Emerging Technologies in Horticulture Seminar

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AUSVEG Ltd

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2013 Emerging Technologies in Horticulture Seminar
(Due date 31/08/2013)

A seminar designed to identify, demonstrate and expand upon advancements in technologies related to the production of vegetables

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The 2013 Emerging Technologies in Horticulture Seminar was designed to identify, demonstrate and expand upon advancements in technologies related to vegetable production.

Technologies explored at the seminar were those which might assist in mitigating issues predicted to impact Australia's vegetable production capability over the next 10 - 20 years.

The purpose of this report is to collate seminar feedback and develop recommendations intended to guide and improve the design of future 'Emerging Technologies' seminars.

This project has been funded by HAL using the National Vegetable Levy and matched funds from the Australian Government.

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Media Summary

The 2013 Emerging Technologies in Horticulture Seminar was held on May 30, 2013 at Jupiters, Gold Coast. The Emerging Technologies seminar was designed to assist Australia's horticulture industry tackle current and future challenges; showcasing new opportunities for levy investment and promoting collaboration between vegetable producers and researchers on a global scale. The seminar hosted 100 vegetable growers from across Australia and assembled a delegation of eight international and domestic research specialists to showcase emerging horticultural technology.

The Emerging Technologies Seminar acted as a mechanism for vegetable growers to identify opportunities for levy investment and promoted dialogue between researchers and growers. The seminar exhibited research and technological innovation previously unknown to many Australian vegetable growers. The assemblage of vegetable growers intent on increasing productivity and embracing new techniques emphasised the significance of future planning to Australia's vegetable production industry. Maintaining industry knowledge of emerging research and the availability of new technology will further assist growers in making long-term business decisions.

The Emerging Technologies seminar illustrated a whole industry initiative to support the adoption of technological innovation and promote enhanced collaboration between industry and research. The substantial grower participation demonstrated an industry-wide commitment to optimising production methods. The impact of the Emerging Technologies Seminar will resonate throughout Australia's vegetable production industry for some time, encouraging growers to consider challenges in the context of solutions offered by emerging horticultural technology.

Introduction

Australian vegetable growers' inclination to adopt cutting-edge technology has awarded the vegetable industry a reputation for efficiency, modernity and sophistication; however the rate of technological evolution persistently outstrips adoption and agricultural research often overlooks significant on-farm concerns. Investing in learning and development practices aimed at expanding grower knowledge regarding emerging technology, and enhancing collaboration between research and industry is of critical importance to improving the vegetable industry's capacity to manage challenges.

Taking this into consideration, AUSVEG designed the 2011 Mechanisation Seminar. The mechanisation seminar was held on Wednesday 13 April 2011 at the Sebel-Citigate hotel in Brisbane. The seminar hosted 25 growers to discuss their opinions on where the industry should invest R&D dollars in the future of mechanisation, as it had been recognised as a priority by the Vegetable IAC. The seminar promoted open dialogue between researchers, growers and industry service providers in order to identify what growers want to see implemented on their properties.

Following the success of the 2011 Mechanisation Seminar, AUSVEG designed the 2012 Future Technologies Seminar. The Future Technologies seminar was awarded a greater scope, providing 50 growers with the opportunity to increase their knowledge and understanding of a broad subsection of cutting-edge vegetable production R&D. The Future Tech seminar enabled interactive feedback between growers, industry representatives and researchers. An encouraging response from attendees emphasised the seminar's significance and called for an increase in grower participation.

The 2012 Future Technologies Seminar was followed up by the Future Technologies Seminar Forum, which explored numerous potential projects that effectively aligned with overarching vegetable industry priorities contained in the Vegetable Industry Strategic Investment Plan 2012–2017. The Forum assembled presenters from the 2012 Future Technologies Seminar to pitch their project concepts to a sub-committee of the Farm Productivity Resource Use and Management Committee. The Forum acted as a mechanism for which innovative ideas could be further progressed and developed into projects with tangible benefit to industry.

The 2013 Emerging Technologies Seminar (the seminar) was conceived to identify innovative technology which addresses key concerns of Australian vegetable growers now and into the future. The seminar assembled eight domestic and international research specialists to identify and outline the latest technological advancements in vegetable production and to provide a snapshot of how this technology might impact the future of vegetable production in Australia. More than 100 vegetable growers and key industry representatives attended the seminar; the largest attendance of all previous seminars.

The Australian vegetable industry faces a range of challenges including increased competition, various international and domestic market pressures, a fluctuating Australian dollar, rising input and operational costs and the constant threat posed by pests and diseases. Topics presented at the seminar were congruent to identifying and

mitigating current and future challenges experienced by Australia's horticulture industry. In addition to this, several topics had outcomes intended to optimise current and future practices, including educational elements, so that growers are aware of the science behind the technology.

The seminar acted as a mechanism for identifying potential R&D funding opportunities. The seminar took funding decisions directly to vegetable levy payers, giving them the opportunity to feel ownership over how and where their levy is spent. The seminar also gave influential growers the opportunity to meet researchers firsthand and discuss farm-specific issues. In addition to this, seminar presenters (particularly internationals) were given a crash course introduction to Australian vegetable production - improving their capacity to tailor R&D for the social, economic and environmental conditions endemic to Australian horticulture.

The seminar was a whole industry initiative to support the adoption of technological innovation. The substantial turnout from across Australia exemplifies the industry's commitment to pursue cutting edge tools and processes to enhance production methods. The seminar was a successful approach to improving the outcomes of R&D for vegetable growers across Australia, promoting industry consultation and researcher collaboration. The seminar's impact will resonate throughout Australia's vegetable industry for some time, encouraging growers to think about industry challenges in the context of potential solutions offered by emerging technology.

Seminar attendee and Vegetable IAC member Danny De Ieso (left) discussing the potential of horticultural robotics with CyPhy Labs' roboticist, Dr. David Ball
Photo courtesy: John McRae

Seminar Details

The 2013 Emerging Technologies in Horticulture seminar was hosted at Jupiters, Gold Coast. Due to the substantial response from interested Vegetable Levy Payers, 100 seats were allocated for the seminar (See **Appendix II**) and as a result the seminar was divided into two concurrently run sessions (see **Figure 1.0** below).

The seminar sessions were divided into two broad subsections – Agricultural Science and On Farm Technology. Expert panel Q&A sessions were held at the culmination of each session, providing growers with the opportunity to ask questions and clarify any misunderstandings.

Dr Craig Cormick from CSIRO hosted Expert Panel Q&A sessions for the Agricultural Science subgroup, and discussed public perceptions of biotechnology.

(See **Appendix I** for attendee list)

Figure 1 – 2013 Emerging Technologies Seminar Agenda

Venue 1	**Chair: Mr Peter Ward**
Time	Event
10:00 - 10:10	**Introduction - Chair**
10:10 - 10:40	Synthetic Biology
10:40 - 11:10	Insect Sterilisation Technology
11:10 - 11:30	**Morning tea**
11:30 - 12:00	Biotechnology
12:00 - 12:30	Plant Symbiosis
12:30 - 12:50	Panel Discussion / Q&A
12:50 - 13:30	**Lunch**
Time	Event
13:30 - 13:40	**Introduction - Chair**
13:40 - 14:10	Auto Weed Control
14:10 - 14:40	Harvesting Technology
14:40 - 15:00	**Afternoon Tea**
15:00 - 15:30	Packaging Technology
15:30 - 16:00	Liquid Air Engine
16:00 - 16:20	Panel Discussion / Q&A
16:20 - 16:30	**Conclusion - Chair**

Venue 2	**Chair: Mr Jeff McSpedden**
Time	Event
10:00 - 10:10	**Introduction - Chair**
10:10 - 10:40	Automated Weed Control
10:40 - 11:10	Harvesting Technology
11:10 - 11:30	**Morning Tea**
11:30 - 12:00	Packaging Technology
12:00 - 12:30	Liquid Air Engine
12:30 - 12:50	Panel Discussion / Q&A
12:50 - 13:30	**Lunch**
Time	Event
13:30 - 13:40	**Introduction - Chair**
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15:30 - 16:00	Plant Symbiosis
16:00 - 16:20	Panel Discussion / Q&A
16:20 - 16:30	**Conclusion - Chair**

Expected Outcomes

The 2013 Emerging Technologies in Horticulture seminar was designed to provide valuable feedback for research scientists and relevant groups that make recommendations on the expenditure of levy funds. The Seminar was designed to provide researchers firsthand feedback from stakeholders set to benefit directly from their research. This feedback will assist the alignment of future research with the needs of Australian vegetable growers, in addition to identifying potential opportunities for the expenditure of vegetable levy funds.

Discussions held during the Expert Panel/Q&A sessions were expected to serve as a catalyst for growers to share their ideas and opinions regarding the technology, the relevance of the technology to their operations and the potential effectiveness of the technology if applied on their farms. The views expressed in the seminar were expected to bridge the gap between research undertaken and the developments that growers wish to see funded.

A post-seminar delegate feedback form (See **Appendix III**) was sent to attending growers to gauge their opinions. Various informal conversations with growers regarding their views of the technology presented were held following the seminar. The results of feedback collected was used to guide recommendations within this report.

CFO of The Dearman Engine Company, Jeremy North (right) received firsthand feedback from Wilson's Farm Fresh Fruit & Veg Managing Director, Daryl Wilson

Photo courtesy: John McRae

Products

One of the major issues growers have with the investment of levy funding is the lack of on-farm application of R&D undertaken. AUSVEG has provided growers with as much relevant information as possible regarding the 2013 Emerging Technologies in Horticulture seminar to ensure they are fully aware of the day's proceedings and the outcomes produced. The following material was circulated through AUSVEG distribution outlets following the seminar's completion:

1. Background papers and agenda for the seminar.

Disseminating background papers (See **Appendix IV** / Emerging Tech Presentations) and the seminar agenda (**Figure 1** - Seminar Details) enabled growers, industry representatives and interested researchers who were unable to participate in the event to be aware of the topics that were identified and discussed. These papers were made available to all levy payers via the Vegetable Industry Communications Strategy. This information will assist in planning future events, as it clarifies topics covered.

