Hort Innovation

Final Report

National Banana Development and Extension Project

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The Department of Agriculture and Fisheries (DAF)

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Content

Summary

The Australian banana industry consists of several hundred producers spread across 3 main production regions – the wet tropics of north-east Queensland, the sub-tropics of the east coast from Bundaberg to Nambucca and the arid sub-tropics of the west coast based in Carnarvon, Western Australia. Prior to the commencement of this project there was no national extension program that coordinated the communication and knowledge transfer of outputs from industry investment in research and development. Therefore the objective of this project was to implement a coordinated information development and dissemination program that ensured a focused and systematic approach was taken to deliver information and results from industry-funded R & D projects and products funded from other sources. The project was focused on delivering information to banana growers around Australia. To reach this target audience strong linkages and networks were built and maintained not only with growers directly but also other key information providers such as consultants, agricultural retailers, banana agents and catchment management groups. Close association with the Australian Banana Growers Council led communications project and its established communication mechanisms and networks significantly contributed to information uptake by the target audience.

The flagship activity of this project was the biennial series of technical information updates commonly referred to as the 'Banana Industry Roadshows' which were hosted in 6 locations around Australia in 2014 and 2016. This project also played a key role in supporting activities to improve grower knowledge about Panama disease tropical race 4 and facilitating the adoption of on-farm biosecurity practices following the detection in the main growing region in North Queensland.

Keywords

Banana; Extension; Roadshows; Communication; Growers; Field day; NextGen,

Introduction

The Australian banana industry consists of several hundred producers spread across 3 main production regions. The wet tropics of north-east Queensland, the humid sub-tropics of the east coast from Bundaberg to Nambucca, and the arid-sub-tropics of the west coast based in Carnarvon, Western Australia.

Since 2007, the industry has had a national R & D and marketing levy system in place for investment in products that address the stated priorities in the industry's strategic plan. This investment in developing innovations in products and practices is significant for the industry and the successful communication and adoption of the results from the funded activities is a key part in achieving the stated outcomes for the banana industry's strategic plan.

A review of extension needs of the banana industry (BA10011) identified that growers are time poor so they may be unlikely to leave their farms to be engaged. It indicated many growers utilise consultants and therefore it was important that these people were engaged to transfer correct and accurate information to growers. In terms of new information and technology, the report revealed that most growers are influenced by other growers, with emphasis on seeing proof of a practice in a commercial setting and requiring evidence of costs and returns associated with any practice change before they are willing to implement a practice change or new technology.

Prior to the commencement of this project there was no national extension program that coordinated the communication and knowledge from past, current and future project funded by the industry's investment in research and development. This had often resulted in an ad hoc approach to disseminating and communicating individual project results. This approach was inefficient and often could miss opportunities to link related project areas and outputs.

The overall objective of this project was to implement a coordinated information development and dissemination program that ensured a focused and systematic approach was taken to delivering information and results from industry-funded R & D and other sources. This project aimed to present existing information and research where required and seek information on identified knowledge gaps.

This project focused on achieving objective three in the Australian Banana industry strategic plan 2014/15 – 2018/19. Improve industry capacity and R & D adoption; and demonstrate benefit of levy investments by: Engaging >50% of production acreage in the technical series update, Increasing participation in Banana BMP to >50% of production acreage and continuously increasing adoption of best management practice across industry, achieving an ROI of banana industry R & D levy funds of 4.1:1 over the life of the plan.

Methodology

Banana growers are very time poor as they are involved in production and harvest activities year round. Their time is very valuable to them. Therefore the project utilised a number of extension tools and delivery mechanisms to provide information to growers and encourage uptake of new and emerging practices. This approach also addressed the different learning and communication preferences within the target audience. Some find certain mediums better than others, while most people need to be exposed to information a number of times and potentially in a number of formats before they retain it. This project used the following extension tools and delivery mechanisms to reach banana growers around Australia.

Project Team

The project was set up and initially led by Naomi King (Queensland Department of Agriculture and Fisheries (QDAF)). Between December 2014 and March 2015 Stewart Lindsay (QDAF) briefly took over project leadership until Tegan Kukulies (QDAF) was appointed who led the project from March 2015 till its completion in June 2017. Stewart Lindsay played a key role throughout the entire project. Ingrid Jenkins (QDAF) was involved in the project predominantly involved in video production. From September – June 2016 Shanara Veivers (QDAF) was also involved in the project assisting with roadshow and field day events as well as the small innovation field trials. The NSW Department of Primary Industries (NSW DPI) team initially consisted of Mark Hickey then Matthew Weinert when BA13025 commenced.

Project Reference Group

A project reference group (PRG) was established at the commencement of the project to provide on-going support and to help steer the direction of the project. The PRG was responsible for setting the priority development and extension topics for the project along with providing guidance on the strategies for delivery. The PRG played a key role in determining the content that was delivered at the Roadshows. They also provided guidance on effective monitoring and evaluation techniques, assessed outputs against requirements and provided evaluation and guidance at the mid-term project review. A mid-term review was also conducted in June 2015 using input from the PRG.

The PRG members were:

- Naomi King (until December 2014) followed by Tegan Kukulies (from March 2015)
- Stewart Lindsay (Project team member, QDAF)
- Kris Horsford (North Queensland banana grower)
- Gavin Devaney (North Queensland banana grower)
- Peter Molenaar (New South Wales banana grower)
- Chaise Pensini (Supply chain representative, Nutrano Produce Group)
- Dr. Jay Anderson followed by Dr. Rosie Godwin (ABGC R & D Managers) (transition in October 2015)
- Alison Anderson followed by Bianca Cairns (Project managers, HIA) (transition in January 2016)

Development of linkages and networks with key information providers in the banana industry

Banana grower associations groups: Banana grower associations have long been a communication and networking opportunity to keep growers updated on activities in this project and receive feedback on emerging issues. There are two groups in north Queensland, the Cassowary Coast banana growers association (Tully – Innisfail, held monthly) and the Mareeba and District Banana Growers Association (held bimonthly) and three groups in the Subtropics, the Coffs Harbour Banana Growers Association, Nambucca Banana Growers association and the Tweed/Richmond Banana Grower Association. Regular attendance at these producer association meetings was a targeted output for the project.

Key supply chain member visits: Developing strong networks and linkages with supply chain businesses to facilitate improved communication between growers, R&D providers and supply chain personnel in the banana industry was a high priority output for the project. Relationships were built and regular communication was maintained with key market suppliers: Costa's, Mackays Marketing, Nutrano and LaManna. Throughout the project extension staff welcomed visits from supply chain personnel when they travelled to north Queensland. Project members also strengthened relationships with members of the supply chain with a visit to Melbourne (ripening facilities and markets) in March 2016 and a visit to a ripening and distribution facility in NSW (Golden Dawn) in conjunction with the 2016 Roadshows.

NextGen young banana growers group: The NextGen group which was established at the commencement of this project is a group of young growers typically under 40 years of age (however not limited by age) that are proactive, positive, and willing to be innovative and share their experiences. The project facilitated 2-3 group meetings per year and also managed logistics for the group to participate in activities. As a group the members nominated the topics/areas they would like to investigate and subsequently trips to different agricultural businesses were organised.

Service providers: The Banana Agribusiness Managers (BAGMan) group which is chaired by the project leader is made up of consultants, resellers, agronomists and service providers in north Queensland. This group was used to communicate the latest R & D updates, discuss topical events and identify emerging issues.

Australian Banana Growers Council (ABGC): Regular communication was maintained with the peak industry body ABGC particularly the communications team the R & D Manager and the industry strategy manager.

National Banana Roadshow Series

In alternating biennial years to the Australian Banana Congress, (2014 and 2016) a series of technical information updates known as roadshows were hosted at 6 locations in the main production centres: Innisfail (QLD) Walkamin/Mareeba (QLD), Tully (QLD), Coffs Harbour (NSW), Murwillumbah (NSW) and Carnarvon (NT). The quick paced, one day events were laid out in a 10 minute presentation format with built in opportunity for networking and questions. They showcased the latest information on farm production, environmental practices, farm business management, marketing, Panama disease tropical race 4 and supply chain management. Each event consisted of national information consistent across all production regions as well as information tailored for specific regional priorities. See Appendices 3.1 and 3.2 for the agendas of the roadshow events.

Demonstration sites

Four demonstration trials were established on two grower's properties in north QLD and two in NSW. The two in NSW focused on nematodes and soil health. In north QLD one was aimed at investigating different soil amendments and the other about variety options which may have some level of tolerance to Panama disease tropical race 4. Both of these demonstration sites were finished early due to the biosecurity risks following the detection of Panama disease tropical race 4. Full methodology of these demonstration trials are detailed in Appendix 4.

