (NICTA) uses digital cameras which are capable of reading colours not visible to the human eye to assess plants for diseased material. Similar technology is also being used in surveillance trapping devices. This technology will sense insects in traps and take images of them so they can be identified instantly and remotely through computer screens.

Through the NRP of *Frontier technologies for building and transforming Australian industries*, we are undertaking research which is consistent with *'Smart information use'* including our PDA project which uses existing technology to provide more robust methods of recording surveillance activities and the Remote Microscope Network and Plant Biosecurity Toolbox™. Both of these digital tools have changed the way plant pests are diagnosed by using existing technology and adapting them to a plant biosecurity context.

Through our collaborative and innovative projects we are also addressing the NRP of *Promoting an innovation culture and economy*.

NATIONAL RESEARCH PRIORITIES	CRC RESEARCH (%)
AN ENVIRONMENTALLY SUSTAINABLE AUSTRALIA – Transforming the way we use our land, water, mineral and energy resources through a better understanding of environmental systems and using new technologies	
Responding to climate change and variability	2%
SAFEGUARDING AUSTRALIA – Safeguarding Australia from terrorism, crime, invasive diseases and pests, and securing our infrastructure, particularly with respect to our digital systems	
Protecting Australia from invasive diseases and pests	87%
Protecting Australia from terrorism and crime	2%
FRONTIER TECHNOLOGIES FOR BUILDING AND TRANSFORMING AUSTRALIAN INDUSTRIES – Stimulating the growth of world-class Australian industries using innovative technologies developed from cutting-edge research	
Frontier technologies	3%
Smart information use	4%
Promoting an innovation culture and economy	2%

The CRC NPB Ltd Board meets quarterly to oversee and provide strategic direction

Governance and Management

The Board of CRC NPB Ltd provides strategic direction, considers commercial matters and oversees research activities. The skills based Board is made up of a Chair and six other Directors – all independent of Participants. The Board was established with careful consideration to ensure a wide spectrum of expertise to maximise the value of the Board's input into our direction and management.

At the 2009 Annual General Meeting (AGM), the tenure for the Chair and three Directors (Mr Chris Richardson, Dr Jim Cullen and Mr John Sandow) was due to expire. The Chair was re-elected unopposed. All three retiring Directors were renominated for the vacant Director positions along with one further nomination. As a result, the four nominees were put to the AGM of the CRC NPB Ltd members for election on a preferential basis. The election resulted in all three of the retiring Directors being reappointed to the Board of the CRC NPB Ltd.

The Finance and Audit Committee provides assistance to the Board of Directors in fulfilling its corporate governance and oversight responsibilities in relation to financial reporting, internal control structure, risk management systems and external audit functions.

The Board Nomination Committee consults with the Participants and Directors to identify suitable candidates to the members for election as Directors.

The names, qualifications, special responsibilities and experience of the Board of Directors in office during the period and until the date of this report are provided at below.

CEO, Governing Board Members and Committee Members

Name	Organisation	CRC Position/Role
Dr Simon McKirdy	CRCNPB	Chief Executive Officer
Professor John Lovett		Chair, Board of Directors
Mr Barry Windle		Deputy Chair, Board of Directors; Chair, Board Nomination Committee (2009)
Ms Christine Campbell		Board Director; Chair Finance and Audit Committee
Dr Jim Cullen		Board Director
Professor John Irwin		Board Director; Finance and Audit Committee
Mr Chris Richardson		Board Director; Finance and Audit Committee
Mr John Sandow		Board Director
Mr John Chapman	Department of Employment, Economic Development and Innovation	Board Nomination Committee
Mr David Fienberg	CBH Group	Board Nomination Committee
Dr David Hall	Industry & Investment NSW	Board Nomination Committee
Dr Rohan Rainbow	Grains Research and Development Corporation	Board Nomination Committee
Dr Shashi Sharma	Department of Agriculture and Food, Western Australia	Board Nomination Committee
Mr Geoff Masters	Viterra (was ABB Grain)	Board Nomination Committee

Key skills of Board members

Professor John Lovett: BSc Hons (Agric), PhD, FBS, FAIAST, MAICD
Chair: Agrifood Awareness Australia Ltd (2004–present), Chair: CRC for Greenhouse Accounting (2004–2006), Board member: HRZ Wheats Pty Ltd (2004–2006), Member Executive Board: Global Crop Diversity Trust (2006–present), Member Board of Primary Industries Education Foundation (2009 – present); Managing Director: Grains Research and Development Corporation (1994–2003), Managing Director: Lovett Associates Pty Ltd (2004–present), Professor of Agronomy: University of New England (1987–1993), Professor of Agricultural Science: University of Tasmania (1984–1987).

Mr Barry Windle: B AgS, Dip Hort Sci
Chair: AFMA Great Australian Bight Trawl Fishery Management Advisory Committee (current), Chair: Central Hills Water Allocation Plan Advisory Committee and member of the Central NRM Group – Adelaide and Mount Lofty Ranges, NRM Board (current): Chair: Working Group on Market Access Research and Development HAL (current) Executive Director: Agriculture, Food and Fisheries, Primary Industries and Resources SA, Executive and Policy roles PIRSA (1988–2004), Horticultural Research Officer and related policy roles (1971–1988).

Ms Christine Campbell: FCPA, GAICD
Director: Twynam Agricultural Group, Executive Chairman (1999–2010), CEO (1986–1999) and Financial Controller (1977) Twynam Agricultural Group, Chair: of the National Farmers' Federation Water Taskforce (2005–2006), Chair: Australian Cotton Industry Council (2002–2005), Member: Policy Council of the National Farmers' Federation (2004–2005), Member: Executive Committee of the National Farmers' Federation (2002–2004) Chair: Cotton Australia (2001–2003), Private Sector Advisory Panel to International Cotton Advisory Council (2004–2005), Director: Cotton Australia (1999–2005).

Dr Jim Cullen: BA (Hons), PhD
Member: Quarantine and Exports Advisory Council (1997–2003), Chief: CSIRO Entomology, (1997–2002), Board Member: CRC for Australian Weed Management (Weed Management Systems) (1995–2002) (Acting Director 1995), Member: Australian Weeds Committee (1988–2002), Founding President, ACT Branch, Australian French Association for Science and Technology (AFAS) (1991-1993), Director, Entocosm Pty Ltd, (2002–2004), External Advisor (Science and Research): Environmental Risk Management Authority NZ (2002), President: Australian Entomological Society (1997–2000).

Professor John Irwin: BSc Hons (Agric), MSc (Agric), PhD, DSc (Agric)
Professor Emeritus: University of Queensland (2009 –present); Editor in Chief: *Crop and Pasture Science* (formerly *Australian Journal Agricultural Research*) (2009–present); Professor: School Biological Science: University of Queensland (1993–2009); CEO: CRC for Tropical Plant Protection (1999–2006); CEO: CRC for Tropical Plant Pathology (1992–1999); Member: National Crop Improvement Committee; Grains Research and Development Corporation (1991–1993); Lecturer Senior Lecturer, Reader: University of Queensland (1982–1992); Member: Oilseeds Research Council (1989–1991); Plant Pathologist/ Research Fellow: Queensland Department of Primary Industries/ University of Wisconsin (1972–1982).

Mr Chris Richardson: Diploma in Agriculture, GAICD
Chair: Biosecurity Council of WA (2008–present), Chair: Agriculture Protection Board of WA (Board member since 1998 and Chair since 2002), Chair: WA Footrot Eradication Campaign Advisory Committee (1999– present), Chair: WA Ovine Johnes Disease Advisory Committee (2004–present), Board member: Corredene Pty Ltd, CEO: Australian Merino Society Inc 1999–present).

Mr John Sandow: BSc, MSc, MAICD
Director: Cooperative Research Centre for Australian Weed Management (2002–2008), Western Australian Herbicide Resistance Initiative (WAHRI) (2002–2007), Member: Steering Committee 'Grain Protection Genes' (GRDC/CSIRO joint venture) (2002–2007), GRDC Program Manager: Crop Protection (2002–2007), Crop Care Australasia Pty Ltd - National Technical and Development Manager (2001-2002), Marketing Services Manager (2000–2001), Group Product Manager (1998–2000): Product management and technical roles (1989-1998), Entomologist: Western Australian Department of Agriculture (1979–1989).

Function and frequency of Board meetings

The Board meets quarterly in various locations around Australia. During the 2009–10 financial year, there were four scheduled Board meetings. Attendance is indicated below:

Name/Date	22 Sep 09	24 Nov 09	16 Mar 10	8 Jun 10
Professor John Lovett	✓	✓	✓	✓
Mr Barry Windle	✓	✓	✓	✓
Ms Christine Campbell	✓	✓	✓	✓
Dr Jim Cullen	✓	✓	✓	✓
Professor John Irwin	✓	✓	✓	✓
Mr Chris Richardson	✓	✓	✓	✓
Mr John Sandow	✓	✓	✓	✓

Program Leaders

Name	Organisation	CRC Position/Role
Dr Paul De Barro	CSIRO Ecosystem Sciences, Brisbane	Program Leader: Preparedness and Prevention Research Program
Dr Deb Hailstones	Industry & Investment NSW, Camden	Program Leader: Diagnostics Research Program
Ms Jane Moran	Department of Primary Industries Victoria, Melbourne	Program Leader: Impact Management Research Program
Dr Pat Collins	Department of Employment, Economic Development and Innovation, Brisbane	Program Leader: Post-Harvest Integrity Research Program
Dr Kirsty Bayliss	Murdoch University, Perth	Program Leader: Education and Training

Changes to Participants

CABI, an international not-for-profit science based agricultural development and information organisation became a supporting participant during the financial year. As a supporting participant, Commonwealth approval was not required.

In September 2009, core participant ABB Grain Ltd was acquired by Canadian company Viterra, and as a result, now operates under the name Viterra.

Research Programs

Research activities and achievements

The past financial year was a very exciting time for the CRCNPB as many projects reached maturity and delivered tangible outcomes to end-users. In addition, publication of our research in peer-reviewed journals has increased as a result of the high-level science been undertaken throughout our portfolio.