2. Seminar notes capturing the ideas raised and discussed at the seminar.

The seminar notes (see **Appendix V**) are included as an appendix to this report.

3. Filmed presentations to be made available on the AUSVEG YouTube channel.

The 2013 Emerging Technologies in Horticulture Seminar was professionally filmed, with footage available here.

4. Directed feedback from non-Design Team levy payers regarding new technologies that may be worthy of National Vegetable Levy investment.

Each participant at the seminar was provided with a post-seminar survey form so that they could provide personal opinions on topics presented, researcher engagement and the events' worthiness for levy expenditure. These surveys were made available in hard copy and digital copy online. The surveys were then collected and analysed, and the data generated used to guide the recommendations section of this report.

(See **Results** for graphed data and **Appendix III** for a copy of the delegate feedback form)

5. Final report (this document), summarising the outcomes of the seminar and including detailed recommendations for potential future investment.

As well as being distributed, all articles and presentations will be made available on the AUSVEG website so that industry members can access and download them when necessary.

Materials and Methods

The materials and methods for conducting the seminar are outlined below in the same format as it was proposed in the project submission:

1. **Choose topics and set an agenda**

Topics were researched using a variety of methods including exhaustive internet research, liaising with important researchers via phone and email, and recommendations from AUSVEG, HAL and the Vegetable IAC Sub-Committee. Topics were chosen based upon the level of applicability to vegetable production and potential capacity to mitigate key issues facing Australia's vegetable production industry.

2. **Present recommendations for Vegetable IAC Sub-Committee for approval**

A meeting was held in Sydney on January 24, 2013 with members of the Vegetable IAC Sub-Committee comprising Mr Jeff McSpedden, Mr Danny De Ieso and Dr Kevin Clayton-Greene. The Sub-Committee was satisfied with all recommendations put forth; suggesting the addition of a 'Public Policy Specialist' to discuss the implications of adopting biotechnology. Dr Craig Cormick was selected to occupy this role.

3. **Liaise with potential speakers for the approved topics**

Liaison took place via email and phone. Some potential speakers were unable to participate due to prior arrangements; eight speakers accepted the invitation to participate. This stage involved a thorough selection process, including in depth analyses of potential speakers and the applicability of their science to vegetable production in Australia.

4. **Invite relevant industry participants**

In order to generate industry awareness of the 2013 Emerging Technologies in Horticulture Seminar, seminar invitations were sent to 50 potential participants; 42 of which accepted the invitation.

Following the initial invitations, a seminar flyer (See **Appendix VI**) was published over AUSVEG communication networks to encourage levy paying vegetable growers to register their interest in the seminar. In addition to the seminar flyer, an assortment of articles and media releases (See **Appendix VII**) were published through AUSVEG communication networks and various media outlets to raise public and industry awareness of the seminar.

5. **Present final event draft to Vegetable IAC Sub-Committee for approval**

A detailed progress report (See **Appendix VIII**) outlining work to date and seeking input from the Vegetable IAC Sub-Committee was sent to relevant members of AUSVEG, HAL and the Vegetable IAC Sub-Committee on April 2, 2013. All input received was invigilated into the seminar's final design.

6. **Liaise with all participants to make travel arrangements**

Travel and accommodation were organised for each participant based upon individual requirements.

7. **Make all necessary arrangements with the venue**

All venue arrangements were made through Jupiters, Gold Coast. A/V was managed by Blue Shadow Media Productions and footage captured by John Kovacs at Candlelight Pictures.

8. **Develop seminar notes capturing discussions for future use**

Minute takers were allocated to each of the seminar sessions (See **Appendix V** for minutes).

9. **Utilise all project related materials to develop final report (this document)**

10. **Submit final report (this document) to HAL by 31 August 2013**

Dr Luke Alphey (second from left) fielded several questions during Expert Panel Q&A sessions

Photo courtesy: John McRae

Results

I. Media:

Effective media is a valuable method of communicating R&D information and activities back to industry. A strong media presence also demonstrates to the public that Australia's Vegetable Industry is being proactive in securing its future. Increasing public awareness of vegetable R&D is essential to progress the image of Australia's vegetable production as secure, hi-tech and world-class.

The 2013 Emerging Technologies in Horticulture seminar received widespread media attention prior to May 30, 2013 including airtime on 2NM and articles on the Fruit Portal website and in Shepparton News. Media items following the seminar included features on ABC Gold Coast, ABC News 24, NBN Gold Coast and WIN News Gold Coast. Media generated by the 2013 Emerging Technologies in Horticulture Seminar exceeded that of previous seminars considerably.

Dr Luke Alphey being interviewed post-seminar
Photo courtesy: William Churchill, AUSVEG

AUSVEG Chairman John Brent being interviewed post-seminar
Photo courtesy: William Churchill, AUSVEG

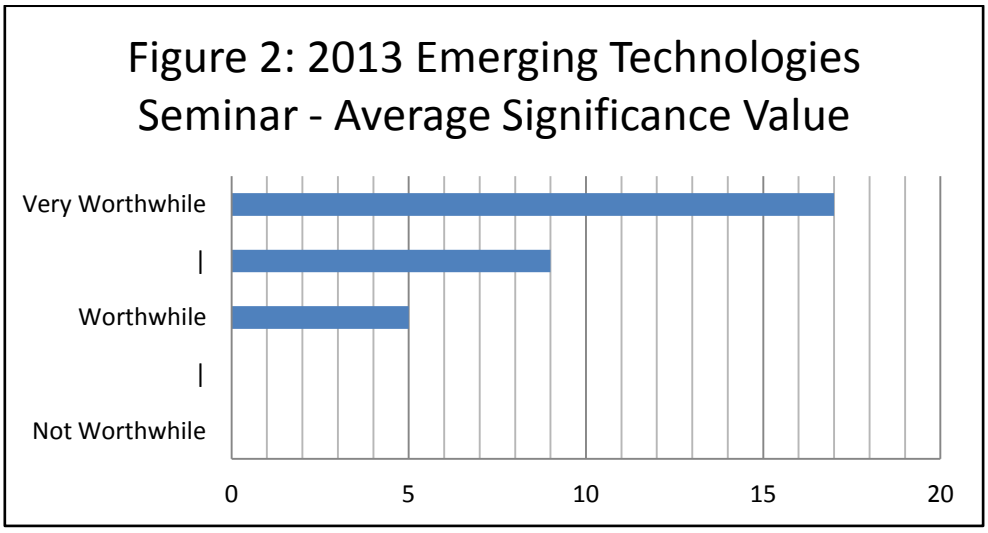
Bundaberg Fruit and Vegetable Growers Association (BFVGA) Executive Officer Peter Hockings being interviewed post-seminar
Photo courtesy: William Churchill, AUSVEG

Dr David Ball (left) and Andrew Bate, designers of CyPhy Labs' autonomous weed control robot, being photographed post-seminar
Photo courtesy: John McRae

II. Attendee Feedback:

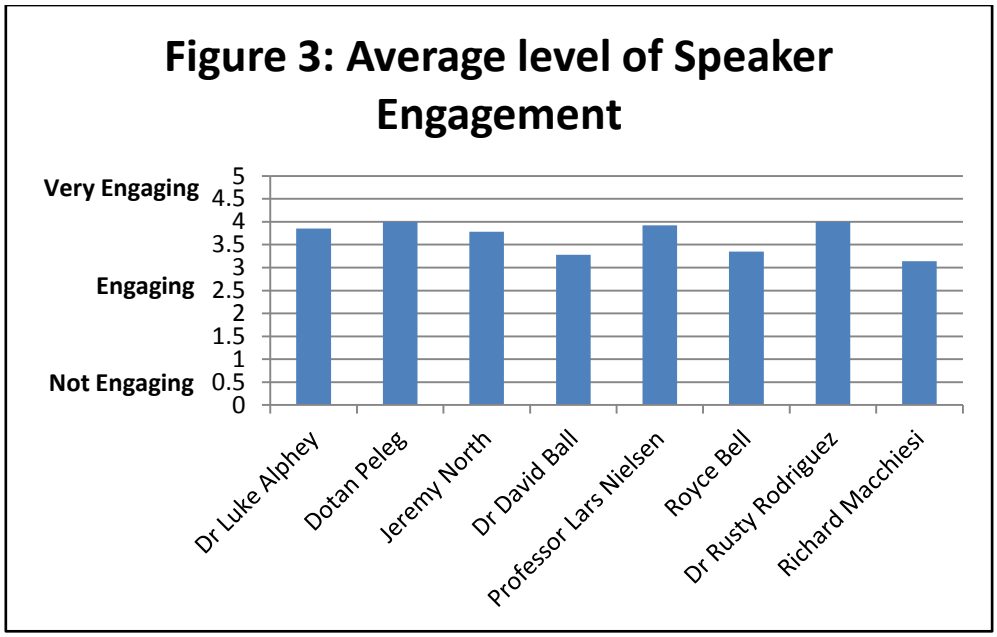
Delegate feedback forms (See **Appendix III**) were sent to attending growers and made available online following the seminar to gauge their attitude toward the seminar and its content. In addition to this, various informal conversations were held with growers prior to and following the seminar. Minutes (See **Appendix V**) were taken during the seminar, to provide records of topics covered and growers' questions and comments.

