Australian Government
Cotton Research and Development Corporation

TRAVEL & CONFERENCE REPORT

Part 1 - Summary Details

Please use your TAB key to complete Parts 1 & 2.

CRDC Project Number: **DAN 1301 and CSP1301**

Project Title: Travel to Attend the International Congress of Entomology Conference in Daegu, South Korea, 18-26 August 2012

Project Commencement Date: 18/8/2012 **Project Completion Date:** 26/8/2012

Research Program (from CRDC Strategic R&D Plan 2008-2013): 2. Farming Systems

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Signature of Research Provider Representative: _____

Part 3 – Travel Report

(Maximum two pages)

1. A brief description of the purpose of the travel.

Drs Robert Mensah and Lewis Wilson were invited by on the Organising Committee of the International Congress of Entomology Conference to organise a symposium on the 'Biological control of emerging pests on transgenic cotton crops' which is of significant importance to our situation in Australia. The symposium attracted world renowned entomologists working on pests on transgenic cotton crops.

2. What were the:

a) major findings and outcomes

The International Congress of Entomology (ICE) is held every four years in different countries in the world. It serves as a forum where those involved in all facets of entomology can interact and learn from each other. The congress in Korea gathered 2,900 entomologists from all over the world working on various aspects of entomology from taxonomy through to pest management and covering all aspects of crop production and medical entomology. Scientists, particularly renowned entomologists working in other crops and also in cotton, normally attend the ICE conference to present the papers in their area of specialty. Thus this provides an opportunity for researchers to present and hear about pertinent research problems in their areas of specialty. The conference also attracts extension officers, agro-chemical companies, administrators, entomological suppliers and publishers. The conference covered aspects of entomology such as integrated pest management, insect biological control, insect behaviour and chemical ecology, pesticides, GM crops, resistance, toxicology, conservation, biodiversity, climate change, insect biological control, medical and veterinary entomology, invasive species and quarantine, stored products and post harvest entomology, acarology, insect related interactions at a multi-trophic ecosystem, genetics, genomics and evolutionary entomology, systematics, phylogeny and zoogeography. The conference has enhanced Drs Mensah and Wilson's research in Australia.

Title of the symposium we organized at the conference

The title of the symposium jointly organized by Dr Robert Mensah and Dr Lewis Wilson at the conference was "Biological control of Emerging pests on transgenic cotton" (Symposium 1104). Many audiences attended our symposium, showed significant interest in papers presented and generated good discussion, especially about the contribution of GM crops to enhanced biological control. Dr Mensah also presented a paper in another symposium on the use of a natural plant extract for the management of sucking pests on cotton in Australia (Symposium 608 on 24 August 2012). Dr Wilson also presented a paper on 'Evaluating the IPM fit of insecticides; Sorting myth from reality' in Symposium 1010 on 21 August 2012. Both papers were well received and stimulated a range of questions by the audience. Many of the applied entomologists working on IPM in field crops were most interested to use biopesticides being developed in Dr Mensah's research for field trials in their target pests and crops. The Technical Editor for the Australian Journal of Entomology asked Dr Wilson to prepare a review article of his presentation.

The papers presented in our Symposium 1104 were:

- Mensah, R. K. and Austin, L. Microbial Control of cotton pests: Use of a naturally occurring entomopathogenic fungus (Aspergillus sp.) for managing *Creontiades dilutus* and beneficial insects on transgenic cotton crops in Australia
- Dhillon, M. K. and Sharma, H. C. Relative abundance of natural enemies of crop pests on Bt- transgenic and non-transgenic cottons in India
- Shrestha, R. B. and Parajulee, M. N. influence of transgenic Bt cotton on predacious arthropod assemblage and their impact on non-target pest suppression in Texas
- Keshlaf, M., Spoonerhart, R. and Mensah, R. K. Honeybee foraging and pollination efficacy in Australian Bt cotton
- Naranjo, S. E. and Ellworth, P. Biological control of a cotton pest: *Bemisia tabaci* in Arizona transgenic cotton as a case study
- Davies, A., Carr, Christopher, Scholtz, B. and Zalucki, M. Ecology of *Trichogramma* egg parasitoids in Australian transgenic cotton landscapes and their utilization for biological control
- Wilson, L. and Heimoana, S. Emerging pests and silverleaf whitefly: a challenge for Australian cotton systems