The commentary below demonstrates key research achievements for each program during the reporting period. We have also mapped our achievements against each program's 'Indicators of success' as outlined in our revised *2009-2012 Strategic Plan*.

Program 1: Preparedness and Prevention Research

The Preparedness and Prevention Research Program's strategic objective is to undertake research that will provide rapid identification of plant biosecurity threats in order to decrease the cost of eradication and impacts through rapid response.

During 2009–10, this program delivered important benefits to end-users including a threat prioritisation tool which has been used by government in a recent incursion.

Economics/policy:

A key focus in the past year has been delivery of outputs which saw three projects completed. These projects focused on the following policy tools:

- Development of an approach to identify threats: *Early Warning of Pre-emergent Emergency Plant Pest Threats.*
- Method for prioritising across competing biosecurity threats: *Enhanced Risk Analysis Tools*.
- Comparison of approaches to import risk analysis: *A Rigorous Comparison of Quarantine Risk Analysis Systems from Other Countries.*

Two new projects have also been initiated. The first considers the role of networks and the risks associated with both shipping containers and container cargo ships – *Network Theory and Invasive Species – Six Degrees of Preparation*. This research is based on network analytical methods and involves the Australian Quarantine and Inspection Services (AQIS) as a key end-user. It seeks to provide AQIS with a means to more effectively identify high risk containers for inspection. The second project, *Communicating Uncertainty in Biosecurity Adaption*, extends from our recently completed Enhanced Risk Analysis Tools project. Here we seek to explore the role uncertainty plays in prioritisation and how best to communicate this to stakeholders. The project also seeks to deliver a user friendly interface for the enhanced risk analysis tool to facilitate its adoption.

Science:

The completed projects yielded nine manuscripts that have either been published or are under review in peer reviewed journals.

Capacity/collaboration:

The completed projects strengthen Australia's ability to address the likelihood of entry and consequence and ability to improve our capacity to better allocate resources in terms of biosecurity prioritisation. This body of work helps deliver towards the risk-return approach recommended in the *2008 Beale Review* of Australia's quarantine and biosecurity arrangements.

Impact/adoption:

From the completed projects, a method for identifying threats is now being incorporated into the Australian Biosecurity Intelligence Network. Plant Health Australia Ltd will also use the threat identification tool as part of their revision of the biosecurity threat identification process within the wheat industry biosecurity plan.

Based on these achievements, a new focus was developed which extends the scope of the program from one that aimed to develop and deploy tools that have focused on the biological dimensions of individual pathways to one that encompasses the human as well as biological dimensions.

Program 2: Diagnostics Research

The Diagnostics Research Program aims to undertake research that will provide rapid identification of plant biosecurity threats in order to decrease the cost of eradication and impacts through rapid response. As indicated, below, it has been a very rewarding year for this program with many projects reaching maturity and delivering clear outcomes to end-users.

Economics/policy:

Research was completed on an examination of the genes that confer resistance to the inexpensive and versatile fumigant, phosphine, in *Rhyzopertha dominica* (Lesser grain borer) and *Tribolium castaneum* (Rust-red flour beetle).

Treatment of stored grain with phosphine provides assurance that it is free from insect infestation, an important aspect of grain quality for export markets. However, insects develop resistance and managing these risks and assessing whether management strategies are successful in controlling the spread of resistance requires the ability to test individual insects in a timely and cost-effective manner.

The research identified DNA markers that are either tightly linked to resistance, or contain the actual causative nucleotide changes responsible for resistance in both insects. In both cases, strong resistance is caused by two major genetic loci that confer weak resistance on their own but strong resistance when both are present and individual insects are homozygous for the resistance alleles. In its final year the project has targeted these regions and gradually narrowed the search for the actual genes themselves to being contained within just a few genes at each locus. The work has identified mutations that appear to cause resistance in both insect species and are in a gene that is highly conserved between the two species. The team continues to zero in on the 'holy grail' of phosphine resistance, the perfect DNA marker for high-level resistance. The work has also created a valuable scientific resource, being the sequence information for most of the expressed genes in *R. dominica,* which will reduce the expense of future projects. It has also used the linkage data and DNA sequence information from this project to improve the international reference genome sequence of *T. castaneum*.

Science:

Research was completed on applications for optically-encoded beads of less than a few hundred nanometers in size. Specific biological molecules, either short pieces of DNA or antibodies, are bound to the beads and mixed with plant samples to test for the presence of complementary molecules that indicate the presence of specific pathogens in the sample. Optical analysis of the beads shows which have registered 'hits' and, so, which pathogens are detected. The ability to multiplex lots of different beads together means that multiple different pathogens can be detected simultaneously in a single sample, improving throughput and reducing the costs of diagnostic testing. These factors can be critical when identifying, monitoring or managing a biosecurity situation, and this, together with the fact that the testing is delivered using a widely available machine (a flow cytometer), has the potential to increase the uptake of this type of testing in the future.

The use of nanoparticles in this way is a new and emerging field, and as such we recognised that this project carried an inherently higher risk than many of the others we have undertaken. There have been significant technical difficulties to overcome, particularly given the complex chemistries involved, but this has been a challenging and exciting research area to work in and the project has successfully completed all its milestones. Generally, the results have been much more impressive with the antibody-based detection than with nucleic acids, and the project will publish several papers that significantly contribute to this developing field.

One of our most innovative projects is using available sequence data for the red flour beetle to identify and characterise the genes for the proteins that specifically bind insect pheromones. To date 18 genes are under investigation for their potential as pheromone receptors and for their role in insect

communication. This has involved developing and optimising methods for quantitatively analysing how the genes are expressed in the heads and antennae of adults, and determining the location and orientation of the receptors within insect cells. Selected proteins could be used in the future as the basis for a novel biological sensor for use in grain storages to detect infestation by these insects.

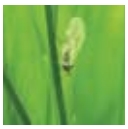
Capacity/collaboration:

A range of biological approaches, including bioinformatics and behavioural, morphometric and mating studies, have been used to examine a particular complex of fruit flies. The species currently named as being within the complex are extremely challenging to differentiate but would impact very differently from each other on Australia's trade and quarantine, should any of them be detected locally.

Data from the different disciplines will be combined and analysed as a whole to determine, on balance of all available data, how many species exist within the group and to design improved diagnostics for the valid species. Currently, one of the project team members is spending a year in the laboratory of a collaborating group at the International Atomic Energy Agency (IAEA) in Vienna, where such biological studies can be conducted without compromising Australia's plant biosecurity. A resounding confirmation that the project's aim, team and scientific approach were sound was provided during this reporting period when the IAEA announced that it was initiating a project on the same theme, and invited our project team to be part of the international effort. This adds significant value to our project, in effect, increasing the number of specimens and resources that will flow into our work.

Impact/adoption:

The National Diagnostics Database project, being the Remote Microscope Network (RMN), the Plant Biosecurity Toolbox™(PBT) and the Biosecurity Bank, continued to grow strongly. More than 30 nodes of the RMN are now established Australia-wide and the network continues to grow in south-east Asia, with new nodes in Laos, Singapore and East Timor added to those already present in Thailand, Malaysia and New Zealand. The project team has conducted a series of workshops with users involved in diagnostics, to demonstrate the functionality of new portals and conduct training for emergency plant pests for trainees at locations remote from the expert. This offers significantly better potential to manage the risks with quarantine pests, in taking the 'expert to the sample', via the internet, rather than taking the risk of moving the pest itself around the country. The next stage is the integration of information tools including the Pests and Diseases Image Library (PaDIL) (which is a virtual collection of plant pests and diseases hosted by Museum Victoria) the PBT, and RMN to capture diagnostic information from a broad base of users through a single diagnostic portal. Uptake of these tools to date suggests that they may eventually form and underpin a National Diagnostic Network for plant biosecurity.



Program 3: Surveillance Research

The goal of the Surveillance Research program is to contribute to a more effective national surveillance system based on scientifically sound sampling tools and survey methodologies. The reporting period has seen a number of activities continue to deliver outputs to end-users who are using the new technologies in the field.

Economics/policy:

Early detection of exotic plant pests is critical to successful eradication and the consequent savings, for affected industries, of the ongoing impacts of new established pests. Active surveillance is a costly activity, particularly if it is to provide the level of sensitivity necessary to detect pests at a sufficiently early stage of introduction. Risk-based identification of sites for surveillance, based on consideration of introduction pathways, and mechanisms of establishment and spread has the potential to extract the maximum value from investment.

The Australian Government Department of Agriculture, Fisheries and Forestry has invested over

two million dollars over the past four years to develop and deliver a risk based urban surveillance program and over five million dollars over the past decade on a ports of entry trapping program. The state and territory agencies delivering these programs have contributed to this investment through in kind contributions. What these activities need are sound analytical tools that can provide some measure of the return on investment compared to alternative approaches. Passive surveillance—drawing on the capacity of a well informed population to detect and notify of possible new pest introductions—is an alternative approach to early detection capability.

We are evaluating the relative effectiveness of targeted active and passive surveillance in urban situations in relation to the costs associated with those activities. It will provide an overarching framework for comparing surveillance systems and making decisions about the value of components of those systems.

Data have been acquired from two urban surveillance schemes and research is focusing on a specific innovation to develop tools to quantify sensitivity where surveillance consistently returns zeroes (absence of a species). The analysis will account for mechanisms such as publicity campaigns and reporting incentives, thereby allowing comparisons between structured sampling and informal surveillance methods. Recent work on search theory and geographic simulation to infer risks can be incorporated in this general decision-making framework.

Science:

While the concept of unmanned aircraft has been in existence for over 70 years, the technological advances of the past 20 years has equipped them with capabilities that create formidable surveillance and spatial data collection tools.