Figure 2 – Significance Value of the 2013 Emerging Technologies Seminar according to attending growers



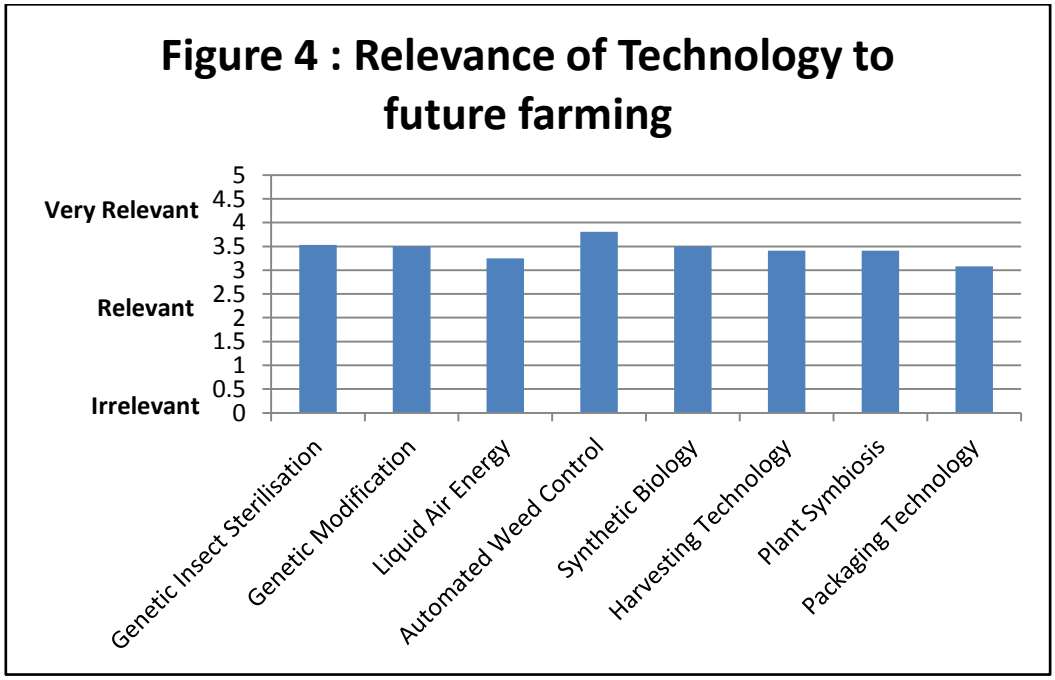
As indicated by the above graph, 54% of attendees found the seminar to be "Very Worthwhile". No attendees considered the seminar to be less than "Worthwhile".

Figure 3 – Average level of speaker engagement according to attending growers



Attending growers rated Dr Rusty Rodriguez and Dotan Peleg equally most engaging. Professor Lars Nielsen weighted second most engaging, followed by Dr Luke Alphey and Jeremy North as equal third most engaging.

Figure 4 – Average relevance of technologies to attendee farming operations



Attendees rated Automated Weed Control as the most relevant technology to the future of their farm. Genetic Insect Sterilisation was rated second most relevant, followed by Genetic Modification and Synthetic Biology.

III. Delegate Feedback Form – Comments

The following excerpts are responses to questions four, five and six of the delegate Feedback Form (See **Appendix III**). These excerpts have been considered when formulating the recommendations section of this report:

4) Please comment on areas of the seminar which you think could be improved:

Excerpts from delegate feedback forms:

"I feel that the topics could have been more practical or not presented until they were more practical/actualised."

"Overall I think no improvement really needed. The speakers were not too long. There were enough breaks and speakers were interesting and insightful."

"Very happy with the day. All the gene speakers were interesting and frightening at the same time, we need to be aware of these technologies and how they are advancing. We do need to carefully consider what role they may or may not play in fresh food. Being NON GM is a key advantage we currently have. Is this worth risking?"

"Presenters should have been given shorter presentation time or reduce number of presenters, to allow for more question time and panel discussion. It is the question time and discussion that the theory becomes more practically relevant to the growers."

"Limiting the sessions to 50 people was probably unnecessary given the presentation format. Craig Cormick gave a good short talk on public perception, which is a crucial issue, and then chaired the panel discussion well."

"The seminar was fantastic. It needs to be linked to the conference again. The next day small rooms should be organised for presenters and other experts at the conference to meet with small groups of growers."

"Water is the limiting factor on our farming enterprise and probably for other growers."

"The things we saw were good, but a long way into the future. I would like to see more stuff that is relevant to now & technology that can help me increase production & efficiency & quality, I would like to see technology that helps our consumers recognise & purchase our products, stuff that is simple & practical."

5) Would you consider attending future Emerging Technology seminars? Why or why not?

Excerpt from delegate feedback forms:

"Yes, for networking opportunities and get awareness of what technologies are available in the future."

"Yes the future of farming is in the technologies and this was very well covered."

"Definitely, as long as it was new innovations or an addition to what we already have been presented."

"Yes. It's a great way to learn about what's out there. Usually don't have time to research such topics and probably would never learn about them otherwise."

"Yes I would. I have attended last three all with slightly different approaches and speakers. All of value in their own way."

"Yes. It introduces you to things that you didn't realise were being researched in the industries. And because of these reasons it motivates you."

6) Please list any further comments you may have regarding the 2013 Emerging Technologies Seminar:

Excerpts from delegate feedback forms:

"Would be good to have a copy of presentations, or even a single sheet showing details of the speakers, and their respective companies."

"2 speakers then break in room – you really need to be attentive to take in all information. Session slightly long – CSIRO was not needed! Turned off."

"Enjoyed the day, interesting speakers and great food and topics. An opportunity for me as a farmer that I wouldn't normally get the chance to participate in. Well worthwhile and am keen to attend similar seminars in the future."

"Interesting contrast between the speakers – one academic, two scientists ex-academic now business and one non-scientist CEO. You get different styles from such people! But worth considering how much data vs. how much marketing you want and selecting speakers accordingly. Probably a good mix as was, but worth considering."

"My take home messages were: robotics, weed management options, seed treatments and new energy options.

IV. Excerpts from Seminar Minutes:

The following excerpts are from the Seminar Minutes (see **Appendix V**). The quoted sections are discussion points raised by growers expressing interest in areas to investigate or areas in which they wish to see further outcomes achieved. These excerpts have been considered when formulating the recommendations section of this report:

Synthetic Biology:

- An attendee inquired as to the vegetable industry's contributions in terms of synthetic biology, noting that the sugarcane industry is comparatively advanced in this field.

Session Chair Mr Peter Ward reiterated that the question highlights the purpose of the seminar, encouraging levy payers to consider conceptual ideas and follow them up with AUSVEG so that they may be acted upon as potential R&D projects.

- An attendee inquired as to how the detection process (of environmental stressors) could be improved through biological engineering.

The speaker explained that earlier sensing and localised sensing would be preferred options; hence better intervention processes could be given through sensing mechanisms. As an expression of this engineering, a luminescent light could be engineered within a plant to detect water, nitrogen or any programmable insufficiencies.

Genetic Insect Sterilisation:

- An attendee inquired as to when the diamondback moth would be killed in its lifecycle, and also how markers could be expressed.

The speaker explained that the larvae isn't killed, rather its ability to reproduce is affected.

- An attendee inquired as to whether the natural predators of mosquitoes would be effected by completely eradicating the pest population.

The speaker noted that environmental risks are assessed on an individual basis. The speaker considered that most insect pests are alien to their region; hence killing off these species could be considered 'cleaning' the ecosystem. Native species in the native range would need to be considered in greater detail.

- An attendee inquired as to costs compared to similar technologies.

The speaker noted that the technology should be cheaper, as it was more cost effective and costs would be spread around over multiple pest affected farms.

Biotechnology:

- An attendee inquired as to whether it was possible to transfer genes via grafting.

The speaker noted that it is indeed possible for the technology to be transferred through grafting, which was the initial trial method for transferring the technology.

- An attendee raised issue with sending genetic material through the postage service. He raised concerns as to whether international transmissions would have regulatory and security implications.

The speaker noted that dry genetic material would not show an effect outside of plants and that permission had been given for importing and exporting the material through Europe and the United States. The speaker considered regulatory issues associated with postage to be non-existent.

- An attendee inquired as to whether desired traits had to come from a plant of the same species.

The speaker noted that the host plant should not matter and that in many instances the scenario had proven successful. The speaker considered the main issue to be obtaining the target trait, therefore the need to isolate and consider traits for genetic and toxic elements should be given consideration prior to implementation.

Plant Symbiosis:

- An attendee inquired as to whether the plant's symbiotically enhanced growth would be sustained.

Dr Rodriguez considered that, in the long run, non-symbiotic plants would catch up to symbiotic plant growth; however symbiotic plants would ultimately grow faster.

Autonomous Weed Control:

- An attendee inquired as to the health and safety concerns, and hence, Australian health and safety regulations within automated agriculture.

The speaker noted that health and safety regulations had not yet been established and although it is an eminent issue, development needed to occur before laws.

- An attendee inquired as to why robotic industries are not focusing more on agriculture.

The speaker noted that he suspects innovation in agricultural robotics is stalling. The speaker explained that funding, specifically for agricultural technological advancements is likely being ignored.

- An attendee said that they would like to see robots designed specifically for horticulture. The attendee believed that inexpensive robots are needed for intense horticulture.

The speaker indicated that he is interested in working with horticulturalists. It was said that a low cost approach would be important in this space.

- An attendee asked about the amount of research going into system development and sensing and where the balance in research existed.

The speaker believed that designing robots with a cost effective approach; in particular adopting smart-phone technology, is important. It was said that a move from lasers to vision-based sensing would improve robots' capacity to perceive multiple variables e.g. vegetable type and maturity. It was said that computer-based vision groups are working on sensing equipment that relies solely on vision-based sensing.