Activities

The XXIII ICE Conference was held in the International Convention Centre (EXCO) in Daegu in South Korea from the 19th –25th August 2012 (Figure 1). The conference attracted 2900 entomologists, administrators, agro-chemical companies and marketers all over the world. The conference included 6 plenary lectures and 18 concurrent sessions. Both Dr Mensah and Dr Wilson were extremely diligent at attending all sessions, though with so many concurrent sessions it was often hard to attend all of the presentations that were relevant. Unfortunately we missed plenary speeches of Prof. Stephen Simpson (before we arrived) and Prof. Takema Fukatsu (while we were collecting registration packages).

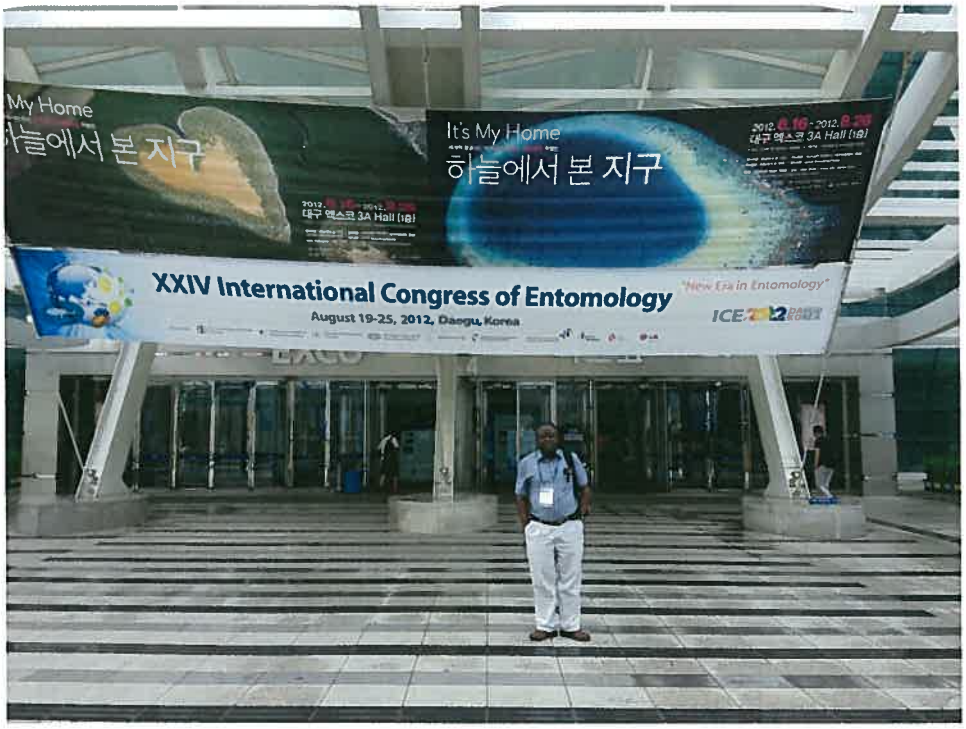

Figure 1. Dr Mensah outside the entrance to the ICE Congress.

Plenary lectures

Renowned research entomologists in different specialty areas of entomological research gave the plenary lectures. The plenary speakers were entomologists chosen from Australia, Japan, USA, Finland, Kenya and China. Each of the plenary speakers was given a selected topic in their areas of expertise to overview and communicate to participants. Questions and informal discussions follow each plenary session. This allowed participants and speakers to interact and discuss the subject. The plenary lectures were given before the concurrent sessions. This allowed all participants to attend the session. The plenary speakers and their papers are given in Table 1.

TABLE 1. Plenary speakers and lectures organised at the XXIV ICE Conference in Daegu in South Korea, 19th-25th August 2012.

