remote MICROSCOPES

plant biosecurity TOOLBOX

Project Leader, Dr Gary Kong showcases one of the elements of the digital diagnostics project.

Digital Diagnostics

revolutionising plant pest and disease diagnostics

Cooperative Research Centres Association | Awards for Excellence in Innovation

Category A: Innovation arising from the application and use of research

CRC PLANTbiosecurity

Cooperative Research Centre for National Plant Biosecurity

1. Linking the approach to outcomes

1.1 Outcomes

Imagine you are a field officer working remotely in Kununurra, Western Australia and find an insect that you suspect is an invasive species which could potentially cause widespread damage to local crops and communities. You refer to a standard field guide and search the internet to try to identify the insect, but cannot be sure you have a correct identification. There are no entomologists in the local area and you need an identification quickly. In order to get this identification, you need to physically send the sample to your state laboratory in Perth; a lengthy process that could potentially heighten the risk of the insect's spread and damage.

This scenario is played out across Australia regularly in our field offices and ports. In instances of a potential incursion, time is the most critical factor and one that is exacerbated by isolation and remoteness. The Cooperative Research Centre for National Plant Biosecurity (CRCNPB) has addressed this problem by developing a suite of innovative digital approaches bringing quick, efficient and effective diagnostics to rural and remote communities.

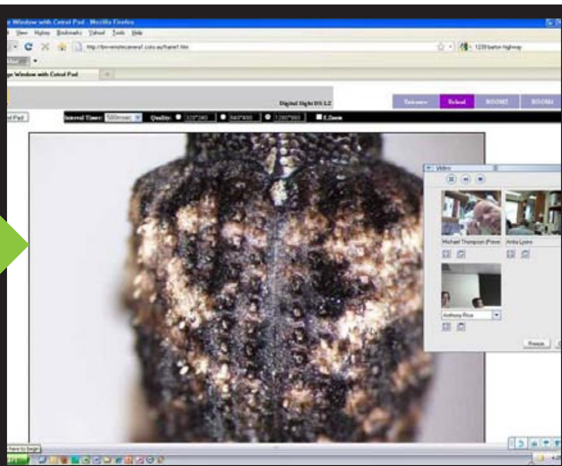
If you have access to an internet connection and a basic microscope with digital camera, irrespective of your location, an expert from anywhere in the world can assist you to identify a plant pest using the CRCNPB's Remote Microscope Network (RMN) within a short time frame. While viewing the specimen together, you and the expert can use the interactive whiteboard and/or communicate via audio or built-in messenger that will record the session. While the specimen is being manipulated, images are captured, annotated, stored and logged to the session details register. You can also access previous identification logs (surveillance data) recent history frequency and movement of the pest.

The RMN has been coupled with a comprehensive diagnostic information database, the Plant Biosecurity Toolbox® (PBT) which is available online (www.padil.gov.au/pbt/) via the Pests and Diseases Image Library (PaDIL) (www.padil.gov.au). These diagnostic tools provide reference material for the identification, potential threat level and global geographic distribution of the pest, as well as high quality images to assist in confirming your diagnosis, view species specific variation, symptoms and damage levels.

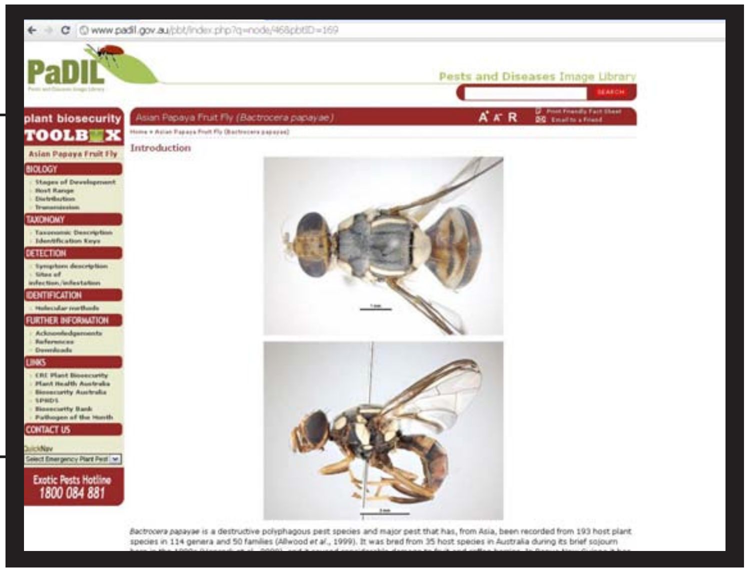
With access to the RMN and PBT we can now more quickly identify and respond to potential harmful pests and diseases, protecting both our environment and agricultural industries. This can potentially save millions of dollars in eradication costs and lost market access for our producers.