Building from this trend, we have successfully tested a new concept for air sampling via the integration of a prototype spore trap onboard an Unmanned Aerial System (UAS) and ground vehicle platforms. The use of stationary air sampling devices in remote locations and where topography is severe is almost impossible. In such scenarios, airborne and mobile samplings have been suggested as viable alternatives and we have integrated a prototype spore trap onboard UAS and ground based platforms to allow for the capture of spore pathogens in multiple remote locations; otherwise not possible with stationary sampling devices.

The new sampling system has the ability to spatially monitor fungal spores, and protocols to interpret their spatial distribution. These tools will greatly enhance the ability to detect new incursions of fungal pathogens and to enable more accurate delimiting of distribution. The technology will allow for earlier detection of plant biosecurity threats in difficult areas and provide efficient and effective airborne surveillance.

Capacity/collaboration:

The capacity to effectively detect insect pests in stored grains is of critical importance to timely implementation of insect control interventions required to ensure market access and to demonstrate the absence of exotic pests. Accurate sampling of large grain bulks is inherently challenging and in addition, insect infestation is highly uneven and irregular. In collaboration with grain industry partners, we are developing a new sampling system for grain bulks that will provide much increased confidence.

The research team has reviewed current industry practice and is developing a conceptual statistical framework, including a simulation model that merges existing methods and exploits knowledge of insect distribution patterns. This new approach is substantially different to strategies that have been previously used. To provide confidence that parameter values used in the simulation model are reasonable, the new sampling strategy has been tested in field trials undertaken on farm bins and a central storage. Results from these trials are being used to determine sampling intensity.

Impact/adoption:

In conjunction with the development of pest specific contingency plans, we have developed a surveillance planning tool to assess the types of activities and resources that make up both targeted surveys and general surveillance. In addition, an expert

elicitation framework is being developed that will provide improved estimates of the less well defined parameters. This information will be used to increase the rigour of outputs, increasing confidence in end-users.

An important outcome from this program is the continued promotion of biosecurity awareness to the industry. Production of biosecurity extension material (with links to outputs from some of our other projects) includes the development and production of pest-specific information with the recent release of several fact sheets covering key biosecurity pests. Biosecurity information is being delivered to the grains industry through a partnership with the Grains Farm Biosecurity Program managed by Plant Health Australia Ltd.

Program 4: Impact Management Research

The Impact Management Research Program's strategic objective is to undertake research that will minimise the social and economic impact of a harmful pest or disease incursion through the development of management strategies. During the reporting period, we have received positive results from field trials and laboratory tests which will impact the development of these strategies.

Economics/policy:

All high-risk planting material enters Australia via post entry plant quarantine (PEQ) and national plant industries seek rapid access to new germplasm to enable global competitiveness. The time a plant accession spends in PEQ varies from three months to three years, depending on the assessed risk. During this time plants are screened and tested for the presence of exotic diseases. The time limiting step is testing for viruses. Last year, a break-through was achieved with the design of a diagnostic test that can reliably detect a group of viruses. This work has made remarkable progress and group specific degenerate primers for the *Furovirus*, *Hordeivirus*, *Rymovirus* and *Tritimovirus* genera have been designed and validated in Australia and in the New Zealand Ministry of Agriculture and Forestry (NZ MAF) laboratories. Selected primer sets for each genus have detected all virus species screened thus far and have not generated any false positive reactions.

In another area, research was started on the development of non-chemical approaches for the management of incursions in urban and peri-urban areas. As cities sprawl and overseas trade increases, urban and surrounding small landholdings (hobby farms) are increasingly becoming involved in incursions of harmful plant pests and diseases. The public is becoming more aware of 'green' issues and opposition to pesticide use continues to increase. Consequently, it is becoming increasingly difficult to employ techniques traditionally used to eradicate pest incursions. There is public sensitivity to broad spectrum pesticide usage and to aerial application even if low toxicity organic products are used. Tree removal is also becoming increasingly expensive in the current user pays and litigious environment. Our research is aimed at producing eradication programs that are acceptable to the general public and more cost effective for industry.

Two new projects commenced this year. One was designed to enable the safe and secure movement of diagnostic samples between laboratories that met new International Air Transport Association standards. Effective triple packaging has been determined that maintains integrity when posted or sent by courier. Recommendations are being developed and will be provided to laboratories and other stakeholders who package samples for transport. The other project, Airport Forensics was designed to evaluate the risk posed by returning travellers to Australia. Researchers, growers and tourists often visit farms or other related enterprises while overseas on holidays or business. These individuals represent an undefined risk for inadvertently introducing harmful plant pathogens into Australia if appropriate biosecurity measures are not followed. The project is a preliminary investigation into the usefulness of police forensic tape combined with advanced diagnostic detection methods for the detection of harmful plant pathogens on travellers' shoes and clothes.

Science:

Work has commenced on using pheromones to disrupt mating in both urban and agricultural settings. In collaboration with scientists from New Zealand and the United States of America (USA), sterile med-fly was used to disseminate light brown apple moth pheromone in urban Perth. In vineyards in South Australia mating disruption of Light Brown Apple Moth equivalent to the current industry standard treatment was achieved using the innovative 'SPLAT' (Specialised Pheromone and Lure Application Technology) formulation. There was also good progress with the development of advances in sterile insect technology in partnership with USA collaborators which holds strong promise as a component of a new integrated approach to the management of harmful insect incursions.

On another front, the research directed towards PEQ has been internationally published and peer-reviewed. This research has the potential to significantly improve the existing diagnostics bottleneck through the application of this strategy to additional virus genera. This capability is especially important in PEQ due to the large number of viruses that are tested for and the risk of imported plant material containing undescribed virus species.

Capacity/collaboration:

Building a capacity to respond to changing virulence status in harmful plant pests and diseases is a critical element in managing impact. This is particularly the case where a key strategy in the management of harmful plant pests and diseases is through the development of resistant Australian germplasm. In these instances, plant resistance is commonly achieved through simple genetic resistance mechanisms which can be disadvantaged when there is the capacity for harmful plant pests and diseases to develop a complementary virulence factor.

Russian wheat aphid (RWA) is a harmful plant pest of major concern to the Australian grains industry and is known to develop new biotypes that are able to overcome resistance. In order to target breeding programs for resistance it is essential that the mechanisms that drive virulence in RWA are well understood at the molecular level. This research has contributed to the publishing of the first completed genome of a sap sucking insect, the pea aphid, that will form the basis for further investigation into the RWA genome. This has further resulted in the first peer-reviewed paper that compared the genetics of global invasive Russian wheat aphid populations. In addition, we also hosted an international workshop in Singapore for researchers to collaborate on the RWA. Along with the Grains Research and Development Corporation, we provided sponsorship for the workshop, while Murdoch University and CSIRO offered their expertise in developing the scientific program.

Impact/adoption:

The development of novel control strategies is critical to the capacity to manage the impact of harmful plant pests and diseases. In the case of plants, management of a harmful plant disease incursion relies partly on the removal and destruction, by fire and/or burial, of part or entire affected plants. This strategy has proven effective with the eradication of apple scab while recent eradication programs for citrus canker, grapevine leaf rust, black sigatoka of banana and fire blight of pome fruit have all involved the destruction of host plants.

However, this strategy may also result in negative economic and social impacts where affected plant industries are based on perennial species. Earlier research revealed a lack of scientific evidence for the effectiveness of burning or burial of infected perennial tree material. In the previous year, this led to an innovative research model to develop alternative eradication strategies using related endemic pathogens followed by validation of the target exotic pathogen in an overseas country where it is endemic. During 2009, this approach resulted in the development and implementation of a new eradication protocol for black rot on vines located on the Cornell University research station, New York, USA. The development of protocols to manage a possible incursion of black rot pathogen is a high priority for the Australian viticulture industry and the project team continues to engage with the industry regarding findings from the joint US trials and their implications. This work continues with further field trials and an examination of the impact of burning and deep burial on pathogen viability.

Program 5: Post-Harvest Integrity Research

In collaboration with industry partners and other programs across the CRC, the Post-Harvest Integrity Research Program aims to provide practical, scientifically-based biosecurity solutions that underpin market access for Australian grain. During 2009–10, the third year of its operation, the Post-Harvest Integrity Research Program delivered immediate important benefits to end-users and laid the foundation for the long-term biosecurity of Australian grain.

In 2009, a major independent review of our research into resistance to phosphine in insect pests of stored grain was commissioned. The recommendations of the review have guided further investment in this area.

Economic:

To meet market demands for insect and residue-free product, the Australian grain industry has implemented a high-risk strategy of almost complete dependence on phosphine fumigant. There is no practical replacement for this material and its continued use is now seriously threatened by the development of resistance in target pests. Our response to this challenge is to develop a multi-disciplinary research portfolio that provides industry with practical solutions to combat current resistance outbreaks, improves the efficacy and practice of pest and resistance management tactics, develops alternatives to phosphine and provides essential knowledge of the biology of target insects to underpin long term biosecurity.

Science:

Research on the dispersal and colonisation of grain insect pests in rural landscapes continues with surprisingly high numbers being detected in various parts of the landscape. However, population genetics analysis on one of the major species, *T. castaneum*, suggests that the population structure is stable with no spatial or temporal variation. Analysis of the population genetics of *R. dominica* is still in progress. Similarly, preliminary results of gene flow in the flat grain beetle indicate that there may be significant levels of gene flow in this species. In addition, a molecular diagnostic tool was developed to distinguish between the major pest *Cryptolestes ferrugineus*, and minor species with similar appearance, *C. pusillus* and *C. pusilloides*. In other work, no insects have been detected feeding on non-cereal hosts in farm land or areas of native vegetation. This finding suggests that these insects depend on cereal seeds alone to support population growth. Bayesian statistical analysis of farmer surveys from Queensland, New South Wales and Victoria revealed that social research of this type can provide data on the grain storage and handling practices of growers and their potential impacts on pest ecology and resistance development. The effect of life-stage under selection has been incorporated into mathematical modelling of resistance development.

Impact/adoption and Policy:

The new nationally standardised resistance monitoring program was deployed this year providing the grains industry with tactical and strategic information on the frequency, distribution and strength of resistance across Australia. This program detected new high level resistance in a key species. The program is also providing crucial information on infestations and feedback on the success of management interventions. In addition, new fumigation protocols were developed in consultation with industry. The protocols were validated in industry field trials and are now included in the industry resistance eradication plans developed in consultation with the project team.