- An attendee referred to the time intensity of robots, asking whether small robotic equipment would require more input time from farmers.

The speaker noted that Professor Salah Sukkarieh's group is currently working on system failure by installing fail-safe mechanisms e.g. other members of a robot team take over if an individual robot fails.

Packaging Technology:

- An attendee inquired as to VISY's vision for the future of Australia's vegetable production; particularly regarding export to China.

The speaker responded by discussing contamination issues in exported produce. It was said that Australians aren't entirely patriotic and are therefore not more likely to purchase Australian produce. The speaker believes a strategic approach is key to ameliorating these issues.

Liquid Air Energy:

- An attendee inquired as to whether the ambient temperature impacted the efficiency of liquid air engines.

The speaker noted that the engine's efficiency might be impacted at extremely low temperatures; however above -10 degrees centigrade the engine will maintain the same efficiency.

- An attendee inquired as to the benefits of liquid air engines in cold rooms.

The speaker discussed the regulation of carbon emissions from cold rooms and the way in which liquid air engines could reduce or eliminate the emission of greenhouse gases.

Vegetable IAC Chairman Jeff McSpedden (second from left) discussing potential collaborations between The Dearman Engine company and John Deere

Photo courtesy: John McRae

Evaluation of Effectiveness

Feedback was gathered by means of delegate feedback forms, verbal interviews during and after the seminar and email and phone discussions with attending growers and industry service providers.

Figure 2.0 - Results shows that the majority of attendees found the seminar to be very worthwhile. No attendees found the seminar to be less than worthwhile, indicating a significant justification for levy investment. Several attendees indicated that they feel uninformed and disconnected regarding scientific advancements generally, and the seminar was a successful means to gain an understanding about what research is taking place globally and how it might impact their businesses.

Several growers noted that information gained from the seminar motivated them to keep farming, as they were made aware of how research is focussed on the needs of horticulture and how farming methods are continuing to evolve. According to one grower, the seminar was "... exceedingly well run". This sentiment was shared by the majority of attendees, indicating that the foundations of the seminar are solid. One grower claimed that being face-to-face with researchers, as opposed to accessing information online, allowed them to "... get more out of it".

Growers found that meeting other growers with a common goal of increasing productivity and embracing innovative new techniques was highly beneficial. One grower claimed the networking capacity awarded by the Emerging Technologies Seminar was extremely valuable; particularly as his business is located in rural Western Australia. Growers believed the seminar focussed their businesses on the future; allowing them to make long term business decisions by understanding the possibilities offered by emerging technology.

A grower claimed the presentations regarding biotechnology were both "... exciting and frightening", noting that growers need to be aware of biotechnological developments in order to analyse the risks and benefits associated with adopting gene technology.

Figure 3.0 – Results show the average level of speaker engagement was good, with several speakers given high amounts of praise for the quality of their presentation. This indicates that speaker selection was effective and that a combination of science and business oriented speakers is valuable. Growers found the diverse delegation of speakers which ranged from accomplished scientists to chief financial officers, provided a diversity of presentation styles. One grower claimed that an entire delegation of scientists would have been boring and the diversity contributed to the overall interest factor of the seminar.

Figure 4.0 – Results shows that all technologies discussed were considered relevant to attendees' farming operations; with several topics considered to be very relevant. This indicates an effective selection of topics. Several growers are currently in discussion with seminar speakers regarding on-farm pilot trials of their technology. Dr Rusty Rodriguez from Adaptive Symbiotic Technologies in Seattle mentioned that he had received multiple expressions of interest from attendees regarding adoption of symbiotic technology on their farms. Dr Rodriguez is currently seeking regulatory approval for pilot trials.

Recommendations

The following recommendations are based on grower feedback, discussions with seminar speakers, seminar minutes and on-site observations. These recommendations should be taken into account when designing future iterations of the 'Emerging Technologies' project.

I. Focus on practical technology designed to assist and enhance international trade of Australian vegetables

The 2013 Reverse Trade Mission (VG 12101) was designed to showcase Australian produce to leading industry figures from key export markets. The 2013 Exporting to China Symposium (VG 12093) was designed to increase growers' understanding of the Chinese market and consumer behaviour, and ultimately enhance growers' capacity to successfully conduct business with China.

The next step to improve the export capacity of Australia's vegetable production industry is to distinguish technology which attenuates issues associated with export processes. Preservation of freshness throughout the export value chain is essential to substantiate the cost of Australian vegetables in overseas markets. Showcasing export technology would further enhance growers' capacity to successfully export vegetables and improve outcomes for growers already exporting.

II. Select an even mix of domestic and international speakers

The 2013 Emerging Technologies in Horticulture Seminar hosted an even mix of international and domestic researchers. The mix gave growers an opportunity to see research taking place both globally and on home soil. The inclusion of international and domestic researchers was fundamental to the overall success of the seminar, as:

- R&D taking place internationally is frequently on the cuff of scientific paradigm shifts. For example, Dr Luke Alphey's research into genetic insect sterilisation was only theoretically possible ten years ago; advancements in DNA recombination technology have only recently rendered this technology practical.

- Expanding Australian vegetable industry knowledge of global R&D is crucial to making well informed domestic business decisions and directing R&D funding accordingly. Effective R&D may be available overseas and hence should be considered.

- Enhanced ties with international research organisations show Australian horticulture's keen interest in cutting-edge global R&D. The Emerging Tech seminar indicated that Australian vegetable growers' want to be on the forefront of technological adoption.

The inclusion of domestic speakers was also fundamental to the overall success of the seminar, as:

- Growers have direct access to many of the technologies discussed by the domestic speakers

- Funding domestic R&D not only benefits Australia's vegetable industry, but also facilitates further research focussed on the Australian vegetable industry

III. Inclusion of an *Advance Meeting* prior to future seminars

The advanced Emerging Tech meeting held prior to the seminar gave influential vegetable growers and key representatives from horticulture the opportunity to familiarise speakers with challenges facing Australian horticulture. These discussions guided the Emerging Tech presentations; focussing them on the context of Australian horticulture. The meeting also provided an opportunity for growers to reflect on the technology and prepare questions for the following day. This meeting was extremely beneficial and seminar speakers were appreciative of the feedback given. The inclusion of an Advanced Meeting in future seminar preparations is a necessity.

IV. Where possible, inclusion of Design Team Members

Due to timetable issues, Design Team Members (particularly those from the Farm Productivity Design Team) were unable to attend the Emerging Technologies seminar. This is unfortunate, as Design Team members are known to be 'early adopters' of the latest horticultural technology and are well positioned to understand levy investment opportunities offered by potential R&D projects. Where possible, allowances should be made during advanced planning stages to ensure members of the Design Teams are able to attend future seminars.

V. Future seminars should include a Public Policy Specialist / Public Policy Topic

Attendees of the 2013 Emerging Tech seminar were particularly interested in Dr Craig Cormick's address regarding the public perception of Genetic Modification technology. It was important that growers were aware of how consumers might react to vegetables grown using GM technology. This might be considered as a topic of its own when planning future seminars.

VI. Inclusion of 'Fast Tracking Adoption' meeting and/or topic

Many growers were left to chase speakers following the seminar to discuss potential field trials. In this situation growers and speakers run the risk of missing out on valuable collaborations. The inclusion of post-seminar meetings to facilitate the adoption of certain technologies would bypass this issue.

Meetings might involve groups of roughly 10 growers per speaker and would be based upon interest (growers could sign up following the seminar). Minute takers would be required to monitor meetings, along with facilitating the sessions. Uploading minutes from the sessions would allow growers unable to attend the sessions to benefit from items discussed.

The inclusion of a topic discussing avenues for farmers to adopt technologies would also be beneficial. It would be advisable for the speaker to be familiar with the technology to be discussed so that they may research potential issues associated with adoption. This presentation might be titled "Mechanisms for Technological Assimilation".

VII. Ensuring the validity of science

Ensuring the scientific validity of speakers' claims is integral to providing attendees with the best possible representation of emerging technology. All topics should be thoroughly assessed for relevance and scientific factuality.

VIII. Investigate the possibility of reducing the number of speakers

Several growers thought the seminar went for too long; claiming that it was difficult to maintain focus and take in all of the information. Furthermore, growers also believed that the Expert Panel Q&A sessions were not long enough. Reducing the number of speakers from eight to six would allow more time for breaks between sessions and an increased allotment of time for Expert Panel Q&A sessions. This would potentially improve attendees capacity to maintain attentiveness throughout the seminar.

IX. Design questions for Expert Q&A sessions prior to seminar

The Expert Panel Q&A sessions, while extremely valuable, were not utilised to their full potential. The seminar coordinator should liaise with leading industry figures (growers, researchers and other industry service providers) prior to the seminar to generate a series of questions for presenters. These questions might then be used as a catalyst to generate further questions from attendees.

X. Recap of previous year's topics, focussing on technological uptake in the vegetable industry

The Future Technologies Seminar Forum assembled presenters from the 2012 Future Technologies Seminar to pitch their project concepts to a sub-committee of the Farm Productivity Resource Use and Management Committee. If future iterations of the Forum are to take place, it would be valuable for its outcomes to be presented at the seminar; effectively summarising how technologies presented at the seminar are funded and adopted by the vegetable production industry.

XI. Hold a similar seminar in 2014

Seminars which showcase horticultural technology are an established mechanism for vegetable growers to develop relationships with the research community. However, the relationship between the Australian vegetable industry and researchers remains underdeveloped and as a result there exists a less than satisfactory level of developed technologies reaching growers. Holding future seminars designed to showcase horticultural technology would further promote grower-researcher interaction and collaboration, guiding research goals to produce outcomes tailored for vegetable production in Australia.