In a world first, this project pioneered the use of existing technologies to develop a new and innovative approach to diagnostics for the plant health community. The project built a national and international network of users and developed the processes and organisation needed

Existing tools and new technology is used to connect the Remote Microscope Network, revolutionising the way plant pests and diseases are diagnosed.



The specimen under the microscope as seen by a remote microscope user. Other remote participants seen in the side panel can collaborate online to discuss the diagnosis.



A wide range of diagnostic information on Asian Papaya Fruit Fly is available on the Plant Biosecurity Toolbox. This is one of the key pests featured on the PBT.

for its operation, including providing the equipment, installation, training, instruction and user manuals, support and advice. Prior to the development of the RMN, specimens had to be sent to species experts for identification which was costly, inefficient and increased the risks posed by potential harmful pests and diseases.

To complement the network, the PBT was developed to centralise diagnostic information in recognition of the need for plant health workers to have quick and easy access to accurate diagnostic resources for Australia's harmful plant pests and diseases. Prior to the development of the PBT, much of the diagnostic information for exotic pests was hidden in the literature, locked up as personal experience or was unpublished in people's filing cabinets. Until now, no attempt has been made to gather that information together and put it in one place.

The impact of digital diagnostic tools can be demonstrated through:

- *Improved response time to potential harmful pests and diseases*

In early 2010, an exotic mealy bug found in cotton fields in Queensland was identified within a matter of hours by an expert in California who used the RMN to examine the specimen. Incursion management response was then triggered by the confirmed identification (The gross value of Australia's cotton production in 2008-09 was $684.7 million[1]).

Since the April 2010 outbreak of Myrtle rust on the New South Wales Central Coast, experts have used the RMN to share images and train others to identify it accurately. This has expanded the number of field officers skilled to identify myrtle rust and therefore manage the incursion in a more timely and efficient manner. Once identified, the PBT and PaDIL databases provided comprehensive diagnostic information to assist in the incursion response process (Myrtle rust attacks a wide range of native plant species).

Reduced costs of improved response times

The financial benefit of digital diagnostics in supporting the early identification, intervention and response of an exotic pest is difficult to quantify. The costs will vary with the pest, the plants and crops it affects and our ability to respond; however the costs of prior incursions can act as a guide. To give an indication, in the case of the 1995 Papaya fruit fly outbreak, the cost of eradication and loss of market access was estimated to be $134 million[2]. The 2004 citrus canker outbreak cost $18.12 million in destruction costs and an additional $9 million from Australian and Queensland governments to assist affected growers[3]. If Karnal bunt were to establish here, it is estimated the cost to the grains industry would be around 17% of the value of production which is approximately $500 million[4]. And finally, if Khapra beetle, the world's worst pest of stored grain became established here, it would cost the grains industry approximately $1.8 billion[5].

- *Improved training and education*

While a great tool for diagnostics, the RMN is also a highly effective training tool. The RMN promotes knowledge sharing and collaboration and also provides diagnostics up-skilling through informal interactions.