During the reporting period, research was completed on a mathematical model that predicts concentrations of sorbtive fumigants administered by fan forced systems throughout industrial scale grain stacks, enabling fumigant performance to be evaluated. The model was subsequently validated with field trials, successfully described complex leakage, weather effects and gas dispersion parameters that predict success or failure of fumigation. A key finding was that, depending on the balance of these parameters, even poorly sealed stores can effectively disinfest grain and stores

with excellent seal can incur inadequate fumigant concentrations. In addition, key 'weak zones' were identified as well as procedures to address these. An output of this research was the development and evaluation of a prototype fan-forced fumigation technology that implements fast and thorough fumigant distribution, as well as enabling integration with aeration-cooling.

Capacity/collaboration:

Two new areas of research were commissioned during the reporting period. The first of these was to develop and evaluate 'low oxygen' as an alternative disinfestation method. Although thought to be generally slower than the use of phosphine, this method offers a completely chemical free treatment. The very low oxygen levels required to control insects can be obtained by purging silos with an inert gas. The most practical inert gas is nitrogen and trials have been undertaken trials on medium scale wheat storages to evaluate the cost-effectiveness and suitability of a nitrogen generator and gas application methods. As an example, Lake Grace WA Farmer Group has introduced a set of PSA nitrogen generators to treat wheat and offered wheat without insect and chemical residues. As result, the nitrogen treated wheat was sold at a premium price ($20–30 higher than if it wasn't treated with nitrogen). In the laboratory, research has been initiated into insect pest population extinction profiles at various oxygen levels and the reaction of grain in these atmospheres. Results from both the field and laboratory research are very promising with successful large-scale application of the technique and elimination of all stages of a major pest species.

The second new area of research includes several initiatives designed to improve the structural integrity of grain storages to meet the highest biosecurity standards. Research will focus on developing storage design standards and management plans, improving sealing and retro-sealing materials and techniques, and developing a safe, effective ground level phosphine application system specifically for farmers. Research is already advanced in several areas. A prototype farm storage phosphine application system consisting of ground-level application coupled with a 'thermo-siphon' gas distribution system has been developed and successfully trialled in several farm storages. Part of the research for this system is determining the parameters required for the safe use of phosphine. In other work, a spray-on, food-grade material has been developed to cap stored grain to improve fumigation outcomes.

Research Collaborations

We continue to develop collaborative linkages across participant organisations through meetings, advisory panels and conferences. We also provide and encourage our research teams to use web-based and teleconferencing technology to enhance collaboration throughout their project. Our Science Exchange held in September was instrumental in bringing everyone within the CRC together and allowing them to further expand professional collaborative relationships.

As indicated in other areas of this report, a network of remote microscopes has been established in Australia and New Zealand with a nominal headquarters in the Australian National Insect Collection (ANIC) which is located in Canberra, Australia.

This project has been instrumental in developing collaborative networks and increasing Australia's pre-border surveillance. Through these collaborative efforts, a community of RMN users and experts has developed, providing a tangible example of our efforts to develop a national network for biosecurity science and provide linkage to international efforts and expertise.

The RMN use has been complemented by the Plant Biosecurity Toolbox™ which provides detailed, web-based diagnostic information to assist with the rapid identification of exotic plant pests and diseases in the event of an incursion and is another example of our efforts to link research efforts to build a stronger national biosecurity community.

During the reporting period our collaborative efforts continued through the quadrilateral scientific collaboration in plant biosecurity (QUADS-SciCo) alliance. This allows us to work with biosecurity colleagues in Canada, New Zealand and the United States of America to share resources to address biosecurity topics of common interest. For example, during the reporting period our researchers attended a Technical Working Group meeting to discuss eradication of Light Brown Apple Moth from California. Data from our research in Australia and New Zealand contributed to authority efforts to gear up for the eradication campaign.

Another key research collaboration links Indigenous communities in northern Australia and eastern Indonesia to develop informed 'eyes and ears', alert to strange organisms and able to complement the more conventional surveillance activities of regulatory and scientific bodies. This research comprises many collaborations and partnerships and was recently rewarded with public recognition for information on the issues surrounding citrus pests and diseases. This resulted in an invitation from the Indonesian Government Department of Quarantine for project team members to act as expert advisors to consult on biosecurity matters in the local region and provides an example of our efforts to build human capacity in biosecurity and to equip the biosecurity community with world-class knowledge and tools.

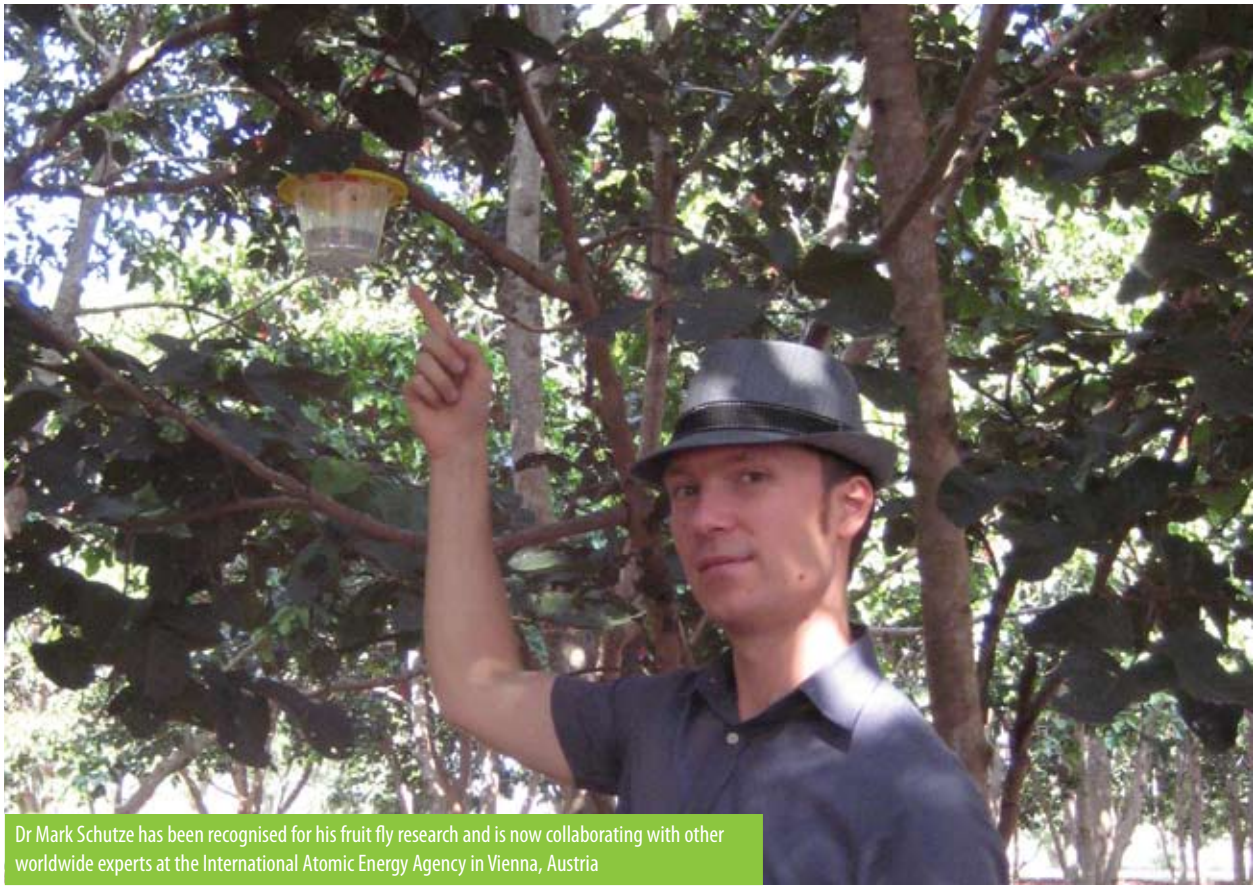
One of our fruit fly projects received international interest from the International Atomic Energy Agency (IAEA) of the United Nations Food and Agriculture Organization (UN/FAO) in the reporting period. In early July, project members Associate Professor Tony Clarke, Queensland University of Technology (QUT) based CRC postdoctoral fellow Dr Mark Schutze and Lincoln University's Dr Karen Armstrong, were three of only 11 people worldwide invited to participate in an international consultants meeting held at the United Nations' IAEA headquarters in Vienna, Austria. The role of the UN/FAO's IAEA is to help member nations facilitate trade and improve agricultural and horticultural industries through the non-military use of nuclear technologies.

During the meeting, global fruit fly experts discussed a proposed new international project on resolving fruit fly species complexes, with a focus on the *Bactrocera dorsalis* complex and the South American *Anastrepha fraterculus* complex. The international project will develop strategies to resolve species boundaries in fruit flies and has applications for sterile insect technique programs and trade.

Following this meeting, Dr Schutze was invited back to Vienna to conduct cross-mating and developmental trials on four different fruit fly species. While Dr Schutze's visit to Austria is to specifically work towards his CRC project, the work is intimately tied to an international effort to understand fruit fly cryptic species complexes. The international project, initiated by the IAEA, similarly focuses on resolving cryptic fruit fly species complexes but from a Sterile Insect Technique perspective. Coupled with the work in Austria and in Australia, there is now a worldwide effort to cooperate in understanding these systems. Researchers from regions such as Asia, South America, Europe, New Zealand, and North America are now engaged in the broader IAEA cooperative research project (in which Associate Professor Tony Clarke of QUT and Dr Karen Armstrong of Lincoln University are also involved).

Also indicated earlier in this report, the successful delivery of the *Global Biosecurity: safeguarding agriculture and the environment* conference enabled a number of collaborative opportunities with colleagues from across the globe and also with other cooperative research centres.