Appendix

I. 2013 Emerging Technologies Seminar – Delegate List

Name	Region	Category	Company
Mr David Addison	TAS	Grower	AUSVEG
Mr James Addison	TAS	Grower	Charlton Farm Produce
Mr Neil Armstrong	TAS	Grower	Harvest Moon
Mr David Ashburner	WA	Grower	Farmland Greens
Mr Le Bach	WA	Grower	Micaya Enterprises
Mr Maxwell Baker	TAS	Grower	M & J Baker Farms
Mr Anthony Barker	QLD	Grower	J&G Barker
Mr Andrew Bate	QLD	Grower	Bendee Farms
Mr Mark Bell	VIC	Grower	Hussey & Co Mixed Salads
Mr Charlie Blogna	WA	Grower	Baldivis Market Garden
Mr Calogera Blogna	WA	Grower	Baldivis Market Garden
Mr Paul Bogdanich	WA	Grower	AUSVEG
Mr Marcus Brandsema	TAS	Grower	Protected Cropping Australia
Cr John Brent	QLD	Grower	AUSVEG
Mr Peter Britt	VIC	Grower	J.C. Cutbush & Co.
Mr William Bulmer	VIC	Grower	Bulmers Farm Fresh Vegetables
Ms Ebony Butler	VIC	Grower	Butler Market Gardens
Mr Ross Cannavo	QLD	Grower	Severn River Produce
Mr Timothy Carnell	QLD	Grower	Kirra Pines Farming
Mr Fabien Carniel	QLD	Grower	Mulgowie Farming Company
Mr John Cirillo	VIC	Grower	J & A Cirillo
Dr Kevin-Clayton Greene	TAS	Grower	Harvest Moon
Ms Deborah Corrigan	VIC	Grower	Corrigan's Produce Farm
Mr Anthony Costa	SA	Grower	Costa Produce
Mr Danny De Ieso	SA	Grower	Thorndon Park Produce
Mr David De Paoli	QLD	Grower	Austchilli
Mr Andrew Dewar	QLD	Grower	SAS Pastoral
Ms Leeann Dimasi	WA	Grower	Dimasi Fruit & Veg
Mr Peter Dobra	WA	Grower	The Loose Leaf Lettuce Company
Mr Joe Elboustani	NSW	Grower	Boustani farms
Mr David Ellement	WA	Grower	Ellement Produce
Mrs Denise Ellement	WA	Grower	Ellement Produce
Mr Rodney Emerick	QLD	Grower	Mulgowie Farming Company
Mr Oliver Flint	NSW	Grower	Costa Group
Mr Nathan Free	VIC	Grower	Duralgai Horticultural
Ms Kerrie Galley	VIC	Grower	Flavorite
Mr Luis Gazzola	VIC	Grower	AUSVEG
Mr Colin Gazzola	VIC	Grower	Gazzola Farms
Ms Emma Germano	VIC	Grower	Germano Cauliflowers
Mr Romeo Giangregorio	SA	Grower	AUSVEG
Mr Tony Gibb	QLD	Grower	Gibb Bros
Mr Tristan Glas	QLD	Grower	Harslett Farms
Ms Bree Grima	QLD	Grower	B'berg Fruit & Veg Growers Assoc.
Ms Bryony Hackett	NSW	Grower	Costa Exchange
Mr Mark Hanrahan	VIC	Grower	Hanrahan Farms
Mr Timothy Harslett	QLD	Grower	Harslett Farms
Mr Jeremy Haw	VIC	Grower	Hussey & Co Mixed Salads
Mr Robert Hinrichson	QLD	Grower	Kalfresh
Mr Peter Hockings	QLD	Grower	B'berg Fruit & Veg Growers Assoc.
Mr Matthew Hood	QLD	Grower	Rugby Farms
Mr Colin Houston	TAS	Grower	Houston Farms
Mr Ben Humphries	SA	Grower	KR & JM Humphries

Mr Sam Humphries	SA	Grower	KR & JM Humphries
Mr Anthony Imeson	VIC	Grower	Veg Growers Assoc. of Victoria
Mr Stuart Jennings	VIC	Grower	Bedad
Mr Jamie Jurgens	QLD	Grower	Jurgens Produce
Mr Mark Kable	TAS	Grower	Harvest Moon
Mr Russell Lamattina	VIC	Grower	The Lamattina Group
Mrs Tina Lamattina	VIC	Grower	The Lamattina Group
Mr Mick Larkin	QLD	Grower	Simpson Produce
Mr Daryl Lohrey	TAS	Grower	Lohrey Pastoral
Mr Mick Maguire	QLD	Grower	Rugby Farms
Mr Daniel Maher	VIC	Grower	Maher Farms
Mr Simon McCarthy	QLD	Grower	Grace Kate Farms
Mr Jeff McSpedden	NSW	Grower	Veg IAC
Mr Brett Metcalfe	WA	Grower	Coastal Plains Produce
Mr Owen Metcalfe	WA	Grower	Coastal Plains Produce
Mr Geoff Moar	NSW	Grower	AUSVEG
Mr Shannon Moss	QLD	Grower	Stanthorpe Fresh Salads & Herbs
Mr Mark Napper	NSW	Grower	AUSVEG
Mr Steve Newman	SA	Grower	Hills Fresh
Mr David Nix	QLD	Grower	D.G. Nix
Mr Gavin Phillips	VIC	Grower	Maiden Gully Produce
Mr Daniel Quattrocchi	SA	Grower	Monika's Organics
Mr Anthony Rehbein	QLD	Grower	Hummock Produce
Mr John Said	VIC	Grower	Fresh Select Australia
Mr Scott Samwell	SA	Grower	Samwell & Sons
Mr Tom Schreurs	VIC	Grower	J & JM Schreurs
Mr Michael Simpson	QLD	Grower	Simpson Produce
Ms Lyndi Smith	QLD	Grower	Harvest Freshcuts
Mr Peter Ward	NSW	Grower	Wollemi Wild
Mr Daryl Wilson	QLD	Grower	Wilson's Farm Fresh Fruit & Veg.
Mr Ed Windley	QLD	Grower	Kengoon Farming
Mr Paul Windolf	QLD	Grower	Windolf Farms
Mr David Wishaw	TAS	Grower	Armidale Stud
Mr Carl Young	VIC	Grower	AR & EF Young
Dr Luke Alphey	UK	Speaker	Oxitec
Dr David Ball	QLD	Speaker	Queensland University of technology
Mr Royce Bell	QLD	Speaker	John Deere
Dr Craig Cormick	ACT	Speaker	CSIRO
Mr Richard Macchiesi	VIC	Speaker	VISY
Prof Lars Nielsen	QLD	Speaker	University of Queensland
Mr Jeremy North	UK	Speaker	Dearman Engines
Mr Dotan Peleg	Israel	Speaker	Morflora
Dr Rusty Rodriguez	US	Speaker	Adaptive Symbiotic Technologies
Mr John Bishop	QLD	Observer	Growcom
Mr Thomas Chirnside	VIC	Observer	Alleasing
Mr David Cliffe	NSW	Observer	HAL
Mr Ravi Hedge	NSW	Observer	HAL
Mr Darren Hicks	TAS	Observer	Agvita Analytical
Mr Alex Livingstone	QLD	Observer	Growcom
Mr Jack Milbank	QLD	Observer	Hortus Technical Services
Mr David Moore	NSW	Observer	HAL
Mr Dave Putland	QLD	Observer	Growcom
Mr Jesse Reader	QLD	Observer	Apple and Pear Australia
Mr John Shannon	WA	Observer	Vegetables WA
Prof Salah Sukkarieh	NSW	Observer	AFCR, University of Sydney
Mr Andrew Taylor	WA	Observer	DAFF
Dr Denis White	VIC	Observer	Stride Consulting

II. Selected Photographs of seminar venue

The 2013 Emerging Technologies in Horticulture Seminar (Pavilion Marquee Session)
Photo courtesy: John McRae

The 2013 Emerging Technologies in Horticulture Seminar (Surfers 2 & 3 Session)
Photo courtesy: John McRae

Dr. Luke Alphey addresses attendees regarding Genetic Insect Sterilisation Technology
Photo Courtesy: John McRae

III. Feedback Form

Dear delegate,

AUSVEG would like to thank you for your attendance and participation at the 2013 Emerging Technologies in Horticulture Seminar. In an effort to continually improve the seminar, we ask that you kindly fill out and submit the following survey by:

- Email to dean.schrieke@ausveg.com.au
- Fax to (03) 9882 6722
- Mail to PO Box 2042, Camberwell West, VIC 3124

Your responses will be used to guide the development of future seminars and will remain strictly confidential. The following survey should not take more than 10 minutes to complete.

1) How worthwhile did you find the 2013 Emerging Technologies Seminar?

Not worthwhile Very worthwhile

1	**2**	**3**	**4**	**5**

2) How engaging were the following presentations: 1 (**Not engaging**) - 5 (**Very engaging**)

Dr Luke Alphey –
Genetic Insect Sterilisation

1	**2**	**3**	**4**	**5**

Dotan Peleg –
Non-Transgenic Genetic Modification

1	**2**	**3**	**4**	**5**

Jeremy North –
Liquid Air Energy

1	**2**	**3**	**4**	**5**

Dr David Ball –
Automated Weed Control

1	**2**	**3**	**4**	**5**

Professor Lars Nielsen –
Synthetic Biology

1	**2**	**3**	**4**	**5**

Royce Bell –
Harvesting Technology

1	**2**	**3**	**4**	**5**

Dr Rusty Rodriguez –
Plant Symbiosis

1	**2**	**3**	**4**	**5**

Richard Macchiesi –
Packaging Technology

1	**2**	**3**	**4**	**5**

3) Rate the relevance of the following technologies to the future of your farm:
1 (**Irrelevant**) – 5 (**Very Relevant**)

Genetic Insect Sterilisation

1	2	3	4	5

Non-Transgenic Genetic Modification

1	2	3	4	5

Liquid Air Energy

1	2	3	4	5

Automated Weed Control

1	2	3	4	5

Synthetic Biology

1	2	3	4	5

Harvesting Technology

1	2	3	4	5

Plant Symbiosis

1	2	3	4	5

Packaging Technology

1	2	3	4	5

4) Please comment on areas of the seminar which you think could be improved:

5) Would you consider attending future Emerging Technology seminars? Why or why not?