The use of RMN to facilitate training has been embraced and expanded to develop a specific training program for pests and pathogens relevant to plant biosecurity. High quality, interactive and real time remote microscopy-based training courses have been delivered to personnel throughout Australia, New Zealand and south-east Asia. The training courses, such as *'Mango Seed Weevil Taxonomy'*, are highly sought after, extremely topical, and are economical in terms of expert input. Each live course is currently being captured and will soon be made available on PaDIL to further foster the dissemination of knowledge to a wide range of users.

- *Improved international partnerships*

International trade is supported by the level of confidence we can demonstrate in declaring our pest status. Digital diagnostics help to strengthen this confidence among our trading partners. By sharing digital diagnostics and by training our neighbouring countries, we have enhanced biosecurity relationships, improved the biosecurity systems of these countries and strengthened pre-border surveillance for exotic pests.

1.2 Key elements to the approach

Before looking at the key elements to the approach undertaken to deliver the project, it is important to understand the drivers behind the conceptual idea of revolutionising plant pest diagnostics.

Firstly, the critical decline in diagnostic expertise and a diminishing pool of human capital was prevalent. This was further accentuated by a decline in diagnostic resources and loss of critical mass. Coupled together, these points drove a downturn in the investment in diagnostic services and poor job prospects for those already in the field.

Finally, the growth of biosecurity risk (as a result of increased trade and people movement) meant diagnosis of potential plant pests and diseases needed to be responded to quickly and accurately so that management strategies could be put in place if necessary.

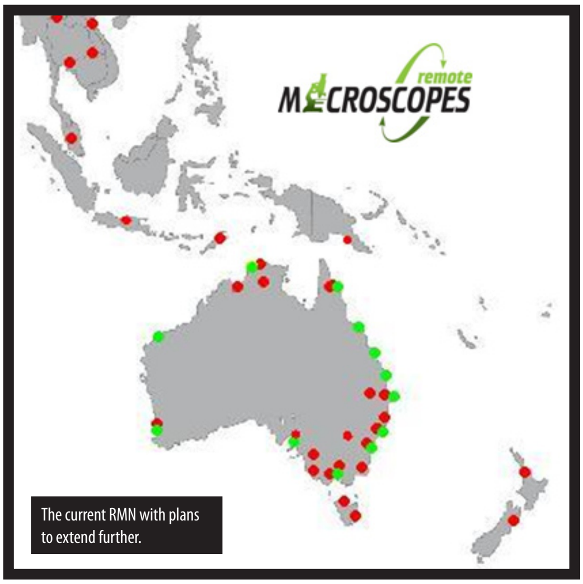
There were several key elements in place to ensure this new and innovative approach to plant pest diagnostics was successful.

Firstly, there was significant collaboration within the project team and across industry and government agencies to ensure consensus of design, principles and processes.

Secondly, a technical support officer was employed to install the remote microscopes, provide training to users and ongoing support, as well as liaison with potential new users.

In addition, the web interface for RMN and the diagnostic information databases (PBT and PaDIL) was built by web programmers, but designed by end-users so that the adoption of the tools would be successful. This was done through an iterative development process; beta versions of databases were developed and the processes subsequently modified according to user feedback.

Finally, before the diagnostic information is populated in the PBT, it is supervised by diagnostic information officers to ensure it is accurate and complies with current protocols.



The current RMN with plans to extend further.

1.3 Adoption

The digital diagnostics project outputs have been widely adopted by diagnosticians and plant health officers in government agencies, consultants, farmers, policy makers and members of the public. This is at both a national and international level.

In particular, the adoption has promoted significant practice change for diagnosticians, field workers and biosecurity agencies in their approach to identifying potential threats, accessing diagnostic information, managing incursion response strategies and mitigating the impact of declines in expertise and capacity.

The Australian Government's Subcommittee on Plant Health Diagnostics Standards (SPHDS) has endorsed the PBT as the primary source of information for developing diagnostic standards.

The PBT and PaDIL had over one million visitors from 190 countries in 2010. These visitors accessed over 13 million webpages.