Innovation Trials

The 6 month extension to the project facilitated scoping 5 innovative practices/activities (4 in north Queensland and 1 in NSW). The concepts of the practices were derived and prioritized from the NextGen group, the Cassowary Coast Banana Growers Association members and the PRG. These predominantly small scale field trials conducted at the South Johnstone research station investigated:

- Use of Gibberellic Acid (GA) in desuckering
- Novel Nitrogen Application
- Chemical removal or banana flower remnants
- Use of RFID Technology for Yield Mapping
- Bagging Trial (NSW)

Full details of the methodology of these trials and research areas are detailed in Appendix 5.

Banana Best Management Practices (BMP) Environmental guidelines

Grower training: Group grower training for the BMP using the on-line system was conducted with growers using iPad and the on-line system in QLD and NSW

Train the trainers: Since mid-2016 the ABGC has been leading two sustainability focused projects. The Environmental BMP is the heart of these programs and ABGC extension staff have taken the initiative to dedicate time to provide one on one training with growers. As a result the project leader trained the ABGC extension staff on how to use the on-line system and how to step growers through the process.

Review: The review of the BMP in 2016 was divided into two components: Content review and an on-line functionality review. The full methodology is detailed in Appendix 6.1. In brief the original PRG that guided the development of the BMP resource was consulted to determine and confirm changes to the content. Engagement with other stakeholders including Freshcare, researchers involved in recent R & D, Coles, Woolworths and Aldi was also undertaken to ensure its alignment with current and potentially emerging systems and to ensure the latest R & D outcomes were updated.

Field walks/workshops

Banana Workshop 2014: Mites and their control, fungicide resistance and varieties were the key topics at a banana workshop and field walk event which was held on the 21/11/2014 at the South Johnstone research station. Refer to Appendix 7.1 for details of the agenda topics.

Panama disease tropical race 4 on-farm biosecurity workshops: Following the detection of Panama disease tropical race 4 in the main growing region in north Queensland (March 2015) a coordinated extension program was developed in conjunction with the Australian Banana Growers Council. Since this was the industry's highest priority at that time Tegan Kukulies and Stewart Lindsay contributed to the development and delivery of the workshops to growers to rapidly educate them about the disease and guide them to implement effective on-farm biosecurity practices between May and August in 2015. Full methodology of the workshops can be found in Appendix 7.2

Panama Field Day (November 2015): As part of the ABGC led on-farm biosecurity project, which ran with the input from BA13004 project staff, a Panama field day was held to bring growers and industry stakeholders up to date with the research, development and extension activities which had been conducted in the 8 months following the detection and insights into future research on the disease. This project was also responsible for the grower practice video session which included making 5 short videos, which helped bring the 'farm' to the field day, which were presented then followed by a grower panel discussion. Full details of the field day can be

found in Appendix 7.2

NSW on-farm biosecurity presentations: The project leader travelled to a field day held on the 17th of February 2016 in Burringbar which was hosted by the NSW department of primary industries in conjunction with the Tweed Brunswick Banana Growers Association to present a presentation about the principals of on-farm biosecurity. Similarly a condensed on-farm biosecurity workshop was delivered to growers in Coffs Harbour on the 4th of May 2016. More details can be found in Appendix 7.2

Panama R & D Open Day 2017: The latest Panama related R & D was presented at an interactive field day which was held at the South Johnston research station on the 12th of May 2017. This was the first event held in the paddock since before the detection of panama disease in 2015. Therefore a large effort went into implementing strict on-farm biosecurity practices to allow attendees to enter the paddock. The agenda for the open day can be found in Appendix 7.3.

Written material

This project maintained close communication with the ABGC led communications program. Project outputs and R & D updates were regularly published in Australian Bananas magazine, Australian banana newsletters and the e-bulletins. Seven factsheets were also produced and hosted on the ABGC website and an additional 5 factsheets where given to attendees at the Panama R & D Open day in May 2017.

Information Technology

Video: Video has become another important tool in delivering information to growers, both as a resource available on or via the ABGC website and also integrated into field days and workshops to provide alternative media between PowerPoint presentations.

Information database review: A needs analysis for an electronic industry-specific database was conducted with a representative sample of key stakeholder groups within the banana industry. This was completed through a series of semi-structured personal interviews which were mainly conducted face-to-face. Full details of the methodology are detailed in Appendix 9.1

Outputs

Project Reference Group

Along with e-mail and phone communication the project reference group met six times throughout the project, two of which were face to face meetings (28/11/2013 and 28/11/2014) and the remainder were via teleconference (22/10/2015, 15/01/2016, 27/05/2016, and 4/11/2016). These meetings successfully helped steer the direction of the project and provide guidance on various aspects of the project.

Development of linkages and networks with key information providers in the banana industry

Banana grower associations groups: Throughout this project either the project leader and/or the NSW IDO utilised banana association networks as a communication and feedback mechanism. The project targets for this event were far exceeded as per the table below:

Table1: Details of attendance at banana grower association meetings

Banana Grower Association	Number of meetings per year	Meeting attendance target	Number of meetings attended
Cassowary Coast	11	6	31
Mareeba and District	6	3	5
Coffs Harbour	4	1	10
Nambucca	4	1	11
Tweed/Richmond	Ad Hoc	1	6

Key supply chain member visits: Project members visited the Melbourne Markets and a ripening facility in Derimut (Costa's) from the 22nd – 24th of March 2016. Retail displays (Aldi, Woolworths and small independent grocers) in the region were also observed during this visit. During the 2016 Roadshows project members also visited a ripening and distribution business in Coffs Harbour (Golden Dawn). These visits strengthened relationships with these supply chain members and has resulted in them informing project staff of uncharacteristic post-harvest issues as they arise. Supply chain relationships have also been strengthened as a result of this project with key members of Mackays Marketing, LaManna, and Nutrano who also provide feedback from the supply chain to project members.

NextGen young banana growers group: The NextGen banana growers group which consists of growers typically under 40 years of age that are proactive, positive and willing to be innovative has proven to be a valuable network. The group met on at least 10 occasions and there were four key activities that the group participated in 4 activities throughout the project.

The first was a visit to three relatively recently established banana properties in Lakeland Downs to explore the latest in harvesting and packing systems: Swiss Farms, Kureen Farming and Mackay Estates Lakeland farm. Twenty five growers participated in this overnight trip 17th – 18th March 2014.

The second was a sharing activity where the group visited each other's properties. This activity occurred after the detection of Panama disease tropical race 4 during October 2015. To minimise the biosecurity risk growers were randomly assigned into 4 groups of 5 and they visited each of the farms in their group, as this is a manageable amount of people to fit in a vehicle to tour the properties. Careful consideration was taken to adhere to the on-farm biosecurity practices in place on each property. One 'spokesperson' from each group presented photos and the key highlights from the farm to the full NextGen group. Growers were given a checklist to stimulate conversation about the following areas: environmental practices, on-farm biosecurity practices, shed systems, record keeping, nutrition management, pest and disease management, production practices and any innovative practices.

The third activity was a visit to other production systems in the district. This included visits to blueberry and coffee production at Howe Farming (Mareeba), coffee and papaya production at Skybury (Mareeba), blueberry and macadamia production at Kureen Farming (Tolga) and barramundi farming at Moresby (22/04/2016 & 3/06/2016).

Following the visits to different production systems in the immediate region the group was particularly interested in travelling away to expand their horizons to look at different production systems with an emphasis on exploring technology integration in farming. Seventeen growers participated in a two day tour (8-9/09/2016) to visit the Bowen and Gumlu region where they were exposed to high tech packing sheds with automated, computerized photographic colour grading systems for tomatoes, capsicums and rockmelons (Koorelah Farms & NQ Produce). The tour included a visit to an innovative mango grower (Marto's Mangoes) with automated irrigation and fertigation system, a mechanical harvesting aid and an innovative spray rig capable of applying fungicides to the top of the hedge canopies. In addition to this the group was able to visit Rugby Farms and witness mechanical field harvesting of green beans and sweet corn and tour their high labour intensive production lines in their shed.