6) Please list any further comments you may have regarding the 2013 Emerging Technologies Seminar:

Thank you for taking the time to complete this survey. Your responses will be used to guide and improve future seminars.

Please contact Dean Schrieke via email at dean.schrieke@ausveg.com.au or by phone on (03) 9882 0277 if you have any further questions or comments

AUSVEG

HAL
Horticulture Australia

IV. Background Information

Synthetic Biology:

Professor Lars Nielsen - Head of Systems and Synthetic Biology, Australian Institute for Bioengineering and Nanotechnology

http://www.aibn.uq.edu.au/

Synthetic Biology refers to the creation of new biological systems and devices; essentially cataloguing useful genes (much like a mechanic's parts catalogue) then rewiring and combining them to perform a preordained function. The applications of synthetic biology in vegetable production are ostensibly limitless; including plants with enhanced photosynthetic capabilities, plants which are tolerant to environmental stressors and plants which produce useful products.

Professor Lars Nielsen heads the Systems and Synthetic Biology Group at the Australian Institute of Bioengineering and Nanotechnology. Professor Nielsen's work revolves around the advancement of bioengineering science and its application to specific problems. The System's and Synthetic Biology Group's research varies from medical applications of synthetic biology, to the modification of complex metabolic pathways in plants.

Insect Sterilisation:

Dr Luke Alphey, Co-Founder and Chief Scientist, Oxitec (UK)

http://www.oxitec.com/

Pest management has undergone a series of paradigm shifts in recent years; from the development of chemical controls to the genetic modification of plants in a quest to amplify pest and disease resistance. Recently, pest insect sterilisation has become a feasible option; however insects sterilized through conventional irradiative processes typically exhibit less fitness than unaffected individuals and are therefore less likely to reproduce - limiting the process' effectiveness.

Dr Luke Alphey from UK start-up Oxitec Ltd has devised a novel solution to the issue of sterilised insect fitness. By inserting a heritable lethality gene into the target insect species, offspring which inherit the lethality gene die before reaching sexual maturity. Dr Alphey's approach avoids impacting fitness and may actually improve the fitness of targeted individuals, making it more likely that they will reproduce and pass on the lethality gene.

Biotechnology:

Dotan Peleg, COO Morflora, Israel

http://www.morflora.com/

Biotechnology encompasses a wide array of procedures for modifying organisms. Useful plant traits such as increased tolerance to salt, heat, cold, drought and nutrient deficiency can, through biotechnological processes, be conferred to plants of interest. Recent advancement in biotechnology have the potential to dramatically increase the area on which vegetables can be grown in Australia; however opponents of biotechnology commonly raise legitimate biosecurity concerns.

Israel's biotechnological innovator Morflora offers an alternative to conventional genetic modification processes, alleviating any potential threat to biosecurity. Morflora's patented TraitUP technology is a revolutionary fast and non-transgenic platform for trait introduction into seeds enabling immediate expression of traits in plants. Traits can be applied to plant seeds and expressed within weeks. Morflora COO Dotan Peleg will discuss the potential of TraitUP technology in the Australian context.

Plant Symbiosis:

Dr Rusty Rodriguez, CEO Adaptive Symbiotic Technologies, Seattle US

http://www.adaptivesymbiotictechnologies.com/

Symbiosis refers to a closed and long term mutually beneficial relationship between two or more biological species. The most important plant symbiotic relationships involve beneficial fungi which assist plants in capturing phosphorus, sulfur, nitrogen and other micronutrients from the soil. Recent developments in Endophytic research have led to products which optimise plant symbiosis; effectively turbo charging endophytic relationships' mutuality.

CEO of Seattle's Adaptive Symbiotic Technologies, Dr Rusty Rodriguez, is on the forefront of Endophytic research. He has a wealth of knowledge regarding microbiology, genetics and plant biology; researching plant-fungal symbiosis for over 20 years. Dr Rodriguez has operated a plethora of laboratories in academic and government institutions, and worked closely with a variety of industry affiliates. Dr Rodriguez is considered an international expert in the field of plant symbiosis.

Automated Weed Control:

Dr David Ball, Research Fellow, CyPhy Labs Queensland University of Technology

https://wiki.qut.edu.au/display/cyphy/Robotics%2C+Vision+and+Sensor+Networking+at+QUT

The field of agricultural robotics is constantly redefined by advancements in a variety of key areas such as sensory technology, materials development and increasingly complex autonomous mechanisms. Automation of on-farm processes is poised to play a decisive role in minimising input and maximising output of future agriculture. Fortunately for Australian growers, there exists a plethora of world class robotics research taking place on Australian soil.

Dr David Ball from CyPhy labs at the Queensland University of Technology is currently devising a swarm of small, cooperative weed-killing robots with the goal of increasing crop production and reducing environmental impact. Dr Ball's robots will thrive on an advanced sensory capacity using low-cost components – unlike costly GPS alternatives – while cooperating with other robots in a robust system. Other CyPhy labs' projects include Persistent Robotic Navigation, Vision-based Teleoperation, Brain-Based Sensor Fusion and Visual Navigation.

Harvesting Technology:

Mr Royce Bell, Tactical Segment Manager, John Deere

John Deere has a proud history of providing growers with the most advanced machinery available; staying true to its original core values of integrity, quality, commitment and innovation. Royce Bell, Tactical Segment Manager at John Deere, will discuss John Deere's latest technological advancements, including the exciting farm management suite – Farmsight.

Farmsight consists of several key components, together providing an all-encompassing management solution. 'Machine Optimisation' combines precision technology and wireless data networks to improve productivity and increase uptime, 'Logistics Optimisation' enables the remote control of machinery through fleet management solutions and machine-to-machine communication and 'Ag Decision Support' consists of user-friendly monitors, sensors, and wireless networks that provide easy access to machinery and agronomic data.

Packaging Technology:

Mr Richard Macchiesi, Insights and Innovation General Manager, VISY

The 2013 Emerging Technologies Seminar will play host to an unveiling of the latest packaging technology devised by masterminds at VISY. Insights & Innovation general manager Richard Macchiesi was coy about exactly what VISY has in store for attendees of the seminar; however he did mention the revolutionary packaging technology is a world first, aimed at preserving produce quality.

Liquid Air Energy:

Mr Jeremy North, COO and Founding Director, The Dearman Engine Company, UK

http://www.dearmanengine.com/

Liquid Air Engine technology was originally developed by Peter Dearman, a garage inventor in Hertfordshire, U.K. Dearman's idea works by chilling air to its cryogenic state (-196°C), effectively turning it into a liquid, which is then stored in a vacuum flask. Turning the liquid air back in to gas takes place inside the cylinder with the addition of an ambient temperature heat exchange fluid. This warming process produces energy by means of a rapid and efficient 'regasification'; essentially replicating the mechanism of a combustion engine.

The Dearman Engine's design can be used in conjunction with conventional combustion engines; significantly reducing emissions, fuel consumption and losses associated with heat rejection. The internal combustion engine is likely to be the dominant technology in a number of critical transport markets for the foreseeable transport - as a result, technology which enhances the efficiency of internal combustion engines combined with reducing emissions is likely to have widespread applications. Mr Jeremy North, COO and Founding Director at Dearman, will discuss the applications of The Dearman Engine in Australian horticulture.

V. Seminar Minutes

Minutes: Emerging Technologies Seminar – 30 May 2013

Attendees:	Royce Bell (Harvesting Technology) Professor Lars Nielson (Synthetic Biology) Jeremy North (Liquid Air Energy) Richard Macchesi (Packaging Technology) Dotan Peleg (Biotechnology) Dr David Ball (Automated Weed Control) Dr Rusty Rodriguez (Plant Symbiosis) Dr Luke Alphey (Genetic Insect Sterilisation) Peter Ward (Session Chair) Jeff McSpedden (Session Chair) Dr Craig Cormick (Panel Q&A host) **Guests:** Dean Schrieke (AUSVEG – Seminar Coordinator) Michael Bodnarcuk (AUSVEG – Communications Officer) Felicity Powell (AUSVEG - Journalist) William Gregory (AUSVEG - Journalist)	**Venue:**	Pavilion Marquee and Surfers 2 & 3, Jupiters Casino, Gold Coast.
Apologies:			
Date:	30 May 2013	**Time:**	10.00am – 4:30pm
Meeting objectives:	• *Inform vegetable levy payers of potential opportunities for the investment of R&D funds.* • *Increase scientific knowledge and understanding amongst growers relative to R&D opportunities.* • *Open discussion of R&D possibilities or limitations.*		

The meeting commenced at 10:00AM

1. Welcoming and seminar introduction

The Session Chairs welcomed guests to the seminar. The Chairs spoke about the constant need for

innovation in horticulture, noting that while scientific content was to be discussed, the main goal of the seminar was to explore new potential for the investment of R&D levy funds.

The Session Chair acknowledged the seminar speakers for their participation, and introduced the first speaker, Professor Lars Neilson.