In the reporting period, we continued to provide consultancy services to Chevron Australia Pty Ltd. This commercial collaboration continues to assist Chevron in meeting the environmental operational requirements of the Gorgon project off Western Australia's northern coastline.



Dr Mark Schutze has been recognised for his fruit fly research and is now collaborating with other worldwide experts at the International Atomic Energy Agency in Vienna, Austria

Commercialisation and Utilisation

Commercialisation and utilisation strategies and activities

Commercialisation and utilisation of science outputs are coordinated by the Delivery and Adoption Program. A major focus for this program during the reporting period has been establishing delivery frameworks as the central mechanisms through which our scientific output is provided to end-users. These frameworks were acknowledged by the CRC NPB Ltd Board during the first quarter of the financial year and have subsequently formed the basis for prioritising delivery and adoption activities across the organisation.

In consultation with the Science Committee, the delivery frameworks were developed to provide an overarching structure to optimise the impact of the science portfolio's projects. Five frameworks were developed roughly matching the current program structure and covering the following thematic areas – *Biosecurity Risk, Diagnostics*, *Area Freedom*, *Response* and *Stored Grains Biosecurity*. The frameworks guide the Science Committee and the Delivery and Adoption Program in their commercialisation and utilisation efforts. In both the *Response* and *Stored Grains Biosecurity* areas, a number of key projects had second phase proposals approved and a part of this process was ensuring that significant linkages to government and industry were built into the project design. These projects will mature during the 2010–11 financial year and will become later focuses for the Delivery and Adoption Program. The other three frameworks occupied the Delivery and Adoption Program during this reporting period and the following few paragraphs are examples of how they guided activities over the year.

Our portfolio of *Biosecurity Risk* related research was enhanced with the approval and commencement of the *Communicating Uncertainty in Biosecurity Adaptation* (CUBA) project. The CUBA project forms the foundation of the *Biosecurity Risk* delivery framework as it will act as a conduit to feed in the outputs of a number of our projects in the risk area. Developing a user friendly system to prioritise threats, the project will build on a number of existing models and initiatives (around pest spread, likelihood of pest entry and the impact of climate change) we have developed and trialled project outputs directly with key horticultural organisations that have contributed to the project's resourcing. The Delivery and Adoption Program has been working with the CUBA project leader to ensure that outputs from across the risk research portfolio are included in the ultimate design of CUBA and that CUBA can successfully make accessible for our industry and government partners some of the more complicated research outputs we have developed.

Both the *Diagnostics* and the *Area Freedom* delivery frameworks are dependent on successfully creating relationships with the two national bodies responsible for the coordination of the Australian effort in these areas; the Sub-Committee on Plant Health Diagnostic Standards (SPHDS) and the Surveillance Reference Group (SRG). These two organisations form the key delivery mechanisms for projects in these areas.

In terms of delivery for *Diagnostics* this report has demonstrated the success of adoption and uptake of the Remote Microscope Network and Plant Biosecurity Toolbox™. This was further enhanced during the financial year with SPHDS announcing that all diagnostic protocol information was to be uploaded to the Toolbox, as well as our commitment to providing resources for more remote microscopy sites to be rolled out across south-east Asia. The financial year also saw key projects presented to the QUADS working group made up of high-level diagnostic representatives from Australia, New Zealand, Canada and the United States. It also saw early planning for structured training days in new diagnostic test and techniques that will be rolled out in conjunction with the Education and Training Program and SPHDS.

Similarly, in *Area Freedom,* the delivery framework has resulted in the Delivery and Adoption Program working closely with the SRG to organise the best mechanism, under their imprimatur, through which to deliver our new techniques to state based agencies responsible for national and local surveillance and trapping. Indeed, this has resulted in a technical reference group being established within the SRG to look at new technologies available in surveillance, starting with our PDA project. Planning for a national Surveillance R&D Day also commenced during the reporting period and is expected to be held towards the end of 2010.

As well as coordinating holistic delivery and adoption for our CRC, the program also has responsibility for managing four projects – all of which performed very well during the reporting period. The four projects cover distinctively different areas of biosecurity research, but share a common linkage in their design to specifically focus on end-user and stakeholder engagement, with the aim to facilitate rapid adoption of outputs.

The first of these projects, *Grains Knowledge Network*, continues to go from strength-to-strength with Grains Biosecurity Officers (GBOs) working with growers in Queensland, New South Wales, Victoria, South Australia and Western Australia (which were supported by CRCNPB, Plant Health Australia Ltd and the relevant state agricultural department) and are now managed by Plant Health Australia Ltd. Indeed the GBOs have been the mechanism through which phosphine management practice change initiatives have been delivered to growers in conjunction with the Grains Farm Biosecurity Program. Additionally, the GBOs were pivotal in disseminating the pleasing results of the phosphine best practice management cost-benefit analysis conducted by the project, encouraging growers to spend money in the short-term on infrastructure and management improvements that are aimed at reducing resistance costs in the long-term.

Our PDA project has reached a pivotal stage in development, with the SRG agreeing to the final software modifications for the project's urban surveillance program during the financial year. This will allow the project to deploy the software and associated training in conjunction with the national roll-out of the BioSIRT multi-pest template. Both BioSIRT and our urban surveillance program are now compatible, which will streamline the collection of surveillance data and its storage in this important national database by ensuring the PDAs collect data in a format that can easily link to the database's structure. The PDA software we have developed is now in regular use for surveillance activities in Western Australia, Queensland, New South Wales and the Northern Territory.

The community based biosecurity project based in northern Australia and eastern Indonesia has made significant progress in implementing and validating enterprise development and sustainable workforce development models created in earlier phases of the project through constructive partnerships with various Indigenous communities in both nations. Additionally, our project into the optimal investment in biosecurity research and development has successfully integrated various scientific models into its economic models for fruit-fly and grain pest spread and surveillance. This has been achieved through close collaboration with our horticultural and grains partners, as well as strong linkages with our state agricultural department participants which will facilitate greater end-user uptake as the models get closer to completion.

Finally, two new initiatives developed during the 2009–10 financial year that will help us measure impact were the post-completion and post-implementation surveys. The online post-completion survey is provided to project leaders directly after submission of their final reports. During the reporting period, approximately six surveys were completed and gathered valuable information concerning end-user engagement, research output uptake and the experience of the project leader in coordinating a CRCNPB project. The results of this survey then contribute to the qualitative face-to-face post-implementation survey, which will gather more in-depth information regarding how the project outputs have been used, what has been the resulting practice change of this usage and how great an impact this practice change has had. The first post-implementation survey is scheduled for the first quarter of the 2010–11 financial year.

Intellectual property management

Our well established intellectual property (IP) management processes continued to perform to expectations during the 2009-10 financial year.

Our Canberra office has a responsibility to identify, secure, maintain and protect the new knowledge developed across our research portfolio. Pursuant to our governing documents, we define new knowledge to include both public domain and protected outputs and our IP register appropriately reflects this distinction. The IP register is situated within our online project management system, with access restricted to ensure confidentiality.

Our *IP Manual* continues to be the cornerstone of our IP arrangements, providing policies and procedures for the classification of IP and, if appropriate, acquiring suitable protection on IP that has been deemed suitable for formal protection. The manual remains in compliance with the National Principles of IP Management and is administered by the Business Manager and Delivery and Adoption Officer who, along with the CRC NPB Ltd Board, Chief Executive Officer and Research Leader, received additional IP training during the 2009–10 financial year.

Identification of new IP slowed down during the reporting period owing to the decrease in project development across the research portfolio. Nonetheless, due diligence in identifying new IP was carried out and all new projects continued to have the relevant IP and confidentiality stipulations built into their individual contracts. As a part of ongoing efforts to continually reassess the IP status of our projects, research program leaders continued to provide quarterly updates as to any material changes in the IP status of the projects under their administration.

Additionally, during the financial year, the IP register underwent an audit with a focus on ensuring that all IP suitable for the public domain was updated and listed accordingly on the register to facilitate knowledge transfer to participant organisations and end-users. As an additional level of IP management, the Board receives quarterly reports with an update of the IP status of all research projects and a copy of the IP register.

During the reporting period, we successfully had our first trade mark granted – the Plant Biosecurity Toolbox™. This successful exercise means that the brand integrity and significant resourcing effort in establishing this online tool will be protected as we continue to advocate the use of the Plant Biosecurity Toolbox™ both nationally and internationally.

Furthermore, the 2009–10 financial year saw the first patent application made on behalf of one of our PhD projects, *NICTA Smart Trap.* An application has been submitted to patent a Descriptor of a Hyperspectral or Multispectral Image. This PhD project is a collaboration between us and National ICT Australia (NICTA) and the student has contributed to the IP listed on the application that is part of a much larger project examining the utilisation of highly advanced cameras in surveillance trapping programs. We have a *Collaboration Agreement* with NICTA that outlines the responsibilities regarding IP, its protection and commercialisation and pursuant to this agreement, all action in regards to this patent is the responsibility of NICTA. We liaised with NICTA to ensure that we accrued the maximum possible benefit from this application pursuant to the *Collaboration Agreement* and our financial contribution to the project.

The reporting period also saw our project *Nanobead Diagnostic Platform*, a collaborative initiative between CRCNPB, Nanomics Biosystems Pty Ltd and the Queensland Government, draft an application to patent the Promenade Software on which the system operates. As with NICTA, we have a *Collaboration Agreement* with Nanomics that assigns the responsibility of formal protection and administration of all project IP to Nanomics. As part of this arrangement, Nanomics maintains a right to take licence to commercialise project IP, with the express condition that a commercialisation strategy be developed by Nanomics and agreed to by the collaboration partners. The patent application is in the final stages of negotiation and will be submitted before the end of 2010.

The successful negotiations of both these patent applications signifies that the *Collaboration Agreement* structure we implemented with non-participant research collaborators is working effectively and is a model that we will continue to employ in future collaborative opportunities.