Service providers: The Banana Agribusiness Managers (BAGMan) group which is chaired by the project leader is made up of consultants, resellers, agronomists and service providers in north Queensland. Throughout this project the group met 7 times:

Attendance at BAGMan (Business agribusiness managers) meetings	
Date	**Number of Attendees**
01/05/2014	26
16/10/2014	18
23/06/2015	51
14/07/2015	25
10/03/2016	12
22/09/2016	18
10/05/2017	21

National banana roadshow series

The quick paced 1 day events designed to deliver the latest R & D results to growers and industry stakeholders which are known as the roadshows were successfully delivered in 6 locations around Australia in 2014 and 2016. In 2014 they were held in Murwillumbah (15/07/2014), Coffs Harbour (17/07/2016), Carnarvon (23/07/2017), Tully (31/07/2014), Innisfail (1/08/2014) and Walkamin (7/08/2014). In 2016 they were run in Mareeba (9/06/2016), Innisfail (10/06/2016), Tully (16/06/2016), Carnarvon (23/06/2016), Coffs Harbour (5/07/2016) and Murwillumbah (7/07/2016). Appendices 3.1 and 3.2 detail the full agenda's for each of the locations. In total 117 and 147 growers and industry stakeholders (excluding researchers) attended the 2014 and 2016 national banana roadshow series respectively. Appendix 3.4 shows the percentage distribution of attendees across both years at all locations as well as a comparison of the breakdown of attendance between years. A 20 page A5 booklet which summarised all the banana research projects (including those funded from sources other than Horticulture Innovation Australia) was produced and distributed at the 2016 National Banana Roadshow Series (Appendix 3.5).

Attendance at the 2014 and 2016 National Roadshows (excluding researchers)		
Location	**2014**	**2016**
Tablelands (Walkamin/Mareeba)	25	32
Tully	25	31
Innisfail	29	33
Coffs Harbour	16	19
Murwillumbah	11	15

Carnarvon	11	17
Total Attendance	117	147

Demonstration sites

Four demonstration trials were established on two grower's properties in north QLD and two in NSW. These trials are detailed in Appendix 4 however key outputs of each trial are summarised below:

- *Use of soil amendments to promote soil biological activity and suppression of plant parasitic nematodes in bananas:* This trial which demonstrated the use of hay, Japanese millet, compost, mill-ash and biochar as soil amendments was unfortunately ended early following the detection of Panama disease TR4. However early results showed that mill-ash both applied to the surface and incorporated into the soil had higher and more consistent soil moisture resulting in faster growth of plants. Hay applied to the surface also resulted in some significant increases in soil moisture and growth.

- *Demonstration trial comparing agronomic and quality characteristics of 4 Cavendish varieties with reported Panama disease TR4 resistance to the industry standard variety Williams*: This trial compared agronomic performance of GCTCV 218, GCTCV 119, CJ19, DMP25 to Williams Cavendish under commercial production conditions in Tully. Overall CJ19 responded very poorly to cold wet weather, was slow growing and had significantly smaller bunches. DPM25 was virtually identical to Williams for the measured characteristics, however shading of the block may have contributed to its slightly slower crop cycle. GCTCV 218 had bunch weights and finger length comparable to Williams and DPM25 but demonstrated a much longer crop cycle period. GCTCV 119 was very tall, spindly and exceedingly slow to bunch compared to all the other varieties

- *Soil amendment demonstration trial at Palmswoods (NSW)*: This trial compared compost and groundcovers to the grower practice of applying herbicides to control weeds. The addition of compost and the presence of groundcovers increased the pH and reduced available aluminum levels. Compost also increased soil calcium levels and the cation exchange capacity. Soil microbial activity did not change significantly however there were differences in the plant parasitic nematode populations particularly 2 months following treatment application. At the two month point compost produced higher levels of spiral nematodes in the soil and the groundcover treatments had higher levels of spiral and lesion nematodes in the roots. However 18 months and 23 months following application these nematode levels were consistent across all treatments.

- *Soil amendment demonstration trial at Woolgoolga (NSW):* This trial compared compost, poultry manure to grower practice. The manure treatment resulted in a higher soil pH and both treatments increased the soil carbon levels. The treatments did not affect the bunch weights over the 20 month trial period.

Innovation Trials

Five innovative practices/activities were investigated in the 6 month extension to the project. These trials are detailed in Appendix 5, however key outputs from each of the activities are summarised below:

- *Chemical removal of banana flower remnants:* A literature review of flower thinning/removal products used in the apple industry was undertaken. From this review 9 chemicals (Ethephon, vinegar, sodium chloride, lime sulphur, napthaline acetic acid, gibberellic acid, abscisic acid, benzlyadenine and indole butyric acid) were applied to 65 bunches in total. With none of the

chemicals showing promise, the application method was altered and 12 amount of bells were injected with (Gibberellic acid, abscisic acid and benzyladenine). Unfortunately none of the chemicals, irrespective of the application method, showed promise in removing the flower remnants on bananas

- *Novel nitrogen application*: Two field trials were conducted one which observed the effect of injecting urea solutions into the harvested mother plant (40 plants) and the other observed the effect of injected urea solutions into small suckers (21 plants). Unfortunately none of the treatments in these trials produced significant changes to the growth characteristics (height and leaf emergence). However important lessons were leant particularly that injecting liquid solutions into plants following periods of prolonged rainfall is problematic since the pseudostems of plants are already full of moisture.

- *Use of Gibberellic Acid (GA) in desuckering*: A field trial consisting of 148 Cavendish plants was established to investigate the potential effect on sucker production by applying 3 different rates of GA (50, 300 and 600ppm) to the suckers (compared to a water control). Unfortunately GA at these rates did not reduce or increase sucker production. However it also didn't not affect the growth parameters. Therefore future trials could potentially investigate higher rates.

- *Use of barcode-style technology for yield mapping*: In this activity discussion were held with growers and then commercial companies about the potential to use barcode-style technology to effectively and efficiently yield map paddocks. Although this scoping area did not progress significantly in the time of the extension, from discussions it seems that the proposed system is achievable using RFID tags however would require considerable capital cost.

- *Bagging Trial (NSW)*: Bag colour can significantly affect the colour of fruit over winter as shown by a field trial consisting of 20 bunches which compared four different bag treatments (yellow/silver, double yellow/silver, black/silver, homemade black bag). Unfortunately the black bag treatments (silver/black and homemade black bags) did not reduce under peel chilling as temperatures inside the bags still dropped below 13°C. The fruit in the black bags were lighter, as they were not exposed to sunlight, and the under peel chilling was more obvious. However this trial demonstrated that the colour of bags does influence cosmetic fruit attributes during the cooler period of the year and therefore could warrant further investigation.

Banana BMP Environmental guidelines

Prior to the commencement of this project 3,742 ha had already completed their BMP online. During this project 8 workshops were conducted with 51 farms covering an area of 3,085 ha. Twelve of these farms were in NSW during training conducted following the Roadshows in 2014. This takes the total area of production operating under BMP to over 50%.

Field walks/workshops

Banana Workshop 2014: The workshop which had a large emphasis on mite management was attended by 49 growers and industry stakeholders.

Panama disease tropical race 4 on-farm biosecurity workshops: An interactive four-module workshop was developed and delivered to growers and industry stakeholders. During the period from May – August 17 workshops were conducted in Innisfail, Tully and Mareeba. These workshops were attended by 157 growers and farm managers. The project's contribution to developing the workshops and undertaking these initial

workshops established a strong foundation from which the ABGC led Panama disease tropical race 4 on-farm biosecurity program could continue to deliver workshops with newly appointed staff. The program went on to deliver 37 workshops in total involving 246 growers, partners and farm managers, representing 228 farms. This equates to 77% of total banana farms and 82% of the production area in north Queensland. Full details of these workshops can be found in Appendix 7.2

Panama Field Day (November 2015): The field day was attended by over 140 people, comprising 50% growers. Industry stakeholders including agronomists, tissue culture providers, engineering firms, local councilors and government staff made up the remaining 50% of the attendees. More details of the field day can be found in Appendix 7.2.

NSW on-farm biosecurity presentations: An on-farm biosecurity presentation was delivered to 22 growers and industry stakeholders that attended the field day which was held in Burringbar (17th February 2016). The condensed workshop at Coffs Harbour (4th May 2016) was attended by 30 people in total, 17 were growers and 13 were other industry stakeholder representatives.

Panama R & D Open Day 12th May 2017: The field day was well attended by 109 people. The main target audience of growers and industry stakeholders, namely consultants, agronomists and resellers made up 64% of the attendees.

Written material

The project produced more articles in the ABGC magazine and e-bulletins than the original target. The ABGC newsletter is no longer being published and therefore the project fell short of the target by 1. Appendix 8 gives examples of the written material produced.

Banana Grower Association	Target	Number completed
Articles published in Australian banana magazine	5	17
Articles published in ABGC newsletter	9	8
Articles published in ABGC e-bulletin	9	12
Case studies and grower testimonials as growers trust and learn well from other growers	5	5
Factsheet series, building on the subtropical factsheets and developing for other production regions	9	7 published online (ABGC) 5 separate factsheets available at field days

This project also funded the printing of the manual "Sub tropical Banana Nutrition – Matching Nutrition Requirements to Growth Demands" (500 copies), which was produced as part of BA13025: NSW banana industry development officer. Approximately 250 of these have been distributed to NSW growers and industry stakeholders and 50 have been too distributed to Carnarvon growers and industry stakeholders.

Information Technology

Video: As the project progressed it was evident that video was a popular medium to communicate project outputs with growers. The original target was to produce 4 videos, however a total of 17 videos have been produced as part of the project with a collective total of 8,675 views. In addition to this the project has pioneered the use of videos in lieu of personal presentations at field days and seminars, with 6 videos produced for the purpose of presentations only. Full details and breakdowns of views for each video are detailed in Appendix 9.2. Appendix 3 shows an example of how the hugely successful "Panama disease tropical race 4: Identifying the disease and protecting your farm" was shared on social media.

Information database review: The needs analysis for an electronic industry-specific database which was

compiled can be found in Appendix 9.3. The needs analysis revealed that growers and agribusiness providers liked the concept of a banana specific webpage or database which would host past, and current R & D updates and outputs. There was also support for an electronic pest and disease ID guide.

Outcomes

This project successfully implemented a coordinated information development and dissemination program to growers around Australia. It delivered the latest results and progress updates from industry-funded R & D projects as well as projects funded from other sources through the 12 national roadshow events run in 2014 and 2016. Growers and industry stakeholders were kept informed of additional priority and regionally specific information in the time period between the two roadshow series' via field days and workshops in both north Queensland and New South Wales. The latest information was also successfully disseminated to banana growers through extensive networks with other key information providers (e.g. consultants, agricultural retailers, members of the supply chain and catchment groups) which were built and maintained throughout this project. Growers and industry stakeholders were also informed of key project outputs and alerted and reminded about important industry events (e.g. field days and roadshow events) via written material which was disseminated through existing communication mechanisms and networks via the ABGC led communications project. All of these mechanisms combined has resulted in a more informed Australian banana industry and provided growers with the latest accurate information in a timely manner to allow more informed decisions. This is evidenced through evaluation which has been conducted at the roadshow series' as well as field day events (Appendix 3.4).

During this project in March 2015 Panama disease tropical race 4 was detected on a property in the main growing region of north Queensland. Although Panama disease had already been flagged as a priority in this project, education about the disease and how to implement effective on-farm biosecurity practices to minimise the risk of spreading the disease was highlighted as a very high priority for banana growers following the detection. In the days, weeks and months following the detection, this project played a vital role in providing information to growers about this disease and helped guide them to strategically implement on-farm biosecurity systems and practices on their farms. This ability to rapidly address a high industry priority contributed to the successful containment of the disease on a single banana property for over 2 years.

The Australian banana industry has had a proactive approach to environmental best practice as shown through the development and uptake of the Banana Best Management Practices: Environmental Guidelines. This project through providing training events has established the industry with over 50% of the production area implementing the BMP. Similarly this project through the review of the content and update of the on-line system has ensured the currency of information and improved the on-line system functionality to ensure ease of recording and updating practices. The BMP has recently also informed government policy and regulation, serving as a starting point for the development of minimum practice standard requirements for reef water quality for banana growers in north Queensland.

The use of short videos as a medium to provide project updates, share outcomes from projects, share grower experiences and showcase their practices was extremely well received in this project. It was extremely useful as a tool to 'bring the growers' practices' to events held off farm. An example of this was the grower practice videos and discussion session at the 2015 Panama field day, which was organised and facilitated by the project, and received the highest participant evaluation ratings of the day. Short videos (2-3 minute) of 5 growers' on-farm biosecurity practices were compiled with the 5 growers present on the day as a panel where the audience could ask questions about the practices they had implemented. The outcome of this was that the practices were able to be shared with a large audience, in lieu of being able to take large numbers of growers to other grower's properties, and therefore eliminating biosecurity risks associated with farm visits. This grower-to-grower interaction definitely encouraged and facilitated the implementation of on-farm biosecurity infrastructure and systems.

The grower and industry stakeholder networks, relationships and interactions that the project extension staff built and maintained through this project is difficult to measure and quantify. However, in both north Queensland and New South Wales these relationships played an important role in facilitating practice change, encouraging growers to attend events organised by the project and also making important linkages between growers. These important relationships helped build and foster the successful NextGen banana growers group. This project through this NextGen group has facilitated closer relationships between the next generation of banana growers and started building connections with growers and managers in other industries.

Evaluation and discussion

Approaching banana industry extension with a coordinated, cohesive, and prioritised national program is fundamental to facilitating the uptake of new and emerging practices and keeping industry informed of the progress of R & D projects. This project has succeeded in strategically delivering prioritised R & D updates and outputs to growers and industry stakeholders via various mechanisms. A multi-pronged approach utilising written, visual, audio and interactive tools has successfully contributed to a better informed banana industry.

Formal evaluation was conducted at the 2014 and 2016 National Roadshows which were attended by 117 and 147 growers and industry stakeholders respectively (Appendix 3.4). At the beginning of the day long events attendees were asked to nominate on a scale of 1-5 (1 – nothing at all, 2 – very little, 3 – some idea, 4 good understanding and 5 - I'm across them all) how much they knew about R & D projects currently funded by the banana industry. In 2014 at the beginning of the day 16% indicated a 4 or a 5 compared to the end of the day where 70% fell in these categories. This equated to a 54% increase in the number of people leaving the event with a good to very good understanding of R & D funded projects. Similarly again in 2016 15% indicated a 4 or a 5 compared to the end of the day where 60% fell in these categories – equating to a 45% increase. These percentage increases for each location can be found in Figure 2 of Appendix 3.4. Interestingly when comparing locations the percentage change in the 4 or 5 categories was relatively less in 2016 compared to 2014 on the Tablelands, Innisfail, Tully and Carnarvon. In NSW this change was relatively more in 2016 compared to 2014. This may have been due to the number of growers who attended the NSW events in 2016 which hadn't previously attended in 2014, therefore starting with a lower base knowledge. The 2016 Roadshows were held 15 months after the detection of Panama disease TR4 in Tully. The topic featured in over 1/3 of the program as a significant proportion of banana R&D investment was targeted to address knowledge gaps. This left relatively fewer outputs from other research topics to deliver to growers which may have accounted for the proportionally lower increase in knowledge gain. Similarly in 2014 those that indicated that they would or maybe would consider changing something on their farms as a result of attending the day was 90% compared to 79%. These are two very good results however since many growers attended in 2014 and again in 2016 their knowledge base would have already been at a higher level prior to attending the 2016 Roadshow events. Appendix 3.4 provides more detailed statistics from the evaluation which was conducted in 2014 and 2016.

Although Panama disease generally was raised as a priority at the onset of this project it became a primary focus for the industry when Panama disease tropical race 4 was detected in north Queensland in March 2015. The flexibility in this project to address current and emerging priorities identified with the PRG allowed project staff to rapidly respond to this emergency priority by working with industry (ABGC) to develop a workshop process which educated growers about this disease and strategically helped them plan and implement effective on-farm biosecurity practices. These workshops (delivered to 157 growers) were extremely successful as evidenced by the evaluation that was conducted at the completion of each workshop. Overall 91% of participants improved their knowledge of the disease 'quite a lot' or better (4 or 5/5), 81% understood the risk pathways of the disease 'quite a lot' or better (4 or 5/5) and 84% understood suitable on-farm biosecurity practices for their farms 'quite a lot' or better (4 or 5/5) as a result of attending the workshops (Appendix 7.2). Very positive results from the subsequent Panama field day in 2015, and more recently the Panama R & D open day were identified through the associated evaluation. At the 2017 Panama R & D Open day which was attended by 109 people, 96% of attendees indicated they would change something as a result of attending the event. Similarly 98% of the attendees would attend another similar event and overall 69% rated the event an 8 or higher out of 10 (Appendix 7.5). This very positive feedback was reiterated at all events conducted as part of this project.

Investment in the up and coming generation of banana growers is vital to the future of the Australian banana industry. This project through the NextGen group has made great progress with fostering relationships

between young banana growers and providing opportunities for them to broaden their horizons, encouraging them to think laterally and in turn begin to drive innovation. A WhatsApp group which is facilitated by the project leader has provided a quick way to communicate with the group and demonstrated the power of social media for networking (in addition to e-mail and phone contact) and also allowed two-way conversation between growers. Informal feedback from the group is extremely positive and this has been reflected through good attendance at activities which involved growers giving up consecutive days to participate in planned activities (e.g. Lakeland visit and Bowen/Gumlu visit). Growers also had positive feedback about all the activities that were conducted as part of this project. For example, the growers that attended the Lakeland trip rated it a 9/10. They also had very positive comments about the Bowen/Gumlu trip and learnt from looking at practices in other horticultural industries.