2. Professor Lars Nielsen, Australian institute for bioengineering and nanotechnology, presentation on synthetic agriculture

- The speaker introduced himself and the subject of bioengineering and nanotechnology.
- An overview of achievements, developments and implications of biotechnology already reached within agricultural was given, including potential future achievements.
- It was said that the Australian Institute for Biotechnology and Nanotechnology's research was improving the efficiency of genetic manipulation.
- It was said that costs associated with GM techniques were being reduced rapidly. In addition to this, the time and effort required to sequence genes was reducing exponentially.
- It was said that jet fuel was an example of what could be created by modifying plant metabolic pathways.
- The speaker noted sensors that measure macro scale environmental and plant nutrient fluctuations were to be expected within the next decade.
- The speaker discussed the possibility of developing better biological tools for utilising the natural sensory ability of plants.
- The speaker noted that challenges existed concerning molecular biotechnology; however pathways to create compounds in a cost-effective way were being developed. The concern that changing genes may not produce any effective results was raised.
- The speaker concluded by identifying future directions in the field of biological engineering.

2.1 Question session:

- **An attendee inquired as to detection processes, and how they would be improved through biological engineering.**
  The speaker explained that earlier sensing and localised sensing would be preferred options, hence better intervention processes could be given through these sensing mechanisms. As an expression of this engineering, a luminescent light could be synthetically engineered within a plant to detect water, nitrogen or any programmable insufficiencies.

- **An attendee inquired as to the vegetable industries contributions in terms of biological engineering, noting that the sugar cane industry is comparatively advanced in this field.**
  The Session Chair reiterated that the question highlighted the purpose of the day, encouraging levy payers to consider conceptual ideas, and then give their own ideas to AUSVEG so that they can be acted upon.

3. Dr Luke Alphey, Co-Founder and Chief Scientist, Oxitec UK, insect sterilisation

- It was said that the control of Medfly and Diamondback Moth had been thoroughly investigated; however the speaker would focus on mosquitoes due to their widespread applicability.
- The speaker outlined Oxitec's RIDL genetic insect sterilisation technology. The technology ensures that male mosquito larvae bred in captivity possess a lethality gene. Hence, when larvae are released and mate, offspring inherit the lethality gene which kills them before the reach sexual maturity.
- The speaker noted that this technology was loosely based on concepts associated with irradiation sterilisation, however was much more effective.
- The inadequacies of irradiation sterilisation were explained, including negative impacts on insect fitness which reduce their capacity for successful copulation.
- It was said that RIDL technology could effectively destroy an entire population of insects in a short amount of time - up to an 80% reduction of pest communities were recorded in field trials.
- It was said that RIDL technology was a 'single-species' solution – Insects which reproduce asexually could not be controlled by this method.
- The speaker noted that field studies had been conducted in Malaysia and Brazil. Public hearings, meetings, press and campaigns within local populations had proven successful in regards to public relations and eventual results.
- The speaker identified the next steps of the programing, noting that a pilot trial of relevant pests (examples given were the Medfly, Diamondback Moth, Queensland Fruitfly) should be undertaken.

3.2 Question session:

- **An inquiry was made as to when the Diamondback Moth would be killed in its lifecycle and how genetic markers could be expressed.**
  The speaker explained that larvae were not killed; rather their ability to reproduce would be effected.

- **An attendee inquired as to whether the natural predators of mosquitos could be affected by completely destroying the pest population.**
  The speaker noted that environmental risks were assessed on a case-by-case basis. The speaker considered that most insect pests were alien to their region; hence killing off these species could be considered 'cleaning' the eco-system. Native species in their native range would need to be considered in greater detail.

- **An attendee inquired as to evidence suggesting female fruit fly only needing to mate once. Therefore, the likelihood of offspring spawning from mating which could occur so easily was raised as a concern. Also considered was the cost of this technology compared to existing control methods.**
  The speaker noted that the technology should be cheaper, as it was more cost effective and

costs would be spread around over multiple pest affected farms. Population level effect should not matter because fitness was not decreased.

- **An attendee asked whether the technology could be used on Cane Toads.**
  The speaker noted that potentially, the technology could indeed be used on Cane Toads.

The meeting broke for morning tea 11.28AM

The meeting commenced 11.48AM

The session chair welcomed attendees back and introduced the next speaker, Dotan Peleg.

4. Mr. Dotan Peleg, COO Morflora, Israel, Biotechnology

- The speaker gave a brief overview of research in Isreali biotechnology, particularly at Jerusalem University and within the Morflora laboratories.
- It was said that plants can identify and incorporate external DNA which enables modified plant viruses to act as vectors for GM traits.
- It was said that Morflora's technology represents a paradigm shift in vaccination technology.
- The speaker noted that TraitUP technology was essentially plant vaccination in order to increase stress tolerance associated with climatic fluctuation and the occurrence of pests.
- The speaker discussed the advantages of the the TraitUp product, due its ability to carry the trait into the plant from its seed form, and not alter the plants specific genetic make-up.
- The specific process by which TraitUp achieved this implanting of genetic traits was described by the speaker.
- It was said that Morflora is soon to release a variety of genes, including those which confer drought tolerance.
- The financial and environmental advantages of the TraitUp product were considered.

4.1 Question session

- **An attendee asked whether it would it be possible to graft plants with the technology.**
  The speaker noted that it was indeed possible for the technology to be transferred through grafting, which was the trial method by which the technology was tested.

5. Dr Rusty Rodriguez, CEO Adaptive Symbiotic Technologies, USA, Plant Symbiosis

- Speaker began by posing the question, how could humanity maintain agriculture this century when water could potentially be sparse?
- The speaker considered the reactions that plants have to different forms of stress, detailing the biological results.
- It was said that plants associate with four main symbiotic organisms; however the speaker would focus on Endophytic Fungi.

- It was said that the survival of all plants and animals was reliant upon symbiotic processes.
- It was said that one fungal endophyte was responsible for plant survival in high temperature conditions. Dr Rodriguez identified and isolated this endophyte and found that it conferred heat tolerance traits in other plants.
- It was said that plants optimised by symbiotic technology were able to redistribute their carbon, leading to improved plant growth and water use efficiency.
- It was said that salt tolerance could also be conferred via the introduction of fungal endophytes.
- Genetic engineering for stresses in horticulture were considered, however historically have been lacking in effectiveness.
- Symbiotic plant processes were considered, as they occur in response to various environmental stressors.
- The speaker acknowledged that, not only could resistance to stress be improved upon, but so too could overall growth where symbiosis occurred. Hence, symbiosis could be utilised to further improve agricultural plant growth.
- The speaker noted specific, measurable improvements carried out which enhance symbiotic plant relations.

6. Expert Panel Q&A, hosted by Dr Craig Cormick.

- Panel host Dr Craig Cormick initiated the discussion considering public opinion towards GM, and individual foods as grown utilising GM technology.
- It was said that the public was disconnected from their food and were largely unaware of where their food came from and what was contained in their food.
- It was said that a small amount of people have a big concern regarding GM and a large amount of people had a small concern.

6.1 Panel Q&A session.

- **Professor Lars Nielsen noted that considerations should be made for Dr Doltan Peleg's technology, as it was considered GMO under protocol. In response, Dr Peleg considered the public's view on the technology. Dr Peleg noted that he personally considered his technology as laying in a grey area of GMO. Dr Peleg considered that TraitUp did not ultimately modify plants in a GMO manner. Dr Peleg considered consumers as having a positive opinion of TraitUp technology.**

    - **An attendee raised issue with sending genetic material through the post. He raised concerns as to whether international transmissions would undergo regulatory and security regulations.**
      Dr Peleg noted that dry genetic material would not show an effect outside of plants, and that permission had been given for importing and exporting through Europe and the US. Dr Peleg considered regulatory issues to be non-existent.

Professor Nielsen added that DNA was not regulated and had the potential to be transferred too easily.

- **An attendee asked Dr Peleg as to whether the desired trait had to be from the same species of plant.**
  Dr Peleg noted that the host plant should not matter and in many instances this scenario had proven successful. Dr Peleg considered that the main issue would be obtaining the target trait; therefore the need to isolate traits and consider the potential for genetic and toxic elements associated with that trait should be completed prior to implementation.

- **An attendee enquired as to the initial growth of symbiotic fungi-plants in terms of generational effects, hence, would the life cycle be sustained, or will finished produce teeter off.**
  Dr Rodriguez considered that, in the long run, non-symbiotic plants would catch up to symbiotic plant growth; however symbiotic plants would ultimately grow faster.

Panel broke for lunch 1.15PM

The seminar commenced 1.50PM

7. Dr David Ball, Research Fellow, CyPhy Labs, Queensland University of Technology, Automated weed control.

- The speaker introduced the topic of agricultural robotics by mentioning his project partner, Andrew Bate. It was said that Andrew Bate's broad acre farm and project 'SwarmFarm' was a testing bed for many of CyPhy Labs' projects.
- The speaker considered driverless systems combined with human pickers; illustrating how humans and robots could combine to create a successful system.
- It was said that modular autonomous systems which could be incorporated into existing machinery were not yet possible.
- It was said that CyPhy labs aimed to create a swarm of autonomous robots which go out and perform arduous horticultural tasks.
- Dr Ball noted that field trials for the autonomous weed killing robot were to commence in June 2013.
- It was said that robotics developed at UQ were made for the 'real world'; with development placing a heavy emphasis on field trials.
- It was said that vision only navigation has the capacity to map complex systems with low cost cameras.
- The speaker noted that robotics in agriculture had not been significantly focused upon within the robotics community. The speaker raised concerns over the increased need for innovation in the field of agricultural robotics.

- The speaker considered robotic useability and practicality, noting the importance of these concerns, particularly regarding the cost of maintenance.
- The speaker raised concern regarding the public's misconception of robotics, particularly regarding expectation versus reality.
- The speaker concluded by discussing the future of robotics in agriculture, considering smart technologies in manipulation, pest deterrence, monitoring, alternative fuels, legal and social issues and automation.
- It was said that Dr Ball is currently looking for horticulturalists to collaborate with

7.1 Question session

- **An attendee inquired as to health and safety concerns, and hence, Australian health and safety regulations within automated agriculture.**
  The speaker considered that health and safety regulations had not been established, and although it is a big issue, development needs to occur before laws can be implemented.