Speakers	Position	Title of paper	Date of Talk
Prof. Stephen Simpson	Professor, School of Biological Science, University of Sydney, Australia	From individuals to populations: a tale of swarms, cannibals, ageing and human obesity	19 August 2012 at 18:00 – 19:00
Prof. Takema Fukatsu	Professor, National Institute of Advanced Industrial Biology and Technology, Japan	Biodiversity, Symbiosis and Evolution	20 August 2012 at 08:00-09:00
Prof. Thomas W. Scott	Prof. Department of Entomology, University of California, USA/ Mosquito Research Laboratory, USA	Pathogen transmission dynamics at the huma-mosquito interface	21 August 2012 at 08:00 – 09:00
Prof. IIKa Hanski	Prof. Department of	Habitat loss and fragmentation-	22 August 2012 at

	Biological and Environmental Sciences, University of Helsinki, Finland	What happens to insect populations and species?	0*:00 – 09:00
Dr Christian Borgemeister	Director General and CEO, International Centre of Insect Physiology and Ecology (ICIPE), Kenya	Insect science and poverty alleviation – tales from Africa	23 August 2012 at 08:00 – 09:00
Prof. Kongming Wu	Prof. Director, Institute of Plant Protection, Chinese Academy of Agricultural Sciences, China	Ecological succession of insect populations in Bt cotton agroecosystem: a case analysis in China	24 August 2012 at 08:00 – 09:00 08h00

Report on presentations

1. (Plenary sessions) – Dr Mensah and Dr Wilson

The plenary papers given by Prof. Prof. IIKa Hanski and Prof. Kongming Wu are those related to our research in cotton in Australia.

Prof. IIka Hanski's paper was about habitat loss and fragmentation and what happens to insect populations and species. He spoke about the extinction of insect population species; extinction threshold, extinction debt and evolutionary rescue. According to Prof. Hanski the rate of species extinction in the past was 0.001% but present is 1%. By 2050 the rate will increase to >10%. Habitat loss is due to over exploitation of natural resources resulting in a global threatened species of mammals 24%; insects 20%; birds 15.3%; plants 15.4%. Globally we underestimate the level of threat to biodiversity. The dispersal rate of species is higher in environments or habitats that are highly fragmented than less fragmented. Habitat loss leads to increase isolation of remnant population which accumulate deleterious mutations and eventually lose viability which contributes to poor fitness and often extinction. He concluded the need for the world to fully implement the Nagoya 2010 treaty to protect 17% land area by 2020. In Australia, mining is going to result in habitat loss and fragmentation if not checked by government resulting in species and land loss especially agricultural prime lands.

The presentation by Prof. Kongming Wu was directly related to our research on transgenic cotton. China grows 160 million hectares genetically modified crops and 41% is transgenic cotton crops. In general China grows 5.7 million ha of cotton and produce 6.6 million metric tonnes of lint cotton. He said that China started growing Bt cotton crops as far back as 1997 and by 2011, 3.8 million hectares of Bt cotton representing 70% of the national cotton growing area. Professor Wu and his colleagues showed considerable vision in setting up a range of sites where Bt-cotton could be compared with conventional cotton over time – the results of this study have recently been published. According to Professor Wu, the adoption of Bt cotton in China has significantly reduced population levels of *Helicoverpa* spp not only in cotton fields but also other host crops such as maize, peanut and soybean. On the other hand, the reduction of insecticides on Bt cotton crops has led to a rapid build up and use of synthetic insecticides against sucking pests such as mirids, green vegetable bugs, aphids and ~~mirids~~ whiteflies have acquired pest status in cotton and other crops. Prof. Wu concluded that the growing of Bt cotton crops can bring long-term landscape-level impacts on pests and natural enemy populations, therefore rational and area-wide IPM strategies needs to be developed for sustainable use of transgenic Bt crops. In Australia, there is the need to document the spill over of use of Bt cotton crops on the reduction of *Helicoverpa* spp. not

only on cotton but other *Helicoverpa* host crops. There is also the need to develop and use products that can support IPM on transgenic crops in the context of area-wide management.