This project has played a key role in ensuring the industry has taken a proactive approach to implementation of environmental best practices through the update of the BMP. Many growers, particularly those already operating at best management practice level commented on how the BMP on-line training successfully helped step them through the process to record their practices in the on-line system. These guidelines that growers are now familiar with have recently served as a starting point for the development of minimum practice standard requirements for reef water quality for banana growers in north Queensland. It is anticipated that this familiarity with the BMP will hopefully make this transition to regulation smoother for the industry.

Activities →	Outputs →	Outcomes
• National Banana Roadshow Series 2014 & 2016 • Maintaining and building networks (banana grower associations, supply chain members & service providers) • Demonstration trials • Field days/workshops • Written material • Short videos	• 117 and 147 growers and industry stakeholders attended National Banana Roadshow events in 2014 & 2016 respectively. • Attended banana grower association meetings, visited and networked with supply chain personnel and chaired meetings with service providers (BAGMan). • Reported demonstration trial results • Attendance at 2014 banana workshop (49 people), panama disease workshops (157 people), 2015 Panama field day (140 people), NSW on-fam biosecurity presentations (2 events = 52 people), 2017 Panama R & D open day (109 people). • Articles published in Australian bananas magazine, information published in e-bulletins, factsheets available on-line and handed out at field day events. • 17 videos produced collectively viewed over 8 600 times.	Banana growers and industry stakeholders equipped with knowledge of past and current R & D outputs to facilitate adoption of new and emerging practices and help them make more informed decisions.
• Grower training events • Review, update and upgrade of BMP environmental guidelines	• 51 farms covering 3085ha completed BMP training. • Version 2 of BMP. • Upgraded on-line system.	Banana growers proactively implementing best environmental practices.
• On-farm biosecurity workshops • Panama field day events • NSW on-farm biosecurity presentations • Short videos	• Attendance at panama disease workshops (157 people), setting up the program which then delivered workshops to over 82% of production area in north Queensland. • Attendance at the 2015 Panama field day (140 people), which showcased grower practices via video which ranked the highest session of the day in the evaluation. • Attendance at the 2017 Panama R & D open day (109 people) which delivered the latest R & D outputs and updates. • Delivery of On-farm biosecurity principles to growers in 2 NSW on-fam presentations (2 events = 52 people) • 5 videos published.	Banana growers and industry stakeholders implementing effective on-farm biosecurity practices to minimise the spread of Panama disease tropical race 4. *(96% of growers surveyed which had attended the on-farm biosecurity workshops did not nominate lack of knowledge as a barrier to the adoption of on-farm biosecurity practices)*
• NextGen meetings and activities • Innovation trials	• 10 NextGen meetings held and four large activities facilitated. • 4 innovative field trials conducted and one topic investigated.	Facilitate and foster innovative thinking in the banana industry

Recommendations

- It is important that a coordinated approach continues to be taken to delivering the latest R & D updates and outputs to growers and industry stakeholders
- Growers learn and communicate differently and therefore a range of extension tools in different formats should be utilised to encourage uptake of new and emerging practices. Similarly, new and emerging extension tools and techniques should be considered to both facilitate information uptake and drive innovation among banana growers as their demographic shifts.
- Guidance from a project reference group made up of growers from different growing regions, a supply chain representative, industry and the project manager is essential to ensure the success of future projects.
- The National Banana Roadshow series has been an extremely successful platform to deliver prioritised and regionally specific information to growers around Australia and should continue to be part of future national banana extension programs. The successful elements being the short, targeted presentations and the panel style question time are important attributes that should feature in future roadshow events. However additional features or activities which promote interaction could also be considered to add value to the events.
- The promotion of events (e.g. roadshow events, field days) should continue to be conducted across several channels. The ability to utilise existing industry communication channels namely: e-bulletins, Australian bananas magazine, and mass text messaging which have been established through the communications project is vital. Social media is also an emerging channel which should be considered for future banana extension activities however efficiencies would be gained from building into existing networks such as that of the ABGC. Personalised mailed letters should also form part of a communications plan for future extension projects. Paid print advertisements don't appear to encourage growers and industry stakeholders to attend events and therefore emphasis should be placed on the other channels discussed.
- Project extension staff should continue to build and maintain grower and industry networks to ensure the success of future projects.
- Future extension projects should continue to foster and build upon the successful NextGen young banana growers group.
- Demonstration and/or innovation field trials play an important role in the uptake of existing and emerging practices as growers often need to see for themselves the effects of a practice to weigh up whether or not to implement the practice. Although no significant outcomes were seen from the short (6 month) innovation field trials conducted as part of this project, growers were interested in the outcomes irrespective of their success or failure mainly because they helped identify the areas which were investigated. Future innovation field trials should be driven by growers which will ensure areas of interest and priority are investigated. Regular updates should also be conveyed to growers which could facilitate a feedback mechanism on the progress of the trials.
- The Banana Best Management Practices: Environmental guidelines is an important resource for banana growers and the industry as a whole. As environmental regulation looms this resource and the continued implementation of environmental best practices will become more of a priority for banana growers. At present the focused extension effort for environmental practices is well resourced through two environmental projects which are led by the ABGC. In future extension projects if this is to change then emphasis should be placed on adoption of the environmental BMP. However, in any circumstance close communication should continue to be maintained with environmental BMP extension efforts and topics of priority built into extension events conducted by future national banana extension projects.

- Field day events held in banana paddocks offer a great opportunity to extend outcomes from field based activities to growers and also adds a unique social setting for growers to discuss the outcomes of R & D activities. Careful on-farm biosecurity practices need to be adhered to, to facilitate these events and therefore information should be sought from the BMP for on-farm biosecurity and those with a high level of knowledge about on-farm biosecurity systems prior to holding a field event.
- Future banana extension programs should continue to work closely with the industry's communication project. The relationship between the two projects to distribute written information about R & D project updates and outputs, event promotion, promotion of video material etc. is vital to the success of future extension projects. Similarly it is equally important to remain in close contact with project leaders and staff working in other banana R, D & E projects to ensure accurate project updates and outcomes are delivered to growers and industry stakeholders in a timely manner.
- Although a range of mediums and methods should be used to reach banana growers and industry stakeholders the use of information technology including industry specific based web platforms should be explored to provide accurate and timely information.
- It is vital that future extension projects have the flexibility to address emergent industry priorities

Scientific refereed publications

Kukulies T, Lindsay S, Dullahide S, Bagshaw J, Simpson S, King, N, Leibelt T, (2017) The grower extension response to Panama disease tropical race 4 in north Queensland, Rural Extension and Innovation Systems Journal – Practice - *DRAFT*

Intellectual property/commercialisation

No commercial IP generated

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Appendices

Contents

Appendix 1: Project Reference Group

Appendix 1.1 Mid-project review: June 2015

Background

The National Banana Development and Extension Project provides for a coordinated information development and dissemination program that ensures a focused and systematic approach to delivering the information and results from industry funded R&D and other sources. The project is funded for three years from 18 March 2013 and the life of project value is $568,282. Additional sources of funding are provided by The Department of Agriculture, Queensland and NSW Department of Primary Industries. The Service Provider is The Department of Agriculture and Fisheries, Queensland.

Intended outcomes for the project include:

- A better informed banana industry with improved access to the information needed to make better decisions for their businesses.
- Enhanced communication of project results and sharing of knowledge and information of technical developments, with all levels of the banana industry
- Increasing the value to the banana industry from industry funded R&D
- Improved coordination of information and knowledge generation that builds linkages between related project areas
- More rapid and appropriate adoption of the research outcomes tailored to specific production regions
- Improved opportunity for key industry sectors to identify emerging issues
- Improved communication and networking between key information providers in the banana industry
- A mechanism to identify information gaps and subsequently identifies future R&D priorities
- Improved management of pest and diseases, specifically soil borne diseases such as Panama disease
- Improved soil management practices that minimise off site impacts and improve productivity

Objectives of the Review

1. Assess progress in the delivery of project outputs and the quality of the project outputs.
2. Assess impact of the project on the banana industry and progress towards achieving project outcomes.
3. Comment on the continued suitability of the methodology for supporting Banana Industry Development.
4. Project SWOT analysis.
5. Recommendations for remainder of the project.