- **An attendee enquired as to why robotic industries were not focusing more on agriculture.**
  The speaker noted that he suspected innovation in agricultural robotics was stalling.
  The attendee noted that funding, specifically for technological advancement in agricultural technology, was likely being ignored.

- **An attendee stated that they would like to see robots developed specifically for horticulture, as reducing labour costs was imperative to maintain economically viable vegetable production.**

  Dr Ball said he was interested in working with horticulture and that a low cost approach was key to CyPhy Lab's robots.

- **An attendee asked about the amount of research going into system development and sensing and where the balance in research existed.**
  Dr Ball believed that designing robotics with a cost effective approach, in particular adopting technology from smartphones, was important. It was said that a move from lasers to vision based sensing would improve the capacity to perceive objects. It was said that computer vision groups were working on sensing equipment that relies solely on vision based sensing.

- **An attendee asked about the time intensity of robotics – he asked whether smaller robotic equipment would require more time input from farmers.**
  Dr Ball said that Professor Salah Sukkarieh's group at Sydney University was currently working on system failure by installing fail safe mechanisms e.g. other members of robot team take over if one team member fails.

8. Royce Bell, Tactical Segment Manager, John Deere Australia, Harvesting Technology.

- It was said that understanding what is required, what is currently occurring and reviewing measures undertaken by John Deere was required to have consistent positive impact upon Australian Horticulture
- The speaker identified the central constraint of vegetable production as managerial issues.
- The speaker detailed John Deere machinery, where technology was working to create more efficient systems and reducing the cost of labour.
- Concern was raised as to the current need for compilation of agricultural information, noting that information should be combined and compiled where it may be of assistance to growers.
- The speaker emphasised that John Deere's commitment to optimising currently existing machinery through use of improving technologies.
- The speaker discussed and detailed John Deere's current position in development of logistical optimisation, including short and long term goals for John Deere products.
- The speaker detailed John Deere's Farmsight Technology which consists of three interdependent pillars – Machine Optimisation, Logistics Optimisation and Ag. Decision Support.
- It was said that John Deere equipment could constantly monitor a variety of data including fuel efficiency and localisation.
- The speaker concluded by discussing myjohndeere.com, which is designed as a central repository for on farm information.

Panel broke for afternoon tea at 2.47PM

The panel reconvened at 3.13PM

9. Richard Macchiesi, General Manager, Insights and Innovation, VISY, Packaging Technology.

- The speaker initiated discussion by detailing Visy's role as an important provider to the agriculture industry.
- The speaker commented on shifting trends in packaging, as they occur within the global industry.
- The speaker addressed consumer concerns when regarding packaging of food produce.
- Food safety alternatives were raised, including those relating to handling, composite material concerns and product displays as an alternative to conventional packaging design.
- The speaker suggested future developments, including antibacterial barriers, and long-haul transportation methods.

10. Jeremy North, COO and Founding Director, The Dearman Engine Company, Liquid Air Engine

- It was said that the Dearman Engine was a novel, patented, zero emissions engine that runs on liquid air or nitrogen
- Consideration was given to the liquid air engine hybrid, noted as utilising highly efficient diesel fuels in conjunction with liquid air.

- It was said that Dearman were working on a Diesel replacement and a refrigeration and cooling device
- It was said that off peak and waste energy could be used to liquefy the air.
- Mr North noted that existing infrastructure could facilitate the crossover to liquid air engines unlike electric cars for which infrastructure does not yet exist.
- It was said that Dearman were currently working with universities to develop off grid/renewable energy to liquefy air. This might give farmers the ability to create their own 'fuel' on site and at low cost
- The business logistics of the Dearman Engine were detailed.
- The speaker provided a scientific explanation on how the Dearman Engine was able to run, including the performance quality of the technology.
- Mr North mentioned the website liquidair.org.uk which has information regarding adoption of the liquid air engine design

10.1 Panel Q&A session

- **An attendee inquired as to whether ambient temperature had the ability to change the efficiency of North's engine.**
  Mr North noted that ambient temperature was not particularly likely to affect performance - nor had performance been affected under any lab-tested circumstances of extreme cold. The session chair noted that the primary concern of the question was heat rather than cold.
- **An attendee addressed Mr Macchiesi, inquiring as to the methods by which VISY planned control nano-particle considerations.**
  Mr Macchiessi noted that the functionality for applications of nanotechnology were interesting, particularly regarding biodegradability; however cost was noted as an issue. It was also considered that great applications and uses for nano-particles were exciting; however potential side effects were potentially concerning.

11. Event concluded by session chairs Peter Ward and Jeff McSpedden

Session Chairs concluded noting that growers needed to consider R&D moving into the future, and accordingly, where to invest levy funds. The Chairs implored levy payers to be more involved with these processes, adding that speakers at the Emerging Technologies Seminar were given to inspire, and that growers should consider these technologies in relation to their own farms and contribute ideas accordingly.

Seminar closed at 4.20PM.

VI. Emerging Tech Flyer

VII. Selected Media Releases

New technology will be on show at the Emerging Technology Se...

2NM, Muswellbrook hosted by **Newsreader** 18 Apr 2013 6:38 AM

06:40 Southern Cross Rural News - 0 min 46 secs - ID: W00052918305

New technology will be on show at the Emerging Technology Seminar as part of the **AUSVEG** **National Convention** to be held next month on the Gold Coast. **Hugh** **Gurney**, **AUSVEG**, says the technologies to be on display include synthetic biology, insect sterilisation technology, liquid air engine and plant symbiosis.

Keywords
AUSVEG (2), Hugh (1), Gurney (1), National Convention (1)
Interviewees
Hugh Gurney, AUSVEG
Also broadcast from the following 18 stations

N/A ALL

N/A MALE 16+
N/A FEMALE 16+

Scientists researching the Queensland Fruit Fly are doing te...

NBN Gold Coast, Gold Coast hosted by **Natasha Beyersdorf and Paul Lobb** 31 May 2013 6:08 PM

NBN News Gold Coast - 1 min 19 secs - ID: M00053400556

Scientists researching the Queensland Fruit Fly are doing tests to develop sterile male insects. The farming industry is expected to benefit greatly. Coles and **AusVeg** have launched the **EnviroVeg** standard, a mark of clean and green practices.

Keywords
EnviroVeg (1), AusVeg (1)
Interviewees
Dr Luke Alphey, Oxitec
John Brent, Ausveg
Robert Hadler, Coles
Visuals
Coles

N/A ALL

N/A MALE 16+
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Dr Luke Alphey, Oxitec

John Brent, Ausveg

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Visuals

Coles

N/A ALL

N/A MALE 16+

N/A FEMALE 16+

Emerging Technologies in Horticulture - applications now open!

Levy-paying vegetable growers are encouraged to apply now for the upcoming Emerging Technologies Seminar, to be held at Jupiters Gold Coast on Thursday 30 May 2013.

Following the success of the 2012 Future Technologies Seminar, the 2013 event has been expanded to include twice as many levy-paying growers.

With a range of domestic and international presenters covering topics including insect control, harvesting technology, irrigation and biotechnology, this event is not to be missed.

Successful applicants will receive return economy airfares to the seminar as well as two nights of accommodation. Spaces are limited, so growers should express their interest now to avoid disappointment.

Interested growers should express their interest to Dean Schrieke, AUSVEG Special Projects Officer, via email at dean.schrieke@ausveg.com.au or by phone on (03) 9822 0388.

AUSVEG

HAL Horticulture Australia

VIII. Progress Report

2013 Emerging Technologies in Horticulture Seminar – Progress Report for the sub-committee:

Since our meeting in Sydney on January 24 there has been a number of developments concerning the 2013 Emerging Technologies Seminar. This document will provide you with an update on these developments as well as information regarding the seminar's current format.

Steps 1 to 4 of the 'required steps' stipulated in the VG 12050 project outline have been completed. There are currently thirty-five confirmed seminar attendees and levy paying vegetable growers have begun registering their interest to attend. The seminar's quota of 100 attendees looks likely to be met and potentially surpassed.

Eight speakers (four domestic and four international) have been confirmed to speak at the seminar and the final list of confirmed speakers remains true to topics originally approved by the IAC subcommittee in Sydney on January 24. Confirmed speakers and topics are listed below; international speakers are shown in **bold**:

SPEAKER	TOPIC
Dr Luke Alphey (Oxitec, UK)	Genetic Insect Sterilisation
Mr Yalman A Khan (Agricel, Dubai)	Film Farming
Dr Dotan Peleg (Morflora, Israel)	Biotechnology
Dr Rusty Rodriguez (Adaptive Plant Symbiotics, US)	Plant Symbiotics
Professor Lars Nielsen (AIBN, UQ)	Synthetic Biology
Dr David Ball (CyPhy labs, QUT)	Agricultural Robotics
Mr Royce Bell (John Deere Australia)	Harvesting Innovation
Mr Richard Macchiesi (VISY Australia)	Packaging Technology

I have organised an audio/visual set-up for the seminar including a cameraman to film the presentations. Edited versions of the presentation footage will be uploaded to the AUSVEG website and made available to levy payers.

At this stage, budgetary allocations are on track.

The seminar will be held in two locations simultaneously (50 attendees/4 speakers in each location) – after lunch the speakers will change location to ensure attendees access all presentations. Location one will house presentations regarding "On-Farm Tech" (Irrigation, Harvesting, Packaging and Robotics). Location two will house presentations regarding "Agri-Science" (Synthetic Biology, Biotechnology, Genetic Insect Control and Plant Symbiosis). A tentative agenda for the seminar is as follows: