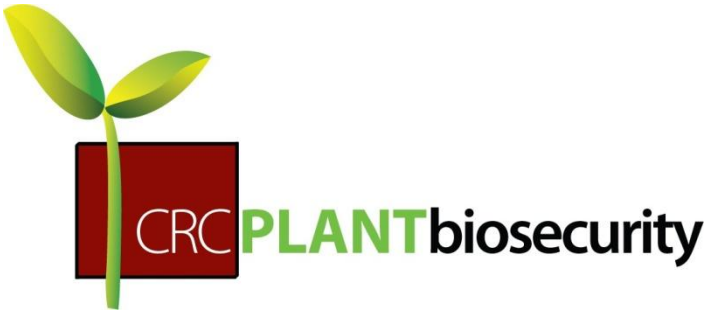


**Cooperative Research Centre**
**for National Plant Biosecurity**

# Final Report

## CRC 70085 (Area 1)

## New Sampling Hardware for Grains (PDA Smartphones)

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# 1. Executive Summary

A high proportion of Australia's agricultural produce is exported at great benefit to the national economy. The markets receiving this produce demand demonstration of freedom from certain plant pests and diseases and as such, providing proof of absence is critical to maintaining and securing new market access opportunities. Pest surveillance is an important tool in maintaining and opening market access and accordingly, credible evidence to confirm pest freedom status is now the expected norm for importing countries.

In the past, nearly all field-collected plant biosecurity surveillance information was recorded manually to paper, reducing the rate of capture, data integrity, conformity as well as the security of the data collected. There is a growing need for plant pest surveillance data collection software and hardware that uses PDA smartphones to provide auditing validation, 'chain of evidence' as well as increasing the volume of data collected and its integrity through relational databases and seamless data transfer to corporate systems. Smartphone data integrity is supported by GPS-located traps, digital voice navigation itineraries, time and date stamps, field printed barcode labels, site and pest imagery – all key tools for supporting a claim of pest free status in an era of diminishing human capacity to undertake an ever increasing array of surveillance activities.

This project has shown that pest identification tools delivered via PDA smartphones are an important, robust and adaptable mechanism allowing immediate identification of potential biosecurity threats in the field and supports Australia's claims of being free of certain invasive pests.

The project produced the following applications and tools to assist this claim:

- Biosecurity hazard site surveillance
- Multi-pest surveillance (MPS, BioSIRT compatible)
- Khapra beetle surveillance
- Forest plantation pest surveys (IPMG)
- MyPestGuide mobile pest datasheets
- Urban plant pest surveillance (USDB)
    - Dermestid surveillance
    - Stored grain ecology studies
    - European wasp surveillance
    - Exotic dung beetle surveys
    - Locust surveys
    - Tramp ant surveys

# 2. Aims and objectives

This project was designed to build on and improve prototype software and related databases developed in CRC30014, the original proof-of-concept project for the CRCNPB's PDA smartphone development. As such, there were two major aims for this project:

1. Deployment and evaluation of PDA smartphones with facility for the capture and transmission of data collected in state-based urban surveillance activities; and

2. Mapping mechanisms and pathways to feed data collected by smartphones into with the national initiatives of BioSIRT and ABIN.

Both aims were broadly met by the project although widespread deployment was hampered by a number of issues outside the control of the project team as explained below.

# 3. Key findings

This section details the key findings of the project against the two major aims listed above. It also covers some key collaborations the project made with CRCNPB industry and international partners.

## a) Deployment and evaluation of PDA smartphones with facility for the capture and transmission of data collected in state-based urban surveillance activities

The smartphone environment is a rapidly changing aspect of information technology; one that even changed significantly during the life of this project. The project developed a number of PDA apps (as listed in the executive summary), but it is the surveillance app known as Urban Surveillance Database (USDB) built with VisualCE for Windows Mobile that has had the most uptake and is of most use for state-based urban surveillance activities. It uses a relational database, GPS connectivity, barcode scanning and printing ability, along with photo linking to database records to assist in data gathering. It uses validity checking and look-up tables to ensure referential integrity that increases the robustness of Australia's claims of area freedom.