Process

The mid-term review was undertaken by HIA Limited (Alison Anderson, Portfolio Manager – Industry Development) using input from the Project Reference Group meeting (28 November 2014) and discussions with the Project Leader, Tegan Kukulies and Project Team Member, Stewart Lindsay. Project reports and outputs were referred to as were other HIA staff, Jane Wightman and Ben Callaghan.

Project Outputs and Outcomes

The project is meeting the delivery of project outputs at or above targets in most cases (as per the project plan). All outputs are well documented and provided to the Project Reference Group and in Milestone Reports to HIA. The supply chain member visits have not yet been achieved and a variation to the project has been made. The Project Reference Group commented that effort has gone where required.

Key project outputs delivered to date include: National banana roadshow series 2014 (6 events with 138 participants); Production of best practice videos (9 with over 2,000 views); Next Gen banana group established; Workshops and field walks (28 grower meetings); Demonstration sites; Banana BMP training (6

training events with 4,600 ha signed up); Linkages and networks with key information providers in the banana industry; General articles (30 plus) and written material in banana industry publications and regional news channels.

Project Reference Group feedback was that there was a very good response to the roadshow series and that the events were very well structured. Presentations were short and a large number of topics covered. Growers and industry stakeholders were given the opportunity to contact researchers individually if they wanted more information on a specific topic. Each event was relevant to the location, especially the benchmarking project. Positive feedback was received from growers who participated, even those that do not normally attend industry events. Each event was evaluated with the project team also documenting the topics where additional information was requested. The project team responded to each request for further information and this was forwarded to each participant, also thanking them for their attendance.

Over 50% of roadshow attendees were growers. Before the roadshow most participants had limited knowledge of projects with 84% responding that they had some idea, very little or no understanding at all. After the roadshow most participants had a good knowledge of projects – 71% had a good understanding or better. Participants were asked if they will change or are thinking of changing practices after attending the roadshow – 41% answered yes and 49% answered maybe. 98% of participants said they would attend a roadshow event again and 62% said they would recommend the roadshow to others.

The videos have enabled the project team to raise the profile of 'behind the scenes' projects. There is evidence that growers are talking about projects featured in the videos. The biggest limitation to producing more videos is the time allocated to video production within the project. The Project Reference Group commented that the video featuring FNQ grower Paul Inderbitzen has driven plastic recycling in NSW.

The Next Gen workshops have been successful with young growers getting involved that have not been involved in meetings and industry events in the past. Next Gen Growers are also moving into more active and leadership roles in the industry. All project workshops and meetings have taken advantage of extending R&D project information to consultants; this extends the reach of project information.

Project documentation, evaluation and Project Reference Group feedback to date indicates that the project is having an impact on the banana industry and progress is being made towards achieving intended project outcomes. Evidence will need to be collated for the outcomes that address improved management of pests and diseases and improved soil management practices.

Suitability of Methodology

The primary activity of the project is the coordination and delivery of results from industry funded R&D. It is the first time the industry has funded a national extension project. The project methodology is suitable and has allowed flexibility such as an additional workshop during the road show in response to the expanding banana industry on the Atherton Tablelands.

The project plan allows the project to be responsive to emerging industry priorities such as the Panama disease TR4 incursion in FNQ by focussing extension activities on priority topics. The project funds a number of outputs (extension events and communications) with Project Reference Group and industry input on the priority topics to be addressed in these outputs.

The Project Reference Group commented that the majority of outputs are FNQ specific. There is an opportunity to better target the sub-tropics, particularly with Matt Weinert in the NSW IDO position (BA13025). There was general comment that the NSW industry will benefit from local trial blocks and that the NSW growers were 'won over' by the roadshow. The NSW IDO is addressing the weevil borer issue, which is one of the biggest issues in NSW.

SWOT Analysis

Strengths • Dedicated staff resources available (1.2 FTE Qld, 0.2 FTE NSW) • Active and engaged Project Reference Group • Identified industry priorities developed by the Project Reference Group • Close collaboration with banana industry communications project (BA13003) • Project has sufficient operating budget to achieve its objectives • Project team have demonstrated extension and banana industry experience • Project has established a profile with the banana industry, particularly the production sector • Project has established networks and relationships with current project leaders in the banana industry
Weaknesses • Project not able to provide extension resources to the level of expectations of all R&D project leaders
Opportunities • Project team able to respond relatively quickly to emerging industry priorities resulting from the Panama disease TR4 incursion in NQ • To better target sub-tropic specific issues and topics • Search function on the database
Threats • Provision of NSW staff resources reliant on another project • Changes in project staff can disrupt ability to achieve objectives • Heavy reliance on banana industry communications

Recommendations

The mid-term review finds that BA13004 is of high value to the banana industry. There has been excellent industry engagement and after the 2014 roadshow there are good indications that engagement will increase in 2015 project activities and the 2016 roadshow (with 62% of 2014 roadshow participants indicating that they would recommend others attend in 2016).

It is recommended that the project continue. However, the project will be subject to a review as part of the HIA Ltd review of all projects that were transferred from HAL to HIA Ltd. This review will be against the parameters of the Deed of Agreement 2014-18. The project will be subject to the outcomes of this review.

For the 2016 roadshow series not as many topics will need to be presented. This is because the banana R&D program is better known amongst growers and industry as a result of the 2014 roadshow series. This will provide more time for discussion on each topic. Presentations should remain short so as to maintain interest. Some topics (with input from the Project Reference Group) could be allocated additional time for presentation.

There is a high cost ($ and time) of holding a roadshow event in Carnarvon. The project team should look at other options (e.g. webinars) now that a relationship has been established. Once the project team has reviewed locations for the 2016 roadshow series the Project Reference Group should be invited to provide input. Activities have been happening as a result of the roadshow going to WA, e.g. Carnarvon growers coming to NSW to view the variety trial at Duranbah. There is scope to look at alternative ways to involve Carnarvon growers in the project and to extend R&D outcomes to them. The Project Reference Group has advised that two roadshow events should be maintained in NSW.

The project team needs to consider topics that are of specific priority to sub-tropical banana growers and build them into the annual work plan.

Topics for workshops need to remain flexible and driven by current issues and relevant projects for the location. Local Project Reference Group members are able to provide advice when workshops are being planned.

There are high expectations on the project to extend R&D project outcomes. It needs to be ensured that the project addresses the high priority topics within the project plan. When there is high demand from a specific R&D project for BA13004 to extend their information the project team need to liaise with HIA and the Project Reference Group to prioritise topics.

It is important that the project team continue with their detailed project monitoring and evaluation, allowing the project to "tell its story". The intended project outcomes should be referred to and cross-checked with the monitoring and evaluation plan so that all are being addressed and appropriate evidence of project success collated.

The project transition from Project Leader Naomi King to Tegan Kukulies appears to have been smooth. Naomi remains in the banana industry in her new role and has continued to provide support to Tegan.

The project should seek to capitalise on its strengths to harness the identified opportunities where appropriate within the project scope and budget. The SWOT analysis and feedback in the report are to be considered by the project team and integrated into the remainder of the project.

Appendix 2: Development of linkages and networks with key information providers in the banana industry

Table1: Details of attendance at banana grower association meetings

Banana Grower Association	Number of meetings per year	Meeting attendance target	Number of meetings attended
Cassowary Coast	11	6	31
Mareeba and District	6	3	5
Coffs Harbour	4	1	10
Nambucca	4	1	11
Tweed/Richmond	Ad Hoc	1	6

Appendix 3: National Banana Roadshow Series

Appendix 3.1: Full agenda of the 2014 National Banana Roadshow Series

MURWILLUMBAH, Golf Club, Tuesday 15th July 2014

9.00 AM - Welcome, overview of the day	Naomi King (DAFF)
Theme 1 – Farm production and best environmental practice	
· Panama management systems: Pulling it altogether	Tony Pattison (DAFF)
· Resistant varieties and greater consumer choice	Mike Smith (DAFF)
· Preparing for Plan B - Agronomic assessments of TR4 varieties	Stewart Lindsay (DAFF)
· Accessing new banana varieties: why, how and who!	Sharon Hamill (DAFF)
· Risky Business - threats, pathways & opportunities	Jay Anderson (ABGC)
Short break	
· 100 years & counting down – Bunchy Top	David Peasley (Peasley Horticultural Services)
· To register, or permit: that is the 'chemical' question	Jay Anderson (ABGC)
· Banana soil health: Overview, options and opinions	Tony Pattison (DAFF) & Justine Cox (NSW DPI)
· Top 3 questions about the Banana BMP answered	Naomi King (DAFF)
· Yellow sigatoka management: chlorothalonil vs. oil based programs	Suren Samuelian (DAFF)
· NEW banana officer for NSW	Mark Hickey (NSW DPI)
Lunch	
Theme 2 – Farm business and marketing	
· Benchmarking the banana industry - 4 years data review	Howard Hall (CDI Pinnacle)
· Banana varieties for market growth	Jeff Daniells (DAFF)
· Australian Bananas Marketing Update	VIDEO
Short break	
Theme 3 – Supply chain management	
· Developing a standardized banana carton	VIDEO
· Packaging solutions to meet your supply chain's needs	Stewart Lindsay (DAFF) & Joe Stacey (Joe's Cartons)
· International insights from Banana Nuffield Scholar Paul Inderbitzin	VIDEO
· Evaluations	Naomi King (DAFF)
3.00 – 5.00PM Field Visit to the Duranbah variety trial block for Race 1 Panama disease resistance	**Mike Smith & David Peasley**