2. Concurrent sections - Dr Mensah

Botannical, Chemical and Agricultural aspects - (S806)

The insect pathology session consisting of biopesticides, semiochemicals - development, and applications was my strong theme amongst presentations. Many of the presentations were related to the development of actives but not on formulations, commercialisation and global marketing of entomopathogens and semiochemicals. The presentation focussed only on research to provide data for journal publication but not applying theoretical outcome of the research to commercial application in agriculture. The production research I am undertaking in Australia for the cotton industry was viewed by colleagues as what chemical ecology and microbial control research should aimed at if research is to provide an answer to the global food shortages that is threatening political and financial security and also driving millions of people in developing countries into hunger and poverty.

Three inspirational papers in chemical ecology were presented by Dr Philip Stevenson (Royal Botanic Gardens and University of Greenwich, UK); Dr Sarah Elizabeth Arnold (University of Greenwich); Robert Spooner-Hart (UWS, Australia) and Murray Isman (University of British Columbia, Canada). Dr Stevenson paper was about phytochemical variation which is a limiting factor in pesticidal plant applications. He reported that even though plants are still valued for insect pest control, pesticidal plant species may have high levels of chemical variability. He showed that *Tephrosia vogelli*, a widely used pesticidal plant in the UK and in Malawi in Africa occurs as two distinct chemotypes. Chemotype 1 contained rotenoids, including deguelin and tephrosin which were responsible for the pest control efficacy whereas rotenoids were absent in chemotype 2 which was characterised by prenylated flavones that are biologically inactive against the insects tested. Sampling from 13 locations in Malawi where farmers cultivated *T. vogelli* for insecticidal use indicated that 25% plants were chemotype 2. Dr Stevenson, concluded that concentration of chemicals in the plant may vary at the different times of the year and different geographical locations.

Based on Dr Stevenson's findings, I will be collaborating with GrowthAg under the Centre for Biopesticides to screen Plant X extracts from Plant X varieties harvested at different times and also from different geographical regions.

Dr Elizabeth Arnold also reported that sex, morph and age may influence responses to behaviour modifying ordours. Their study found significant differences behaviour of male and female beetles of different ages as well as interactive effects of sex, morph and age. They concluded that behavioural experiments on insects should control for sex and age, while considering differences between adult morphs where present in a species.

Prof Murray Isman is one of the world expert in botannicals for pest management. He indicated in his presentation that the potential of plant extracts and plant natural products for insect pest management continues to be a subject of considerable research and scientific interest, but the interest from the agrochemical community and commercial adoption of botanicals lags far behind. The reason for this lag is the logistical and regulatory difficulties faced by companies that have attempted to commercialise botanicals but changes have already occurred in many countries.

Dr Robert Spooner-hart's paper was about the identification and assessment and development of a botanical termiticide. Dr Spooner-hart's research established that the essential oil from the heartwood of *Eremophila mitchelli* (false sandalwood) provides much of the resistance of the sandalwood to termites. Steam distilled *E mitchelli* wood oil displayed toxic, repellent and antifeedant activity against termites. 8 components of the wood oil has been characterised. The termiticide developed by Dr Spooner-hart's team will be incorporated in the cotton biocontrol agent seed treatment trials for 2012-13 season.

Dr Vanda Bueno (Federal University of Lavras, Brazil) reported in her paper that for the past 10 years biological control agents were exposed to the same legislation, including the same registrations, as synthetic chemicals. However, the recently established Brazilian Association of Biological Control Industry has changed the situation and within 2 years 9 microbial agents and 3 natural enemies ~~and~~ are registered in Brazil. Registration involves the ministries of health, agriculture and environment and the registration process has been streamlined and made easier for companies registering biocontrol agents.

Dr Marwan Kershlaf's paper was about foraging and pollination efficacy of honeybees on Bt cotton. He said that although cotton is largely self pollinating, their studies found that cross pollination by honeybees can contribute to improved yield through increased boll set, boll weight, number of seeds per boll and lint weight per boll. Application of the insecticide active fipronil at flowering against green mirids can severely reduce honeybee activity and its continued use caused significant mortalities to honeybees.