Our IP arrangements ensure that CRCNPB technologies will accrue maximum benefits to Australia by releasing material suitable for the public domain while keeping potential commercial successes confidential. As the development of our technologies continue to advance, arrangements for their commercialisation, technology transfer and accrual of national benefits will continue to develop commensurately and will focus on the specifics of the technology and associated market under consideration. This process may involve formal IP protection or technology transferral through mechanisms in the public domain as deemed appropriate by management and as guided by our IP policies and procedures. Irrespective of the pathway, these processes will follow the basic premise of assessing the cost to the CRCNPB versus the return to the CRCNPB, our participants and the return to Australia more generally.

Communication strategy

We have a comprehensive communication strategy which provides overarching guidance for our communication activities. During the financial year, this strategy was evaluated as a way of ensuring all identified tactics were completed within the planned time frames. Continual monitoring and evaluation of the communication strategy to ensure it aligns with our *Strategic Plan* is considered a key role of the communication and executive management teams.

Communication continues to play a major role in the dissemination of our research activities to end-users including industry, plant industry representative bodies, government and growers. To facilitate communication, we continue to work closely with our participants Plant Health Australia Ltd, Grains Research and Development Corporation and Horticulture Australia Limited who act as a conduit to industry.

In addition to this, during the reporting period we developed a *Stakeholder Management Plan* to manage our engagement across industry, government and participants. Recognising it is a difficult task to keep everyone informed of our research activities, as part of this plan, we have identified key people within plant industry bodies to receive information on our research and have targeted them appropriately. We anticipate this strategy will encourage these key stakeholders to further disseminate our research outcomes to their relevant industries/organisations.

We also continue to support agricultural plant industry conferences, using our presence as an avenue to raise awareness of our biosecurity research activities and the benefits they provide to Australia's plant industries. We also support plant science conferences as generally these attendees are the users of many of the technologies and research methodologies we develop. By communicating our research outcomes to these groups, we increase our opportunity for adoption of these outputs.

As part of our communication strategy to reach Australia's rural farming communities and agri-businesses, we undertook a targeted media campaign during the financial year. The objective of the campaign was to raise awareness in regional communities of our research projects and how they will positively impact the industries in which they operate. We had successful uptake with many articles being published in rural publications with wide circulation figures. Issues covered included our research into managing phosphine resistance in stored grain, genetic research on the Russian wheat aphid, eradication strategies in the viticulture industry, forensic research methods for plant pathogens and our investment to increase capacity in stored grain research.

Our website is easy to navigate and enables users to access a variety of information on our projects, researchers, publications, corporate activities, staff, news and events. During the financial year, we implemented RSS feeds and automatic email updates so that people interested in receiving news can easily subscribe. We continue to distribute our electronic newsletter *The Leaflet* every two months to over 700 subscribers from across national and international plant industries. This serves as a vehicle to promote the biosecurity research we are doing which will sustain Australia's export markets and reputation as a supplier of pest free produce. During the reporting period we implemented bibliographic software on our website in an effort to communicate our researchers' contribution in scientific publications. This software provides a citation list of science publications and links them to the relevant projects.

To embrace additional social media technologies, we also developed an online blog for our Chief Executive Officer – talkingplantbiosecurity.com. The blog provides an avenue for two-way communication for people interested in plant biosecurity and the research we are doing. We will assess the uptake of this technology before we implement any further social media communication activities in the coming financial year.

End-user involvement and CRC impact on end-users

A key strength of our CRC is the involvement of our participants who are, in many cases, end-users of research results. This ensures maximum benefit and impact in the delivery of project outputs, development of new products and services and capture of intellectual property. Many plant industries and their relevant bodies are engaged during research activities to ensure research meets their requirements.

Being involved in our research benefits our end-users by having:

- reduced risk of incursions and improved capacity for incursion response and management
- better diagnostic tests to increase accuracy and efficiency of quarantine detection systems
- enhanced data expected to help ensure pest-free status and maintain international export markets
- enhanced research capability to protect Australia's plant industries
- minimised impact of phosphine and protectant resistance in stored grain insect populations, and
- a high-level of confidence in the biosecurity status of areas where they are operating.

Attending industry conferences provides an opportunity to engage with end-users

	End-user name	Relationship with CRC	Type of activity/ end-user location	Nature / scale of benefits to end-user	Actual or expected benefit to end-user
Australian Government (DAFF)	Department of Agriculture, Fisheries and Forestry (DAFF)	Participant	Biosecurity Management (National)	Better preventative systems, diagnostic tests, surveillance methods, and impact management tools.	Reduced risk of incursions and improved capacity for incursion response and management.
	Biosecurity Services Group (BSG) (DAFF)	Participant	Quarantine Assessment and Policy Advice (Canberra)	Improved surveillance data and modelling for quarantine assessments and policy advice.	Enhanced data expected to help ensure pest-free status and maintain international export markets.
	Australian Quarantine Inspection Service (BSG/DAFF)	Participant	Quarantine Services (National)	More accurate, efficient and cost-effective quarantine detection systems.	Better diagnostic tests expected to increase accuracy and efficiency of quarantine detection systems.
	Northern Australian Quarantine Strategy (BSG/DAFF)	Participant	Quarantine services (North Australia)	More accurate, efficient and cost-effective quarantine detection systems.	Better diagnostic tests expected to increase accuracy and efficiency of quarantine detection systems.
	Office of the Chief Plant Protection Officer (BSG/DAFF)	Participant	Biosecurity Management (National)	Improved risk analysis, diagnostics, surveillance and response strategies for biosecurity threats.	Enhanced data and strategies expected to help ensure pest-free status and maintain international export markets.
State Governments	Department of Agriculture and Food, Western Australia	Participant	Biosecurity Management (Western Australia)	Better preventative systems, diagnostic tests, surveillance methods, and impact management tools.	Reduced risk of incursions and improved capacity for incursion response and management.
	Department of Primary Industries, Victoria	Participant	Biosecurity Management (Victoria)		
	Department of Primary Industries and Resources South Australia (PIRSA)	Participant	Biosecurity Management (South Australia)		
	Industry & Investment New South Wales	Participant	Biosecurity Management (New South Wales)		
	Northern Territory Department of Regional Development Primary Industry, Fisheries and Resources	Participant	Biosecurity Management (Northern Territory)		
	Department of Employment, Economic Development and Innovation (DEEDI)	Participant	Biosecurity Management (Queensland)		

	End-user name	Relationship with CRC	Type of activity/ end-user location	Nature / scale of benefits to end-user	Actual or expected benefit to end-user
Research Agencies	Australian Centre for International Agricultural Research (ACIAR)	Collaborative Research Provider	Biosecurity Management (International)	Better preventative systems, diagnostic tests, surveillance methods, and impact management tools.	Reduced risk of incursions and improved capacity for incursion response and management.
	CABI	Participant (since March 2010)	Biosecurity Management (International)	Better preventative systems, diagnostic tests, surveillance methods, and impact management tools.	Reduced risk of incursions and improved capacity for incursion response and management.
	Commonwealth Scientific and Industrial Research Organisation (CSIRO)	Participant	Biosecurity Management (National)	Better diagnostic and surveillance tools.	Enhanced research capability to protect Australia's plant industries.
	Grains Research and Development Corporation (GRDC)	Participant	Biosecurity Management (National)	A high plant biosecurity status is maintained for plant industries.	Reduced risk of incursions and improved capacity for incursion response and management.
	Horticultural Australia Limited (HAL)	Participant	Biosecurity Management (National)	A high plant biosecurity status is maintained for plant industries.	Reduced risk of incursions and improved capacity for incursion response and management.
	International government agencies	Collaborative Research Providers	Biosecurity Management (International)	Better preventative systems, diagnostic tests, surveillance methods, and impact management tools.	Reduced risk of incursions and improved capacity for incursion response and management.
Industry	Viterra	Participant	Biosecurity Management (SA and Vic)	Market access and trade maintained through enhanced grain storage.	Minimised impact of phosphine and protectant resistance in stored grain insect populations.
	Chevron	Industry	Biosecurity Management (WA)	Minimised environmental impact of industry activities.	Provide a high-level of confidence in biosecurity status of areas where industry is operating and tools to ensure accountability to government on retaining pristine environment.
	CBH Group	Participant	Biosecurity Management (WA)	Market access and trade maintained through enhanced grain storage.	Minimised impact of phosphine and protectant resistance in stored grain insect populations.

	End-user name	Relationship with CRC	Type of activity/ end-user location	Nature / scale of benefits to end-user	Actual or expected benefit to end-user
Industry	GrainCorp Ltd	Participant	Biosecurity Management (Vic, NSW and Qld)	Market access and trade maintained through enhanced grain storage.	Minimised impact of phosphine and protectant resistance in stored grain insect populations.
	Ordguard	Industry	Biosecurity Management (WA)	Better preventative systems, diagnostic tests, surveillance methods, and impact management tools.	Reduced risk of incursions and improved capacity for incursion response and management.
	Plant Industry SMEs*	Industry	Principal beneficiaries of CRCNPB outputs (National)	CRCNPB outputs will minimise economic, social and environmental impacts of future pest incursions leading to increased export opportunities and stable production costs.	Enhanced plant biosecurity will ensure market access and enable new market potential. Production costs will not increase due to minimising impact of future incursions.
	Saturn Biotech	Participant	Commercialisation (Perth)	New technologies and tools will provide faster, more cost-efficient and accurate diagnostics.	Outputs from diagnostic projects will enhance Saturn Biotech's service provision to the plant industries.
Industry/government coordination	Plant Health Australia Ltd	Participant	Plant Health Management (National)	Better biosecurity planning and communication tools.	Reduced risk of incursions and improved capacity for incursion response and management.

* Plant Industry SMEs

A3P, Almond Board of Australia, Apple and Pear Australia Limited, Australian Banana Growers' Council, Australian Citrus Growers' Inc, Australian Dried Fruits Association Inc., Australian Honey Bee Industry Council, Australian Macadamia Society Ltd, Australian Mango Industry Association, Australian Nut Industry Council, Australian Olive Association Ltd, Australian Passionfruit Industry Association, Australian Processing Tomato Research Council Inc., Australian Table Grape Association, Australian Walnut Industry Association, AUSVEG, Avocados Australia, CANEGROWERS, Canned Fruit Industry Council, Cherry Growers of Australia Inc., Cotton Australia, Grains Council of Australia, Growcom, Nursery and Garden Industry Australia, Onions Australia, Ricegrowers' Association of Australia, Strawberries Australia, Summerfruit Australia Ltd, Winegrape Growers Association of Australia.