7.00 – 9.00 PM Banana BMP training	Naomi King (DAFF)

COFFS HARBOUR, Showgrounds – Norm Jordan Pavilion,
Thursday 17th July 2014

9.00 AM - Welcome, overview of the day	Naomi King (DAFF)
Theme 1 – Farm production and best environmental practice	
· Panama management systems: Pulling it altogether	Tony Pattison (DAFF)
· Resistant varieties and greater consumer choice	Mike Smith (DAFF)
· Preparing for Plan B - Agronomic assessments of TR4 varieties	Stewart Lindsay (DAFF)
· Accessing new banana varieties: why, how and who!	Sharon Hamill (DAFF)
· Risky Business - threats, pathways & opportunities	Jay Anderson (ABGC)
Short break	
· 100 years & counting down – Bunchy Top	David Peasley (Peasley Horticultural Services)
· To register, or permit: that is the 'chemical' question	Jay Anderson (ABGC)
· Banana soil health: Overview, options and opinions	Tony Pattison (DAFF) & Justine Cox (NSW DPI)
· Top 3 questions about the Banana BMP answered	Naomi King (DAFF)
· Yellow sigatoka management: chlorothalonil vs. oil based programs	Suren Samuelian (DAFF)
· NEW banana officer for NSW	Mark Hickey (NSW DPI)
Lunch	
Theme 2 – Farm business and marketing	
· Benchmarking the banana industry - 4 years data review	Howard Hall (CDI Pinnacle)
· Banana varieties for market growth	Jeff Daniells (DAFF)
· Australian Bananas Marketing Update	VIDEO
Short break	
Theme 3 – Supply chain management	
· Developing a standardized banana carton	VIDEO
· Packaging solutions to meet your supply chain's needs	Stewart Lindsay (DAFF)
· International insights from Banana Nuffield Scholar Paul Inderbitzin	VIDEO
· Marketing Subtropical fruit – Q & A with Paul Gibbins (Golden Dawn) and Dave Norberry (D & D Ripeners)	Mark Hickey (NSW DPI)
· Evaluations	Naomi King (DAFF)
3.30 PM - Program Finish	

7.00 – 9.00 PM Banana BMP training	Naomi King (DAFF)

CARNARVON, Yacht club, Wednesday 23rd July 2014

9.00 AM - Welcome, overview of the day	Naomi King (DAFF)
Theme 1 – Farm production and best environmental practice	
· Panama management systems: Pulling it altogether	Tony Pattison (DAFF)
· Resistant varieties and greater consumer choice	Jeff Daniells (DAFF)
· Preparing for Plan B - Agronomic assessments of TR4 varieties	Stewart Lindsay (DAFF)
· Accessing new banana varieties: why, how and who!	VIDEO
Short break	
· Risky Business - threats, pathways & opportunities	Jay Anderson (ABGC)
· Banana soil health: Overview, options and opinions	Tony Pattison (DAFF)
· To register, or permit: that is the 'chemical' question	Jay Anderson (ABGC)
· Top 3 questions about the Banana BMP answered	Naomi King (DAFF)
· Growing subtropical bananas for quality and yield	Valerie Shrubb (DAFWA)
Lunch	
Theme 2 – Farm business and marketing	
· Benchmarking the banana industry - 4 years data review (VIDEO)	VIDEO
· Banana varieties for market growth	Jeff Daniells (DAFF)
· Australian Bananas Marketing Update	VIDEO
Short break	
Theme 3 – Supply chain management	
· Developing a standardized banana carton	VIDEO
· Packaging solutions to meet your supply chain's needs	Stewart Lindsay (DAFF)
· International insights from Banana Nuffield Scholar Paul Inderbitzin	VIDEO
· Evaluations	Naomi King (DAFF)
3.30 PM - Program finish	

7.00 – 9.00 PM Banana BMP training	Naomi King

TULLY, Tully Senior Citizens Hall, Thursday 31st July 2014

9.00 AM - Welcome, overview of the day	Naomi King (DAFF)
Theme 1 – Farm production and best environmental practice	
· Panama management systems: Pulling it altogether	Tony Pattison (DAFF)
· Resistant varieties and greater consumer choice	Mike Smith (DAFF)
· Preparing for Plan B - Agronomic assessments of TR4 varieties	Stewart Lindsay (DAFF)
· Accessing new banana varieties: why, how and who!	Sharon Hamill (DAFF)
· Risky Business - threats, pathways & opportunities	Rebecca Sapuppo (DAFF)
Short break	
· Yellow sigatoka management: chlorothalonil vs. oil based programs	Suren Samuelian (DAFF)
· Fungicide resistance: Top 5 ways to avoid	Kathy Grice (DAFF)
· To register, or permit: that is the 'chemical' question	Jay Anderson (ABGC)
· Banana soil health: Overview, options and opinions	Tony Pattison (DAFF)
· Top 3 questions about the Banana BMP answered	Naomi King (DAFF)
· Nutrients & Sediment. Do you know what's happening in your banana paddock?	Christina Mortimore (DNRM)
Lunch	
Theme 2 – Farm business and marketing	
· Benchmarking the banana industry - 4 years data review	Howard Hall (CDI Pinnacle)
· Why would I want to map my plantation?	Robert Crossley (AgTrix)
· Banana varieties for market growth	Jeff Daniells (DAFF)
· Australian Bananas Marketing Update	VIDEO
Short break	
Theme 3 – Supply chain management	
· Developing a standardized banana carton	VIDEO
· Packaging solutions to meet your supply chain's needs	Stewart Lindsay (DAFF) & Joe Stacey (Joe's Cartons)
· International insights from Banana Nuffield Scholar Paul Inderbitzin	VIDEO
· Evaluations	Naomi King (DAFF)
3.30 PM - Program finish	

INNISFAIL, Brothers Leagues Club, Friday 1st August 2014

9.00 AM - Welcome, overview of the day	Naomi King (DAFF)
Theme 1 – Farm production and best environmental practice	
· Panama management systems: Pulling it altogether	Tony Pattison (DAFF)
· Resistant varieties and greater consumer choice	Mike Smith (DAFF)
· Preparing for Plan B - Agronomic assessments of TR4 varieties	Stewart Lindsay (DAFF)
· Accessing new banana varieties: why, how and who!	Sharon Hamill (DAFF)
· Risky Business - threats, pathways & opportunities	Rebecca Sapuppo (DAFF)
Short break	
· Yellow sigatoka management: chlorothalonil vs. oil based programs	Suren Samuelian (DAFF)
· Fungicide resistance: Top 5 ways to avoid	Kathy Grice (DAFF)
· To register, or permit: that is the 'chemical' question	Jay Anderson (ABGC)
· Banana soil health: Overview, options and opinions	Tony Pattison (DAFF)
· Top 3 questions about the Banana BMP answered	Naomi King (DAFF)
· Nutrients & Sediment. Do you know what's happening in your banana paddock?	Christina Mortimore (DNRM)
Lunch	
Theme 2 – Farm business and marketing	
· Benchmarking the banana industry - 4 years data review	Howard Hall (CDI Pinnacle)
· Why would I want to map my plantation?	Robert Crossley (AgTrix)
· Banana varieties for market growth	Jeff Daniells (DAFF)
· Australian Bananas Marketing Update	David Weisz (HAL)
Short break	
Theme 3 – Supply chain management	
· Developing a standardized banana carton	VIDEO
· Packaging solutions to meet your supply chain's needs	Stewart Lindsay (DAFF) & Joe Stacey (Joe's Cartons)
· International insights from Banana Nuffield Scholar Paul Inderbitzin	VIDEO
· Evaluations	Naomi King (DAFF)
3.30 PM - Road show program finish	
ANNUAL LEVY PAYERS' MEETING	**Horticulture Australia Limited (HAL)**