When the first phase of this project began there was only one 'industrial strength' mobile platform available and that was Windows Mobile. Popular platforms such as iPhone and Android were not on the horizon. The project made a significant investment in VisualCE through hardware, software, licensing and training. VisualCE allows wizard-driven development of apps and will install and synchronise data remotely through the sister product mEnable. The idea was that the CRCNPB would invest in developing an underpinning smart phone app that could be manipulated by state and federal agencies to suit their own needs by a staff member with a little bit of computing nous. The project team based at DAFWA would then provide troubleshooting support and training to those that needed it. This arrangement worked well with surveillance staff in New South Wales (Peter Gillespie, Debbie Kent) and the Northern Territory (Steven West, James Swan); although other states were less inclined to adopt this model given their hesitation to adopt PDA assisted surveillance (as will be discussed below).

In an attempt to engage with newer platforms on the market, Syware, the developers of VisualCE, released a cut-down Android version of their program at the beginning of 2012 and propose to have the same functionality as VisualCE later in 2012. The project team has begun the process of conversion from VisualCE to DroidDB however, some key features like GPS functionality have not been included in the first release; once again we are ahead of the wave.

Development in the Android environment will allow for rapid smartphone, tablet and mini-tablet engagement while a watching brief will be maintained on cross-platform development environments Rhomobile and device-independent HTML5. This will assist in

the uptake of digital surveillance data collection in states that are either moving to these platforms or to table computer based systems.

The software development achieved by this project means that users of Windows Mobile devices need only to provide the hand-held device name and the app will install remotely and data will be pushed out to it. Field data can synchronise to any ODBC database however USDB uses an Access database that the project has custom built the ability to use Google Earth display, allowing surveillance itineraries to be built that can be sent to smartphone voice navigation systems. The latest version of USDB released in March 2012 has improved ease-of-use through tabbed navigation between pages. Photographs taken in the field of activities and specimens are now synchronised onto the server database and viewed on desktop PCs. This is a very useful addition when the rapid identification of any suspect plant pests is required.

It is an ideal many have talked about where the user can record property and contact details, add geo-located activities including a photo, add as many inspections of those activities as required noting whether or not quarantine pests were seen, add collected specimen details with barcoded labels and photos and have it all synchronised back to their desktop computer. This project has achieved this ideal whilst building in the individual functionality allowing each jurisdiction to tailor the app to its needs.

A multi-pest surveillance app and database was also developed and validated under the auspices of a special working group established by the national Surveillance Reference Group (SRG). The working group consisted of a number of state and federal representatives who worked with the project team to ensure the app and database met the requirements of the jurisdiction and mapped to the national BioSIRT database. The result was a multiple pest species template based on earlier iterations of the app developed by the project that mapped to the BioSIRT database, making the transition from data collection to data storage seamless.

### b) Mapping mechanisms and pathways to feed data collected by PDAs into with the national initiatives of BioSIRT and ABIN.

The key element in achieving this aim was to ensure that the applications developed by the project were compatible with both the national BioSIRT and ABIN platforms. As explained above, this was achieved, with the project team developing and validating a number of apps that were compatible with this national database, developed in collaboration with the states to ensure their needs were incorporated in the software design. With the apps structure being consistent with the databases underpinning BioSIRT, they can automatically upload data collected to a jurisdiction's BioSIRT system – a significant advance on the app developed in phase one of the project. Unfortunately the project never received much buy-in from ABIN despite numerous attempts to involve them in development and potential rollout.

A major barrier to uptake in the first iteration of this project was a lack of national consensus regarding the direction digital surveillance data collection was heading. In an attempt to resolve this, the project team was instrumental in convening a technical working group under the SRG and lead by its chair, Paul Pheloung of DAFF. The group agreed to instigate the national rollout of PDAs installed with the project's apps and conduct training in conjunction with the national expansion of BioSIRT. This happened to some extent but staffing changes within DAFF and technological changes (described

above) stymied this process. This meant that the CRCNPB did not receive an ongoing framework for PDA rollout in a post-CRC environment as originally planned and the SRG lost the impetus to further engage the applications.

This being said, the project team members have found that biosecurity staff are becoming used to the idea of working with smartphones and we are seeing accelerated uptake in Western Australia. Many of the users who previously complained about the device size and keyboard are used to using their personal smartphones. The concept of using one to collect data does not now seem quite so onerous for many DAFWA staff members. This has been achieved by working closely with field staff and responding to their concerns and in some cases, fears about using this technology.

Similar complaints were raised by members of the SRG, who argued that it would never be more efficient to implement PDA assisted surveillance regimes than those already in place. The resistance to the concept of PDAs ultimately restricted the rollout of the technology – whilst the applications were designed for the needs of surveillance staff and their programs, and generally received positive feedback, there was a general lack of confidence in PDAs as surveillance data collecting tools proved difficult to overcome. Again, the project was ahead of the wave in terms of smartphone and PDA acceptability among surveillance managers. Had this project commenced post-iPhone and Android, this resistance may not have been encountered and development of multiple platform software would have been possible.

Despite this, the USDB is now in daily use at DAFWA and has proved to be very adaptable; testament to the fact that it was designed with generic surveillance data collection in mind. It is simply a matter of adding a project name to a drop-down list to engage a new project. It is currently used daily for *Trogoderma* trapping, stored grain ecology, European wasp surveillance and imported dung beetle surveys.

Other jurisdictions to regularly use applications developed by this project include:

- New South Wales – Jo Holloway
- Tasmania – Megan Szczerbanik
- Northern Territory – James Swan, Heather Wallace
- Queensland – Rebecca Sapuppo
- South Australia – Bruce Baker, Wayne Marshall

It should also be noted that Paul Pheloung of OCPPO went to a lot of effort to develop and present PDA smart phones as a fast and accurate surveillance data collecting tool through his role as joint-head of SRG. We are grateful for his assistance.

### c) Collaborations

A number of development collaborations took place during the course of the project that are worthy of mentioning for future research opportunities. These collaborations also indicate the growing acceptance of PDAs as legitimate data collecting tools.

Gordon Gordh (USDA) and Brian McCornack (KSU) have seen the apps developed by the project and are keen to collaborate. Also Heath McCrae (APLC) is interested in working with us to co-develop a locust surveillance app and further expand the PDA surveillance regimes already in use by this this statutory authority. Art Diggle (DAFWA) can see excellent linkages with his Pestfax Maps work and is keen to engage his programmers to develop in Rhomobile.

Murdoch University collaborated in a cross-CRC collaboration developing a mobile software solution, called IPMG Plantation Health (IPH) through developer Nicolas Garel and Francisco Tovar. This software allows foresters to quickly and accurately record pest and disease outbreaks in the field, including; the date of the observation, the extent and severity of any damage caused, GPS co-ordinates and digital images. The software also includes brief weed and pest field guides to aid foresters with correct identification in the field. All the information collected is synchronised to a central database, where it's available for further analyses.

The IPH software developed with VisualCE was recently launched at a workshop attended by the WA bluegum industry companies. Approximately 70% of field foresters were in attendance and the overwhelming response was positive. Following the demonstration a number of companies indicated they would start integrating the use of mobile devices and the IPH software into their everyday field operations. Furthermore, WA companies agreed to further test the software in December 2011. Companies will collectively conduct surveys across the southwest WA plantation estate involving approximately 270 plantations, covering an area of 20-30000Ha and recording approximately 54000 individual pieces of data.

Following this successful test, companies have indicated support for further development with the aim of adding more capabilities and making the software available across different mobile devices (e.g. Android phones, or iPhones). This would ensure the widest possible uptake by foresters.

The developers hope that the use of the IPH software and yearly systematic surveys of plantations will become an industry standard. This will allow both the industry and researchers to access accurate, auditable and geo-referenced data that could serve to address any number of plant biosecurity and plantation health issues.

A recent upgrade to the database structure has simplified the collection of data in the field and a new front-end interface using MS Access Forms was developed. This has allowed users to navigate quickly between records and visualise their locations using custom tools such as embedded maps, export to KML for Google Earth and Excel. The long term plan is to first port the IPH software on Apple iOS and Android for extending the range of devices including tablets and secondly bringing the desktop front end interface online.