Education and Training

The key highlight for the Education and Training Program was the commencement of teaching in three new postgraduate degrees in plant biosecurity. The degrees are taught by a consortium comprised of five participant universities: Charles Darwin University, La Trobe University, Murdoch University, Queensland University of Technology and the University of Adelaide. In February 2010, the first students were enrolled across the Graduate Certificate, Graduate Diploma and Masters of Plant Biosecurity, with an additional cross-enrolled student taking one of the individual units. These students are all employees from various state and federal government organisations throughout Australia.

In the first semester of teaching students were taught in four units – *Plant Biosecurity in Practice* and *Detection and Diagnostics* (taught by Murdoch), *Biosecurity Plant Pests – Invertebrates* (taught by QUT) and *Biosecurity Plant Pests – Plant Pathogens* (taught by La Trobe). The feedback was extremely positive with the following comments received.

- *'Thank you for a very pleasant return to study. Some stressful moments at times but it will always be like that.'*
- *'Excellent course and very relevant, I hope you've had a good uptake on it.'*
- *'Haven't studied for 15 years and never online, interesting experience and a pleasant return to study.'*
- *'Easy to understand format for delivery, timelines for study/assignments/quizzes was good.'*
- *'I would certainly recommend the unit to other colleagues and would even suggest that this unit is completed in the first year of service as it provides a fantastic grounding to the big picture of biosecurity' (referring to Plant Biosecurity in Practice).*
- *'It has been very enjoyable to do the course!'*
- *'The lecture material was very good, very useful!'*
- *'Very relevant and useful.'*

Our PhD candidates continue to work steadily on their many and varied projects, with some starting to publish their first results in peer reviewed journals. We encourage all our students to publish their research. As an incentive, those who publish are eligible to apply for a cash reward, with a higher payment for those who publish before submission of their theses. This incentive is designed to assist students in the timely completion of their theses by encouraging them to write up their results throughout their candidature period and, preferably, publish their research before submission of their theses for examination.

As we have commenced the last three years of operation, we are no longer recruiting PhD students, however, we continue to support new Honours students, with three commencing this year. Industry and participant members continue to co-supervise our students, with a total of 52 supervisors from our participant organisations and 37 academic supervisors from our universities.

This financial year, our students have benefitted from two professional development workshops which coincided with our Science Exchange in September and the *Global Biosecurity: safeguarding agriculture and the environment conference* in February. Science communication was covered in the September workshop and in February students received biosecurity awareness training with Plant Health Australia Ltd, and a session on statistics. They also visited the Australian Quarantine and Inspection Service (AQIS) facility at Brisbane airport to gain a greater understanding of the operational aspects of quarantine. Feedback from these professional development opportunities continues to be very positive, with students recognising the value of the workshops for their PhDs and future careers.

Evaluation of our primary school unit *'Plant Pest Investigators'* was completed in late 2009. Comments and suggestions from teachers who trialled the unit were incorporated into the final version which has now been published and is available from our website

or as a hard copy. Activities for lower secondary school students were also developed and are now available from our website. There has been strong interest in the school activities from teachers across Australia and internationally.

For our researchers and industry participants we continue to offer training in various forms. Several workshops on project aspects and emerging model integration were conducted as part of project *An Indigenous community and local knowledge-based model to manage harmful plant pests and diseases.* These were conducted across Indonesia in Tabanan (Bali), Salatiga (Central Java), Budang (Bali) and Gilinanggu (West Nusa Tenggara) in July, August, January and April respectively. As indicated earlier in this report, we also held a very successful international workshop on Russian wheat aphid in Singapore, with participants attending from 10 countries.

Several workshops have also been conducted as part of the roll out of the remote microscope network, as well as a plethora of information sessions for people interested in using remote microscopy. A number of international visits have resulted in training staff to use the remote microscope network across Thailand, Laos, Malaysia, Vietnam and East Timor. Workshops conducted in Australia have covered mango seed weevil, nematodes, mites and myrtle rust. Several training courses have also been run for our participants 'in house', using the equipment that forms the basis of remote microscopy and demonstrating that the nuts and bolts of this technology are suitable for a wide range of training contexts.

2009-10 PhD students at their annual professional development workshop in September

Back L – R: Jason Thorne, Daniel Jones, Nichole Hammond, Steven Coventry, Mark Stanaway, John Weiss, Brian Garms, Mark Castalanelli, Paul Royce, Sunil Singh, Wayan Mudita
Middle L – R: Rachel Meldrum, Alistair McTaggart, Matthew Tan, Alison Mackie, Rachel Powney, Amy Smith, Bobbie Hitchcock, Bonny Vogelzang, Craig Feutrill, Theo Litaay
Front L – R: Jennifer Spinner, Mai Hlaing Loh, Jenny Vo, Sharon Van Brunschot, Jordan Bailey, Rebecca Zappia, Pattaraporn Khuwuthyakorn, Linda Semeraro

(Absent from photo: Sakuntala Muthuthantri, Kylie Ireland, Alex Rea, Bo Zhang, Anna Rathe, Mingren Shi, Hoda Ragab, David Savage)

Glossary of Terms

ACRONYM	MEANING
ACIAR	Australian Centre for International Agricultural Research
ACERA	Australian Centre of Excellence for Risk Analysis
ASEAN	Association of Southeast Asian Nations
AQIS	Australian Quarantine and Inspection Service
BSG	Biosecurity Services Group
CBH	CBH Group
CRC	Cooperative Research Centre
CRCNPB	Cooperative Research Centre for National Plant Biosecurity
CRC NPB Ltd	Cooperative Research Centre for National Plant Biosecurity Limited (The Company)
CSIRO	Commonwealth Scientific and Research Organisation
DAFF	Department of Agriculture, Fisheries and Forestry
DAFWA	Department of Agriculture and Food, Western Australia
DEEDI	Department of Employment, Economic Development and Innovation
DPIVIC	Department of Primary Industries, Victoria
EPP	Emergency Plant Pest
GRDC	Grains Research and Development Corporation
HAL	Horticulture Australia Limited
ICT	information and communications technology
I&INSW	Industry & Investment, New South Wales
IP	Intellectual property
LBAM	Light brown apple moth
MAF	New Zealand Ministry of Agriculture and Forestry
NAQS	Northern Australia Quarantine Strategy
NICTA	National ICT Australia
OCPPO	Office of the Chief Plant Protection Officer
PaDIL	Pests and Diseases Image Library
PDA	personal digital assistant
PHA	Plant Health Australia Ltd
PhD	Doctor of Philosophy
PIRSA	Department of Primary Industries and Research South Australia
QUADS	Quadrilateral Agreement on Plant Health
QUT	Queensland University of Technology
R&D	research and development
RWA	Russian wheat aphid
SARDI	South Australian Research and Development Institute
SPHDS	Subcommittee on Plant Health Diagnostic Standards
SRG	Surveillance Reference Group

Third Year Review

A full review of our operations was completed in 2008. An independent review panel was selected, chaired by Dr Kevin Sheridan. The other panel members were Dr Craig Phillips, Mr David Crawford and Professor Elizabeth Deane (appointed by the Department of Industry, Innovation, Science and Research (DIISR)).

The CRC NPB Ltd Board was responsible for commissioning and overseeing the review and implementing any recommendations arising from the review. The Board formed a subcommittee consisting of Professor John Lovett, Mr Barry Windle and Professor John Irwin. The subcommittee set the terms of reference for the review (along the lines of the broad terms of reference) as determined by DIISR.

The independent review panel provided our Board with a report that incorporated 16 recommendations. Each of these recommendations has now been met. A status report is provided in the table below.

Third Year Review Recommendations

Recommendation	Implemented (Y or N)	Strategies to implement
Recommendation 1: Greater end-user involvement in all phases of the project cycle	Yes	The CRC NPB Ltd Board has identified his recommendation will be a continuing endeavour for the remaining life of the CRCNPB.
Recommendation 2: That the strategic planning process includes legacy planning	Yes	Meetings have been held with participants and other stakeholders to discuss legacy planning of the CRCNPB. Four considerations were discussed. **Second term:** Some existing participants of this CRC, along with potential new participants have submitted a bid for another term under the name Plant Biosecurity CRC. If successful, this second term will ensure we maximise the outputs of the current term while taking account of new priorities. **Intellectual Property (IP) and project outputs/outcomes:** We have identified and developed a range of emerging technologies in our current research activities along with associated IP. We have identified other organisations who can continue the development through to delivery and adoption of project outputs/outcomes and maintain management of the IP generated if we are unsuccessful in our bid for another term. **Capacity building:** We undertake capacity building through the training of PhDs and appointment of postgraduate researchers into the Australian biosecurity system. We offer each PhD candidate additional training opportunities to assist them in development of a career pathway. To maximise the benefits from this capacity building, we are working with Participants to consider short term placement of PhD graduates within their organisations. **Resources:** During our existing term, we have compiled a significant level of investment in plant biosecurity research. If we are not successful in our bid for a second term there will be a need to identify and source resources equivalent to the current level of investment in plant biosecurity. It is vital that Australia's plant biosecurity status continues to improve and keep abreast of its international market competitors. As part of our normal planning cycle, we completed a full review of our current *Strategic Plan* in mid 2009. The review will re-assess how the current activities align with the national research agenda, determined by Australian and state governments, and the priorities identified by the industry sector.