Insect pathology session

Most of the research into the use of entomopathogenic fungi for microbial control is not directed to development and commercialization of isolates. Rather, most of the research is focussed on discovery and identification of potential isolates for insect pest control. A paper presented by Dr Qiang Gao from Shanghai Institute for Biological Sciences was the only paper that dealt with pathogenesis of a fungal entomopathogen *Metarhizium robertsii*. Work to date has shown that highly active enzymes (proteases, lipases and chitinases play major roles in fungal hypha appresorium penetration of the internal organs of insect hosts. The paper provided insights into the novel mechanisms by which fungal pathogen evade host immunity by masking component usings using cell surface collagen-like protein to produce toxic cyclopeptide secondary metabolites in insects. Theadhesins code named MAD 1 and MAD 2 are chemicals used by *M. robertsii* to attach to insects. The fungus used a mammalian perilipin-like protein code named MPL1 to control lipid storage, appressorium pressure and virulence. After reaching the insect's hemocoel, the fungus up-regulate an osmosensor and a bacteria-like phosphoketolase to modulate its adaptation and propagation in the insect hemolymph. The paper gave researchers understanding of fungal entomopathogenicity but not strategies to increase pathogenicity and development of new fungal isolates for commercial pest control.

IPM, microbial control and chemical ecology were popular themes at the conference, but I was generally disappointed with the scope of the papers presented. In general, most of the papers dealing with microbial and chemical ecology-based IPM are still a very 'theoretical entomology centric' approach, often apparently failing to see the applied entomology or commercialisation/ product development aspect of the chemical actives and fungal isolates identified in their research and how to fit them in IPM on agricultural crops. Emphasis is placed, and rightly so, on the proof of concept phase of the chemical actives and fungal isolates but often stops there. Drs Robert Mensah, Robert Spooner-hart, Peter Gregg's research into semiochemicals and entomopathogenic fungi are leading the world in this area. Dr Lewis Wilson is doing the same applied aspect of entomological research but on synthetic

insecticides. There was however some interesting studies including the use of artificial growth media that enhances fungal growth and infection of insect pests.

The role of beneficial insects in IPM was mentioned in most of the papers but surprisingly synthetic insecticides were the common tools used. There was a general lack of strategies or techniques to conserve or maximise the abundance and effectiveness of beneficial insects in most of the IPM studies presented at the conference. The continued reliance on synthetic insecticides in most of the IPM programs suggest a worldwide lack of IPM compatible tools which may be due to a general lack of developmental research.

A significant number of papers dealt with transgenic Bt-cotton, which generally received mixed receptions as presenters continue to tow the line of the achievements (positives) and not negatives of the introduction of the Bt technology. Most presenters were stressing on no resistance to transgenics, the technology will boost food production and singing praises to Monsanto. I was disgusted about most presenters behaving like Monsanto employee. Hence, I refused to attend most of the transgenic sessions and devoted my time with the insect pathology and chemical ecology sessions that is closely related to my research in Australia.

All of the papers presented by Australian entomologists were well received and well supported, as indicated by larger numbers of attendees for these talks. Many colleagues have expressed interest in collaborating with me to help contribute to IPM programmes in their respective countries. Overall I found the conference valuable, particularly for the opportunity to catch up with colleagues and to make new connections.

2. Concurrent sections - Dr Wilson

I attended a wide range of sessions, but rather than report on them all will draw out presentations that I felt offered real opportunity for new research relevant to Australian Cotton Systems and particularly interesting approaches.

1. Presentation by Dr P. Vichitbandha (Kasetsart University. Thialand) on use of life tables to study plant resistance to broad mite. This presentation outline valuable methods for culturing and conducting life table studies with broad mite and may be relevant in Australia if this pest is recurrent

2. Prof Michael Toews (U. Georgia) presented a highly relevant study of movement of *Euschistus servus*, a pentatomid bug similar to GVB, in an agroecosystem. This species attacks a wide range of hosts including cotton. This included study of overwinter habitat and seasonal host use and the pattern of invasion of crops and within crop movement. Many similarities to studies I have done with GVB, but also some useful techniques.