Projects such as the development of the IPH software, wherein researchers with different skill sets are brought together to aid industry solve problems, highlight the value of the cooperation fostered through the funding and support of Collaborative Research Centres (CRCs).

# 4. Implications for stakeholders

In a trading environment where overseas markets are continuing to demand more robust evidence to support claims of area freedom, the importance of surveillance data integrity is arguably greater than ever before. The continued development of user-friendly PDA smartphone applications by this project contributes to an ever-growing range of technologies authorities have at their disposal to help meet market requirements. This project has produced a number of PDA apps that help surveillance managers increase the robustness and integrity of their area freedom claims, while conducting a greater level of surveillance through efficiency gains in an era of decreasing human capital.

# 5. Recommendations

This project has shown that the use of PDA smart phones is a robust method for collecting surveillance data.

A significant impediment to a widespread and consistent rollout of the applications developed by this project was a lack of drive at the national level. In future, the adoption of such technology would be greatly assisted if it was linked as a condition to funding of national programs – such as the urban surveillance program. If the surveillance funding to state jurisdictions was contingent on them trialling, validating and adopting surveillance technologies such as PDA smartphones, then greater uptake would occur. Such an arrangement will also help in the development of such technologies, ensuring that any developments adequately reflect the requirements of each participating jurisdiction while maintaining national consistency for reporting purposes. In some respects this was achieved by linking in with the BioSIRT team and the multi-pest template that was developed as a result. Yet as not all states use BioSIRT and some were sceptical of the technology developed by the original scoping project, it was difficult to gain traction in terms of rollout and adoption despite significant efforts by members of the project team.

As such, two delivery and adoption recommendations are made:

- Link federal funding of urban-based surveillance programs to surveillance technology development to encourage uptake, national consistency and system adaptability.
- Ensure similar projects that require national agreement for roll-out find a federal level champion, making it easier to engage with the states without placing the entire onus of state cooperation on the project team (in this case, largely restricted to one state).

That being said, the project has had some successes in the ongoing use and user support of the applications developed, highlighting that, with enthusiasm, PDA use in surveillance related activities is an achievable goal. The project also established an online share point for collaboration, troubleshooting advice and a file repository. Such an initiative would be necessary in any rollout of smartphone surveillance technology.

Furthermore, additional research into emerging PDA platforms (such as iPhone, Windows 8 and Android) should be investigated, especially considering the market share and 'desirability' of these platforms and their relevant handsets.

# 6. Abbreviations/glossary

| ABBREVIATION | FULL TITLE |
|---|---|
| ABIN | Australian Biosecurity Intelligence Network |
| APLC | Australian Plague Locust Commission |
| CRCNPB | Cooperative Research Centre for National Plant Biosecurity |
| DAFF | Department of Agriculture, Fisheries and Forestry |

| | |
|---|---|
| DAFWA | Department of Agriculture and Food Western Australia |
| IPH | IPMG Plantation Health |
| KSU | Kansas State University |
| MPS | Multiple Pest Surveillance |
| PDA | Personal Digital Assistant |
| SRG | Surveillance Reference Group |
| USDA | United States Department of Agriculture |
| USDB | Urban Surveillance Database |

# 7. Plain English website summary

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|---|---|
| CRC project no: | CRC 70085 |
| Project title: | New Sampling Hardware for Grains (Bluetooth & Telemetry Phosphine Monitoring System) |
| Project leader: | Giles Hardy |
| Project team: | Rob Emery, Nicolas Garel, Francisco Tovar, Darryl Hardie |
| Research outcomes: | PDA Phase Two project successfully developed and deployed six main applications:<br>• Biosecurity hazard site surveillance<br>• Multi-pest surveillance (MPS, BioSIRT compatible)<br>• Khapra beetle surveillance<br>• Forest plantation pest surveys (IPMG)<br>• MyPestGuide mobile pest datasheets<br>• Urban plant pest surveillance (USDB)<br>- Dermestid surveillance<br>- Stored grain ecology studies<br>- European wasp surveillance<br>- Exotic dung beetle surveys<br>- Locust surveys<br>- Tramp ant surveys<br>The Urban Surveillance Database was built with generic plant biosecurity surveillance in mind and has been adapted for a |