Recommendation	Implemented (Y or N)	Strategies to implement
Recommendation 3: Development of a Board charter	Yes	A Board Charter was finalised in April 2009 and was based on the requirements placed on the Board by the *Corporations Act,* the Company's *Constitution*, the *Commonwealth Agreement* and the *Participants Agreement* and the Company's *Strategic Plan.* The Charter covers the Board's: • Purpose • Membership • Composition • Duties and Responsibilities • Appointment • Remuneration • Removal • Procedures
Recommendation 4: Regular reviews of the policy and procedures manual	Yes	The CRC NPB Ltd Board agrees that the policy and procedures manuals require regular reviews. The policy and procedures manuals which are currently in use and/or under development include an Information Management Strategy (IMS). The IMS outlines the procedures for the production and maintenance of the policy and procedures manuals (manual names and who is responsible for them). The IMS specifies that the policy and procedures manuals will be updated on a needs basis (ie, when changes are required) with full reviews taking place on at least a biennial basis.
Recommendation 5: Extension of the KPI reporting structure and measurement	Yes	The *Strategic Plan* was reviewed and reprinted in late 2009 as third iteration (2009-2012). In revising the *Strategic Plan*, we looked at the performance indicators and rewrote them as 'Indicators of Success'. This measurement is based on the extensive survey we conducted with stakeholders which identified what success for our CRC means to them. These 'Indicators of Success' are reported against in the Research Program text in the *Annual Report.* We also use our Commonwealth milestones as key performance indicators to track our progress.
Recommendation 6: Development of a stakeholder management system	Yes	A *Stakeholder Management Plan* was approved by the Board in March 2010. The plan outlines the various stakeholders who are important to our operations and who have influence over our continued success and uptake of research outputs. Each stakeholder is mapped on their influence/impact on research activities against their interest and how the relationship should be managed and a list of tactics devised to ensure they are engaged at the appropriate level.
Recommendation 7: Development of a comprehensive communications strategy	Yes	A communication strategy was developed which identified the key stakeholders, communication objectives and messages for each audience. It also lists a number of tactics, person responsible and timeframes. We also recognise that communication is a two-way process and is engaging with stakeholders to gain insight into the most effective means of encouraging this to occur.
Recommendation 8: Refinement of the research portfolio presentation	Yes	Several images to identify the holistic view of our research were drafted and workshopped with the Science Committee and the Board. After Board feedback and management discussion it does not appear that a suitable image which clearly represents our research across the biosecurity continuum could be developed. In promoting our research we realise it will be necessary to emphasise how the programs fit across the biosecurity continuum. In addition a corporate publication is being produced (for release in October 2010) with articles that demonstrate how the research portfolio works across industry sectors to address biosecurity issues.

Recommendation	Implemented (Y or N)	Strategies to implement
Recommendation 9: Regular Science Forums	Yes	A successful Science Exchange was held from 22–24 September 2009. All CRC researchers, students, staff, Participants Committee, Board as well as industry members attended. The Science Exchange included two full days of presentations, scientific posters, workshops, meetings and the opportunity to network and exchange ideas on the research portfolio. Planning for another Science Exchange from 8 –11 February 2011 is well underway. The meeting will be held over two and a half days in South Australia and will hold a similar format to the 2009 Science Exchange. In addition to this, the Science Committee also uses its face-to-face meetings in various cities as an opportunity to engage researchers and students by asking them to present their research projects. In early 2010, we partnered with two other CRCs to host an international conference titled *Global Biosecurity 2010: safeguarding agriculture and the environment*. This conference also provided CRC researchers with an opportunity to exchange ideas and network with delegates in an international forum.
Recommendation 10: Clear articulation pathways to adoption for all research projects	Yes	A detailed value survey was completed to engage end-users and assist in identifying adoption pathways. The identification of end-beneficiaries for project outputs is currently being addressed. As well as ensuring that all relevant end-users are identified and engaged, this process will also enable identification of beneficiaries of project outputs. In many cases the end beneficiaries will differ from the end-users and this will be articulated in pathways identified. The *Stakeholder Management Plan* considers the inclusion of end beneficiaries. While the primary focus of our CRC has been on agriculture and horticulture, we also recognise that the outputs for many research activities are relevant for the environmental sector and that they will represent a key end-user. As such the environmental sector will be included in the development of pathways to adoption.
Recommendation 11: Increased investment in prevention research	Yes	In response to this recommendation, the CRC NPB Ltd Board initiated an evaluation of the current balance of investments across the biosecurity continuum to better understand and manage the balance of the research portfolio. Prevention as a biosecurity tool is a key responsibility of Australian Quarantine and Inspection Service (AQIS). Through greater end-user engagement with groups such as AQIS, we will ensure we have research activities that focus on entry pathway management in Australia. We have developed projects that address entry pathways for exotic plant pests. These projects include; assessing the risk of passengers carrying exotic pathogens on clothing when they return from overseas, developing more effective post entry quarantine testing protocols for plants, and evaluating the various pathways of entry into Australia. It seems likely that there will be more opportunities for research aimed at prevention. The projects will provide methodology/technology to assist in decreasing the potential for entry of exotic pests.

Recommendation	Implemented (Y or N)	Strategies to implement
Recommendation 12: Evidence of research benefits is captured	Yes	There is a steady increase in the outputs of research as the CRC matures. As highlighted in the response to Recommendation 5, we are using a 'score card' system to provide evidence of the benefits resulting from research activities. The score card incorporates a register of adoption and identifies meaningful measures in the early phases of project activity. We have a diverse group of stakeholders. At commencement of activities we determine a baseline from which the stakeholder adoption success of deliverables can be measured. We can then determine the science contribution to the Australian biosecurity system. We evaluated the benefit cost analysis methods and the 'Maximum Potential Benefit' system being used by the Pork CRC. We found that this wasn't suitable to be adapted for our use. The approach undertaken to provide evidence will address this issue of different stakeholder groups and will consider the differing social values as they relate to biosecurity.
Recommendation 13: Potential benefits to Australia's natural environment are explicitly considered	Yes	The Board initiated a review to highlight the benefits that will arise for the environment from the current research portfolio. While the majority of the portfolio is addressing issues for the agriculture/horticulture sector of Australia, the original mandate of our CRC, the outcomes from many projects will also provide benefits to natural ecosystems. Through consultancies we have also undertaken some direct research that is targeted at natural ecosystems. We have also taken a generic science approach in developing research projects and the outcomes will be directly applicable to a broad range of areas in plant biosecurity including the environment. As part of the review follow up, and improved stakeholder engagement, consideration will also be given to identify processes to communicate the benefits of the research to a broader group of stakeholders including the environmental sector. Early in 2010, we co-organised *Global Biosecurity 2010: safeguarding agriculture and the environmen*t in recognition that many biosecurity issues are relevant across both agriculture and the environmental sectors. We will strongly consider the inclusion of direct environmental research in the next term of the CRC.

Recommendation	Implemented (Y or N)	Strategies to implement
Recommendation 14: Development of a more robust tool for evaluating project performance	Yes	The Board requested that a review of the current process for evaluating project performance be undertaken. Accordingly, the Science Committee reviewed its project performance reporting process and re-assessed the format in which the evaluation is reported. The existing system of reporting against equally weighted criteria was modified with four criteria examining milestone achievement, collaboration, end-user engagement and external evidence of progress, adapted to measure performance. The criteria are scored as either being below expectations, meeting expectations or above expectations. This matrix system of reporting is completed by each of the six program leaders, with the aggregate score being passed on to the project leader in official feedback signed by the research leader and the results are presented to the Board. Projects scoring below expectations are required to complete an action plan that is then reported against in the next quarterly report. Projects scoring below expectations in two consecutive quarters are sent to the Board with a recommendation for termination if no exceptional circumstances explaining the score are presented. Projects scoring above expectations in two consecutive quarters are also presented to the Board and provided additional encouragements for their exceptional progress. To provide a greater degree of assessment for project performance, we have initiated independent review of research areas that have been overseen by our Principal Scientist. These reviews have focused on the quality of science and the end-user relevance of the outputs being undertaken in each of the project areas. Three reviews have been conducted with two being specific to the areas of climate change and stored grains, with the final being a holistic review of the science portfolio examining its quality, depth, performance, impact and reporting mechanisms. All three reviews were complimentary in their findings and the recommendations have been adopted. In addition, the Science Committee has established a post-completion and post-implementation review process.
Recommendation 15: Appropriate use of social scientists	Yes	The benefit of accessing social scientists has been identified, for example, through 'community awareness' projects in train in Australia and off-shore. Through these activities, we have already identified that engagement of social scientists is critical to ensure effective delivery and adoption of research outcomes. We have a Delivery and Adoption Officer, Communications Manager and Communications Officer who all have qualifications in social science. We have also invested in several projects, including PhDs, that are based around social science. We are engaging social scientists to: • achieve better understanding of strategies and benefits from research, • achieve greater community engagement in project activities, and • improve raising awareness of project activities. We will explore other opportunities to engage social scientists in research activities. Social values and responses to issues will be considered in all research activities.

Recommendation	Implemented (Y or N)	Strategies to implement
Recommendation 16: Implementation of appropriate staff development programs	Yes	Staff recruitment is initiated when a resource gap within the CRCNPB is identified to the Board. 'Filling the gap' may be addressed by recruiting the skills or by providing training for current employees as deemed appropriate. This process is, at present, not formalised as a program. One of the policy and procedures documents developed is the *Human Resources Manual* which outlines: • the process for skills gap identification • the recruitment processes including the addressing of skills gaps within job descriptions, and • the staff review process to enable staff development to match the skills gaps identified. Much of the staff development currently undertaken is in-house, on-the-job training. This recognises the unique needs of the organisation and has made use of skills and experience of existing staff. External training has been utilised to provide specialist knowledge in areas such as intellectual property, commercialisation and software applications. Further, staff development has been undertaken through team building exercises which have promoted the effectiveness of the staff as a working team. We are investigating options for additional leadership training for Program Leaders.

CRC PLANTbiosecurity

The Cooperative Research Centre for National Plant Biosecurity is a collaborative venture between the following core and supporting organisations.

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Department of Agriculture, Fisheries and Forestry

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Department of Agriculture and Food
GOVERNMENT OF WESTERN AUSTRALIA

GrainCorp

GRDC
Grains Research & Development Corporation

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