The RMN has 35 nodes located in 26 different cities, including all Australian states and territories, New Zealand, Thailand, Malaysia, East Timor, Vietnam, Singapore, Indonesia, Papua New Guinea and Laos PDR. As the RMN continues to be adopted, there are 18 future RMN locations currently planned and discussions have taken place with the United States and Canadian governments to deploy the RMN to those regions.

2. Need for the CRC

The CRCNPB began operating in 2005 in recognition of the need to strengthen the scientific capacity of Australia's plant biosecurity system. The CRCNPB's research is underpinned by the national research priority of *Safeguarding Australia*, and in particular, 'Protecting Australia from invasive diseases and pests'. The CRCNPB consists of an extensive collaborative network of researchers and educators from 24 participating organisations representing industry, universities, state and federal government.

In 2010, an independent review was undertaken of the CRCNPB's science portfolio. The reviewers noted in their report[6] that *'The CRC is the only organisation providing a coherent, comprehensive and national approach to plant biosecurity in Australia.'*

It is doubtful that projects such as digital diagnostics would be funded by a single entity, whether this be industry or state/federal governments. With the federal and most state governments as participants, as well as industry, the CRC model enables projects such as this to come to fruition with the benefit of integrating scientific solutions across agencies, jurisdictions and plant industries. This leverage of resourcing and funding provides significant advantages for all those involved in the project, CRC participants as a whole and Australia's farming communities. In addition to the extensive and positive collaboration across participant organisations, this project has also promoted strong international collaboration. Forming these relationships is a key factor to strengthen Australia's pre-border biosecurity efforts while focusing on a national research priority.

3. Letters of support

As indicated in this submission, adoption and uptake of these innovative digital diagnostic tools has been very successful and is changing the way plant pest diagnostics is undertaken. A number of letters of support from industry, government and international agencies are attached.

References:

[1] Anonymous, 2009. *Australian Commodity Statistics*, Australian Bureau of Agricultural and Resource Economics, p. 70

[2] Anonymous, 2007. *Winning the war against Papaya fruit fly, Queensland Governmen*t, http://www2.dpi.qld.gov.au/health/4639.html

[3] van Meurs, L., *Safeguarding the citrus industry from the impacts of pests and diseases,* Biosecurity Services Group, Plant Division, Department of Agriculture, Fisheries and Forestry. http://www.citrusaustralia.com.au/aspdev/about/documents/TuesdayLouiseVanMeurs.pdf

[4] Brennan, J.P. & Murray, G.M., 1998. *Economic importance of wheat diseases in Australia*, NSW Agriculture, Wagga Wagga.

[5] Whattam, M., 2011. *AQIS Operational Science Program and R&D challenges for CRC,* 2011 Science Exchange, Barossa Valley.

[6] Gordh, G., Inglis, A. & Roberts, W., 2010. *Review of CRC for National Plant Biosecurity science portfolio,* Canberra, 12pp.

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11 February 2011

To Whom it May Concern

ACIAR SUPPORT FOR REMOTE MICROSCOPY WORK

Dr Gary Kong has been undertaking Remote Microscopy work as part of an ACIAR-funded biosecurity capacity building project in South-east Asia. Identification and management of plant pests and diseases in many of these countries is hampered by a lack of infrastructure, technical training, but in particular a lack of ongoing access to taxonomic and other expertise. Gary has established remote microscopy facilities in a number of countries and trained local scientists and technicians in the use of this equipment. This has allowed diagnostic and biosecurity staff in developing countries to access the skills of technical specialists in developed countries such as Australia. The potential of this technology is enormous given the geographic spread of developing countries, the lack of infrastructure and the lack of technical capacity in these countries. ACIAR intends to continue to work with Gary to roll out this technology to other developing countries and to develop a plant biosecurity and diagnostic network, initially commencing with the Mekong Countries if Thailand, Laos and Cambodia.

I am happy to provide additional information to support Gary's work on Remote Microscopy.