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| | number of diverse projects. It services the popular need for recording property and contact details, one-is-to-many geo-located and barcoded activities (including digital image), one-is-to-many inspections of activities, one-is-to-many specimen details can be added with barcoded specimen labels and photograph.<br><br>Field-collected data are synchronised (two-way data transfer) from anywhere in the world via GPRS, WiFi to a wireless server hosted at DAFWA where it is available for further analysis and reporting.<br><br>Smartphone pest identification tools have become popular and can be used in conjunction with USDB to ensure rapid field recognition of potential Emergency Plant Pests. This project developed two database-driven smartphone apps (MyPestGuide & PestWeb Mobile). Individual pest records are added on the wireless server and pushed out to devices. These smartphone identification tools can be deployed as a shell for overseas users, or pre-populated with quarantine pests of significance.<br><br>Collaboration with CRC for Forestry resulted in development of the mobile software solution, called IPMG Plantation Health. This software allows foresters to quickly and accurately record pest and disease outbreaks in the field, including; the date of the observation, the extent and severity of any damage caused, GPS co-ordinates and photos. The software also includes brief weed and pest field guides to aid foresters with correct identification in the field. |
| Research implications: | A high proportion of Australia's agricultural produce is exported and demonstration of freedom from certain plant pests and diseases is critical to maintaining and securing new market access opportunities. Pest surveillance is an important tool for market access and accordingly importing countries now demand accurate, credible evidence to confirm pest freedom status.<br><br>In the past nearly all field-collected plant biosecurity surveillance information was recorded manually to paper reducing the rate of capture, integrity, conformity as well as security of the data. There is a growing need for plant pest surveillance data collection software and hardware that uses smartphones to provide auditing validation, 'chain of evidence' as well as increasing the volume of data collected and its integrity through relational databases and seamless data transfer to corporate systems. Smartphone data integrity is supported by GPS-located traps, digital voice navigation itineraries, time and date stamps, field printed barcode labels, site and pest imagery.<br><br>Pest identification tools delivered via smartphones are an |

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|---|---|
| | important tool that allows immediate identification of potential biosecurity threats in the field. |
| Research publications: | Robert N Emery, Michelle Chami, Nicolas Garel (2010) "Smartphones: Capturing insects, images and information". Annual Conference of the Australian entomological Society 2010, The Vines, Western Australia.<br><br>Emery RN, Chami M, Garel N, Kostas E and Hardie DC. (2010) "The use of hand-held computers (PDAs) to audit and validate eradication of a post-border detection of khapra beetle in Western Australia". 10th International Working Conference on Stored Product Protection, Estoril, Portugal. 2010: 1031–1037.<br><br>Rob Emery (2011) "PDA technology and its application for grain industrial data/information collection, surveillance and social awareness". International Symposium on Grain Information Technology 2011, Beijing, China.<br><br>Tovar, F. (2011) Recording damage in WA Eucalyptus globulus plantations - new software, standard methods and collaborative monitoring. Industry Pest Management Group Workshop, 25-25 October 2011, Frankland River, Western Australia<br><br>Tovar, F., Garel, N., and Burgess, T. (2011) Technology and collaboration helping improve eucalypt plantation pest surveillance in Western Australia. The 3rd Combined Australian and New Zealand Entomological Societies Conference, 28 August - 1 September 2011. Christchurch, New Zealand<br><br>Robert N Emery, Manoj K Nayak and Joanne C Holloway (2012) "Lessons learned from phosphine resistance monitoring in Australia". Stewart Postharvest Review 2011, 3:6. |
| Acknowledgements: | The following CRCNPB participants provided constructive criticism during development of the applications; Michelle Chami, David Cousins, Oonagh Byrne, Marc Widmer, Richard Johnston, Mike Grimm, Peter Gillespie, Deborah Kent, Cain Roberts, Paul Pheloung, Greg Hood, Steve Pratt and Deb Riddell.<br><br>Brian McCornack (KSU), Gordon Gordh (USDA) provided a useful US perspective.<br><br>Francisco Tovar (CRC Forestry/ Murdoch University) designed the IPMG application. Peter Davis demonstrated the potential for USDB in ant surveys on Barrow Island. |