3. Presentation by Dr Neil Millar (University College, London) on the evolution of resistance in western flower thrips to spinosad. This species is a pest of cotton in Australia though rarely in early season cotton. Spinosad is p[probably the most effect option we have agaiosnt it, if needed. Resistance was due to a single mutation in the nicotinic acetylcholine receptor.

4. Presentation by Dr Steve Naranjo (USDA ARS) on the biological control of SLW. This was a very interesting presentation illustrating how Bt-cotton essentially transformed management of SLW as well, leading to a very robust system. A key point that Steve reported was the registration of the product flonicamid which provided very effective and selective control of Lygus, thereby relieving a major stress point in their cotton IPM system.

5. Prof Steve Whyard (U. Manitoba, Canada) presented a very interesting review of the development of species specific RNAi technologies to control pests. His group have been able to target specific rapidly evolving genes or portions of highly conserved genes to develop RNAi's that selectively kill one species without affecting closely related species or other genera – however this is species specific and a significant challenge. Delivery if RNAs is still evolving – transgenic plants are the most favoured option but they are also looking at

spray delivery – perhaps encapsulated in the bodies of micro-organisms to make them more environmentally stable. He raised the risk of resistance developing, especially the potential for behavioural resistance to transgenic plants. Overall a very interesting developing area.

6. Presentation by Prof Robert Spooner-Hart on development of an oil extract from *Eremophila mitchellii* as a termite treatment. A valuable story of research and the perils of commercialisation.

b) other highlights

3. Detail the persons and institutions visited, giving full title, position details, location, duration of visit and purpose of visit to these people/places. (NB:- Please provide full names of institutions, not just acronyms.)

Dr Mensah had meetings with the following:

- Prof Gregory Sword of the Texas A&M University to discuss fungal endophytes and their potential for biocontrol in cotton;
- Prof. Qiang Gao from Shanghai Institutes for Biological Sciences to discuss molecular pathogenesis of fungal entomopathogens.
- Prof. Ted Stevens of University of Neuchatel, Switzerland to discuss plant-produced volatiles we need target to improve biological control
- Prof John Pickett of Rothamsted Research, United kingdom to discuss semiochemical based crop protection through the seed.
- Prof. Silvie Dorn, Professor of Applied Entomology ETH Switzerland to discuss insect-host plant interactions and the development of Flight mill actograph to determine the directional and flight capacity of moths under various environmental conditions;
- Prof Dorn and I co- supervise a PhD student Mr Jason Callander. Jason is working on the flight phenology of Helicoverpa armigera in relation to Bt cotton refuges. The meeting with Prof. Dorn discussed the way forward on the Jason's research especially interpreting the results of field and laboratory data presented by the student for discussion.
- Dr Justin Hatting of Small Grasin Institute, South Africa to discuss IPM through sub-lethal synergy between chemical insecticides and entomopathogenic fungi. Also I discussed biopesticides, development, formulations and applications.
- Prof. Jim Hardie and David Hall of the United Kingdom to discuss semiochemicals in IPM.
- Dr Zeyaur Khan on his chemical ecology based IPM strategy for small holder farmers in Africa
- Dr Megha Parajulee to discuss the progress of his landscape-level cultural control as an arthropod pest management approach in Texas High plains cotton agroecosystems. Dr Parajulee also discussed the opportunity of coming ACRI on sabbatical leave to review landscape level cultural control and impact on sucking pests on cotton cropping systems.