Yours sincerely

L Baxter

Les Baxter
Research Program Manager, Horticulture

GrainCorp

14 February 2011

To whom it may concern

Since 2007, GrainCorp has been a core participant of the Cooperative Research Centre for Plant Biosecurity (CRCNPB). As one of the largest grains companies in the Australia, it is essential that biosecurity practices across our grain supply chain are improved and strengthened.

An important part of managing best practice is to invest in R&D and tools and technologies that improve our capacity to quickly and accurately identify and respond to potential biosecurity threats. The CRCNPB's digital diagnostic tools have provided us with an accessible pathway to connect with biosecurity experts rapidly, remotely and in real time.

While our staff have training to identify insects that may be present in stored grain; using the remote microscope network and being able to connect to a scientific expert gives us confidence that any potential biosecurity threats can be identified quickly and accurately, and responded to these threats if necessary. These digital diagnostic tools have strengthened our biosecurity practices and assist us to maintain market access and product integrity across our supply chain.

Last year we discovered an unusual insect at our Geelong grain terminal. We thought it was the Larger Grain Borer a damaging pest species not present in Australia.

This had implications including potentially placing Geelong under quarantine until such time it the insect was correctly identified with potential for expensive delays due lost productivity, remediation costs and demurrage as a ship was loading at the time.

This was solved by initial diagnosis via remote microscopy which revealed this as a local wood pest and followed up and confirmed by full taxonomic assessment. This resulted in no interruption to normal business activities.

We wish the CRCNPB all the very best in their award submission and hope they are recognised for the innovative way they have used existing technology to enhance Australia's plant biosecurity practices.

Kind regards,

Alison Watkins
Chief Executive Officer

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Subcommittee on Plant Health Diagnostic Standards (SPHDS)

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To whom it may concern

The Subcommittee on Plant Health Diagnostic Standards (SPHDS) aims to sustain and improve the quality and reliability of plant diagnostics for plant pests throughout Australia. A part of our responsibility is to coordinate the development of national diagnostic protocols which help Australia meet its international plant protection obligations and which should be used for any diagnosis where a protocol is available.

The Plant Biosecurity Toolbox (PBT) provides easy and instant access to all endorsed protocols. It has improved the way SPHDS operates by providing the first dedicated resource in Australia that takes diagnostic data off laboratory shelves and puts it into a forum that is usable, accessible and invaluable to plant diagnosticians.

SPHDS acknowledges the Cooperative Research Centre for National Plant Biosecurity's (CRCNPB) commitment to improving Australia's diagnostic capability. Through the development of the CRCNPB's digital technologies, such as the PBT, we are making better use of declining human capital and building infrastructure to support future diagnostic efforts in combating biosecurity threats.

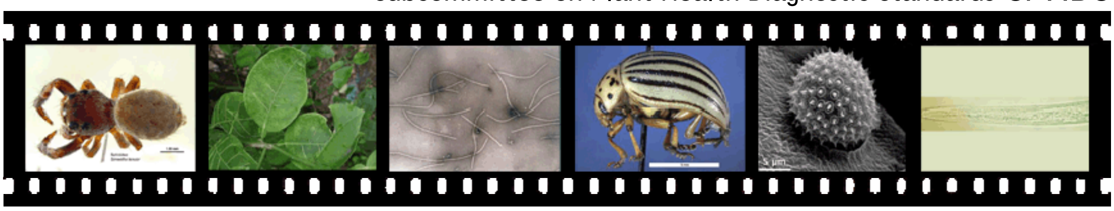
Regards

Ms Jane Moran

Chair, Subcommittee on Plant Health Diagnostic Standards

February, 2011

Subcommittee on Plant Health Diagnostic Standards SPHDS



Plant Quarantine Research Group
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16 February B.E. 2554 (2011)

To whom it may concern,

The difficulty that occurs on a regular basis for plant quarantine officers who served in the diagnosis of pests is to identify and determine the type of pest. Compare pest to guide the identification of the text book makes searching difficult. If the accumulated experience, it may take more time to digest and identify quickly and accurate. For staff inexperienced, it may take a long time to digest accumulated experience and able to identify. Currently intercept specimens are send to expertise taxonomist for identification which take time.

With the technical cooperation between Government of Thailand and Australia through CRCNBC and Department of Agriculture Thailand, innovation technology of Remote microscope network and PaDIL or Pests and Diseases Image Library are superb tools in advance identification help identify and diagnose pests for Thailand plant quarantine officer. Two remote microscopes node were established, one in Central Bangkok and other set up at North Cheing Sann PQ Station. Currently, they are able to gain real time internet access expert for identification with real specimen under Stereomicroscope and PaDIL web. Suspicious insect pest found in import vegetable and fruits are quickly checks and identify. This can speed up the process for quarantine.

Thailand had foreseen the significance and capabilities of this technology. Department of Agriculture prepare to establish RM diagnosis network at least 3 Plant Quarantine Stations in near future.

Yours sincerely,

(Mr. Udorn Unahawutti)
Senior Expert

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USDA

Date: 15 February 2011

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Subject: Letter of Support for CRC Remote Microscopy Project

Mr. Tony Peacock
Chief Executive
CRC Association
Engineering House
Unit 4, 11 National Circuit
Barton, ACT 2600

Dear Mr. Peacock:

This message congratulates the Cooperative Research Centre for Plant Biosecurity and specifically the work undertaken in the area of Remote Microscopy directed by Dr Gary Kong. This Remote Microscopy project has been a significant effort on the part of the CRC as a contribution to the Plant Health Quads "Science Cooperation Work Group." The Plant Health Quads have existed for more than 20 years and brings together Australia, Canada, New Zealand and the USA to work on regulatory matters of mutual concern. The SCWG is an activity of the Quads that has existed for more than six years and is intended to share information in the area of agricultural science and technology. Accurate identification of exotic pests and diseases is supremely important to regulatory agencies such as AQIS and APHIS. Identification of pests and diseases often involve traded commodities and must be made rapidly in order to facilitate trade and preclude the establishment of invasive organisms.

Historically, this identification work has been undertaken by taxonomic specialists in museums or at remote sites. The "turn-around time" for identification has sometimes been considerable. The Remote Microscopy program advanced by Dr Kong and his colleagues is innovative in providing relatively low cost technology to field and port inspectors and electronically ties them to taxonomic specialists in real time. Dr Kong and his team have made their technology available throughout Australia, New Zealand and in several countries of Southeast Asia. The Remote Diagnostics/Microscopy work has enabled many people to consult simultaneously on identifications of mutual concern. The training in Remote Microscopy provided by Dr Kong and his staff has also enabled non-specialists to become more actively involved in identification work, thereby improving the attention of survey and field technicians. The dynamic associated with this project has contributed a general stimulatory effect on pest/disease survey which in turn has had a beneficial effect on plant protection activities. The Remote Microscopy project has also resulted in pest/disease training that is more widespread, less expensive and more effective when compared with traditional equipment and training.

Dr Kong and his colleagues are to be congratulated for their efforts in expanding awareness and utilization of RM technology from Australia to its Plant Health Quads partners, notably Canada and the USA. Last year, Dr Kong and his associates took time out of their busy schedules to give presentations in Canada to CFIA and the USA to APHIS Plant Protection and Quarantine. The technology demonstrated by Dr Kong was superior and less expensive compared with the digital imagery currently used in these countries. By exposing Quads partners to new technology and equipment, the RM group has provided an opportunity to share information about pests and diseases that would otherwise remain concealed. The RM group has taken a significant step forward in globally uniting regulatory agencies in surveillance of pests and diseases. These efforts can only have a positive stimulatory effect on promoting trade and travel while reducing the movement of pests and diseases associated with these commercial activities.

In summary, we appreciate the innovation and spirit of cooperation engendered by Dr Kong and his CRC team.

Very truly yours,

Gordon Gordh

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