Dr Wilson had many discussions. Key were:

- Dr Megha Parajulee, as above, with Dr Mensah
- With Dr Steve Naranjo (USDA ARS, Maricopa, Arizona) to discuss results for our research on SLW ecology. We discussed the research to identify mortality factors and reviewed the methodology, coming to the conclusion that the approach was

essentially identical. There are problems with tracking survival of the crawler stage especially and Dr Naranjo suggested studying that stage separately and provided a short paper describing a study he completed on this. We also compared finding, as in Australia, we have a lot of nymphs simply missing – and it is difficult to say if this is natural mortality or predation. He suggested an approach to analyse the data which we will progress. We also discussed host use patterns and the similarities and differences in systems (Arizona is more arid with generally less alternative host availability). We also discussed the challenge of mirid/lygus control and flow on effects to beneficials and SLW. Steve highlighted the role of flonicamid at providing a valuable option in Arizona. I concluded it would be valuable to have Dr Naranjo visit Australia, both to collaborate and also review our system with new eyes.

- Discussion with Dr James Harwood (U Kentucky) regarding the opportunity to apply molecular markers for GVB and SLW to identify key predators of these pests in Australia. He expressed a strong interest in developing collaboration and I have developed a project proposed to go to CRDC. We also discussed the general role and ecology of generalist beneficials and the commonalities in our perceptions of the systems in Australia and the US (Kentucky) are very similar.
- Discussion with Dr Ian Denholm from Rothamstead and Rick Roush (U. Melbourne) on the results we are finding in collaborative research with Dr Grant Herron, Dr Yizhou Chen and Dr Flavie Vanlerberge-Massutti on clonal structure of cotton aphid and implications for resistance. Dr Denholm encouraged us to look further at the current system where neonicotinoid resistance has emerged and OP/carbamate resistance decline to understand which clones now predominate and if neonicotinoid resistance in a new mutation. I am developing this concept with Grant and Yizhou.
- Met with Mike Furlong (UQld) to review progress of our PhD student Rehan Silva and plan sampling trips to collect thrips from cotton and other crops and hosts. We also reviewed progress on a shared MS on induced resistance.
- Met several times with Dr Mensah and Dr Spooner-Hart (UWS) to discuss a range of bio-pesticides and plant extracts that have been developed. We identified the option to test some of these for their potential as seed treatments in cotton, targeting thrips and wireworm, given the lack of alternative to the neonicotinoids through conventional agrochemical companies.
- Met with Prof Greg Sword (Texas A&M) and Prof Michael Toews (U. Georgia) to discuss movement of sucking bugs (Pentatomids) in agro-ecosystems. This is relevant to a PRP submitted to CRDC by Prof Gimme Walter and James Hereward (I am a collaborator). Recent research is showing that mobile adult pests are very adept at moving around in the landscape to make sure the feed on what they need at the time – eg nectar for energy. This has implications for movement in agroecosystems as well and Drs Sword and Toews have some relevant methods.
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4. a) Are there any potential areas worth following up as a result of the travel?

- The potential research area worth following up is semiochemical based crop protection through the seed. I have already commenced coating cotton seeds with semiochemicals and fungal isolates developed in my project for seed treatment trials in 2012-13 season. Dr Lewis Wilson will also include biopesticide coated seeds in his seed treatment trials.
- Prof James Harwood re-re-use of molecular markers for identifying key beneficial species
- Potential for a visit to Australia by Dr Naranjo
- Develop work on clonal structure of aphids

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Please email at least 30 days after travel/conference to: research@crdc.com.au

Travel Justification

4.1 Detailed itinerary (similar for Wilson and Mensah)

Dates	Destination	Activities
18 Aug 2012 (Aeropelican)	Narrabri-Sydney	Connect to Korean Airlines
19 Aug 2012 (7.10 am)	Sydney-Incheon (Seoul) - Daegu	Arrive at Conference venue; Registration, Welcome Gala Dinner
20 - 24 Aug 2012	Daegu conference centre	Conference presentations
24 Aug 2012	Daegu conference centre	Presentations & Farewell dinner
25 Aug 2012	Daegu - Incheon -Sydney	Return flight to Sydney
26 Aug 2012	Arrive in Sydney	Sydney at 7.10 am
26 August 2012	Depart to Narrabri	Arrive in Narrabri at 1.30pm