WALKAMIN, Sports Club, Thursday 7th August 2014

9.00 AM - Welcome, overview of the day	Naomi King (DAFF)
Theme 1 – Farm production and best environmental practice	
· Panama management systems: Pulling it altogether	Tony Pattison (DAFF)
· Resistant varieties and greater consumer choice	Jeff Daniells (DAFF)
· Preparing for Plan B - Agronomic assessments of TR4 varieties	Stewart Lindsay (DAFF)
· Accessing new banana varieties: why, how and who!	VIDEO
· Risky Business - threats, pathways & opportunities	Rebecca Sapuppo (DAFF)
Short break	
· Yellow sigatoka management: chlorothalonil vs. oil based programs	Suren Samuelian (DAFF)
· Fungicide resistance: Top 5 ways to avoid	Kathy Grice (DAFF)
· To register, or permit: that is the 'chemical' question	Jay Anderson (ABGC)
· Banana soil health: Overview, options and opinions	Tony Pattison (DAFF)
· Top 3 questions about the Banana BMP answered	Naomi King (DAFF)
· Nutrients & Sediment. Do you know what's happening in your banana paddock?	Christina Mortimore (DNRM)
Lunch	
Theme 2 – Farm business and marketing	
· Benchmarking the banana industry - 4 years data review	Howard Hall (CDI Pinnacle)
· Why would I want to map my plantation?	Robert Crossley (AgTrix)
· Banana varieties for market growth	Jeff Daniells (DAFF)
· Australian Bananas Marketing Update	VIDEO
Short break	
Theme 3 – Supply chain management	
· Developing a standardized banana carton	VIDEO
· Packaging solutions to meet your supply chain's needs	Stewart Lindsay (DAFF) & Joe Stacey (Joe's Cartons)
· International insights from Banana Nuffield Scholar Paul Inderbitzin	VIDEO
· Evaluations	Naomi King (DAFF)
3.30 PM - Program finish	

Appendix 3.2: Full agenda of the 2016 National Banana Roadshow Series

MAREEBA, Department of Natural Resources and Mines, John Charles room, Thursday 9th June 2016

9.00 AM - Welcome, overview of the day	Tegan Kukulies (DAF)
Theme 1 – Panama disease tropical race 4	
· Using Zoning to protect your farm: Grower examples	Sarah Simpson (ABGC)
· Biosecurity Queensland Panama TR4 Program – what's new	Rebecca Sapuppo (DAF)
· Banana farming with TR4: Lessons from the Philippines and Taiwan	Dr Rosie Godwin (ABGC) & Patrick Leahy
Morning Tea	
· The down and dirty on disinfectants for Race 1 Panama disease	Kathy Grice (DAF)
· Remote sensing technology: exploring a new method for early disease detection and for the evaluation of plant health	Katie Ferro (DAF)
· Understanding fusarium genetics	Dr Elizabeth Aitken (UQ)
· Varieties Update – 2 years on	Jeff Daniells (DAF)
Theme 2 – Production and environmental practices	
· Timing is everything – crop scheduling with ethephon stem injections	Stewart Lindsay (DAF)
· Fungi & bacteria: the yin & yang of banana soils	Dr Tony Pattison (DAF)
· Introduction to Matt Abbott's Nuffield Scholarship Experiences	VIDEO
Lunch	
· Reef safe nitrogen management	Jeff Daniells (DAF)
· Bananas, water quality and the Great Barrier Reef	Michelle McKinlay (ABGC)
· Banana BMP – What's new and why you should use it?	Tegan Kukulies (DAF)
Theme 3 – Supply chain management	
· Crown End Rot of Banana: Our learnings from the first year	Peter Trevorrow (DAF)
· Implementation of the 15kg 1-Piece Carton	Tristan Kitchener (Kitchener Partners)
· 3 year strategic marketing plan for Australian bananas	Elisa King (HIA)
· Evaluations	Tegan Kukulies (DAF)
2.30 PM - Program finish	

INNISFAIL, Brothers Leagues Club, Friday 10th June 2016

9.00 AM - Welcome, overview of the day	Tegan Kukulies (DAF)
Theme 1 – Panama disease tropical race 4	
· Using Zoning to protect your farm: Grower examples	Sarah Simpson (ABGC)
· Biosecurity Queensland Panama TR4 Program – what's new	Rebecca Sapuppo (DAF)
· Banana farming with TR4: Lessons from the Philippines and Taiwan	Dr Rosie Godwin (ABGC) & Patrick Leahy
Morning Tea	
· The down and dirty on disinfectants for Race 1 Panama disease	Kathy Grice (DAF)
· Remote sensing technology: exploring a new method for early disease detection and for the evaluation of plant health	Katie Ferro (DAF)
· Understanding fusarium genetics	Dr. Elizabeth Aitken (UQ)
· Varieties Update– 2 years on	Jeff Daniells (DAF)
Theme 2 – Production and environmental practices	
· Timing is everything – crop scheduling with ethephon stem injections	Stewart Lindsay (DAF)
· Fungi & bacteria: the yin & yang of banana soils	Dr Tony Pattison (DAF)
· Introduction to Matt Abbott's Nuffield Scholarship Experiences	VIDEO
Lunch	
· Reef safe nitrogen management	Jeff Daniells (DAF)
· Bananas, Water Quality and the Great Barrier Reef	Michelle McKinlay (ABGC)
· Banana BMP – What's new and why you should use it?	Tegan Kukulies (DAF)
Theme 3 – Supply chain management	
· Crown End Rot of Banana: Our learnings from the first year of	Peter Trevorrow (DAF)
· Implementation of the 15kg 1-Piece Carton	Tristan Kitchener (Kitchener Partners)
· 3 year strategic marketing plan for Australian bananas	Elisa King (HIA)
· Evaluations	Tegan Kukulies (DAF)
2.30 PM - Program finish	

TULLY, Tully Senior Citizens Hall, Thursday 16th June 2016

9.00 AM - Welcome, overview of the day	Tegan Kukulies (DAF)
Theme 1 – Panama disease tropical race 4	
· Using Zoning to protect your farm: Grower examples	Sarah Simpson (ABGC)
· Biosecurity Queensland Panama TR4 Program – what's new	Rebecca Sapuppo (DAF)
· Banana farming with TR4: Lessons from the Philippines and Taiwan	Dr Tony Pattison (ABGC) & Patrick Leahy
Morning Tea	
· The down and dirty on disinfectants for Race 1 Panama disease	Kathy Grice (DAF)
· Remote sensing technology: exploring a new method for early disease detection and for the evaluation of plant health	Katie Ferro (DAF)
· Varieties Update– 2 years on	Jeff Daniells (DAF)
Theme 2 – Production and environmental practices	
· Timing is everything – crop scheduling with ethephon stem injections	Stewart Lindsay (DAF)
· Fungi & bacteria: the yin & yang of banana soils	Dr Tony Pattison (DAF)
· Introduction to Matt Abbott's Nuffield Scholarship Experiences	VIDEO
Lunch	
· Reef safe nitrogen management	Jeff Daniells (DAF)
· Bananas, Water Quality and the Great Barrier Reef	Robert Mayers (ABGC)
· Banana BMP – What's new and why you should use it?	Tegan Kukulies (DAF)
Theme 3 – Supply chain management	
· Crown End Rot of Banana: Our learnings from the first year of data collection	Peter Trevorrow (DAF)
· Implementation of the 15kg 1-Piece Carton	VIDEO
· 3 year strategic marketing plan for Australian bananas	Astrid Hughes (HIA)
· Evaluations	Tegan Kukulies (DAF)
2.30 PM - Program finish	

CARNARVON, Yacht club, Thursday 23rd June 2016

9.00 AM - Welcome, overview of the day	Tegan Kukulies (DAF)
Theme 1 – Panama disease tropical race 4	
· Using Zoning to protect your farm: Grower examples	Sarah Simpson (ABGC)
· Biosecurity Queensland Panama TR4 Program – what's new	Stewart Lindsay (DAF)
· Banana farming with TR4: Lessons from the Philippines and Taiwan	VIDEO
Morning Tea	
· The down and dirty on disinfectants for Race 1 Panama disease	Kathy Grice (DAF) via Skype
· Remote sensing technology: exploring a new method for early disease detection and for the evaluation of plant health	Katie Ferro (DAF)
· Varieties Update from north Queensland – 2 years on	Jeff Daniells (DAF)
Theme 2 – Production and environmental practices	
· Timing is everything – crop scheduling with ethephon stem injections	Stewart Lindsay (DAF)
· Nematodes in Bananas	Jenny Cobon (DAF)
· Introduction to Matt Abbott's Nuffield Scholarship Experiences	VIDEO
· Slow release nitrogen management	Jeff Daniells (DAF)
· Banana BMP – What's new and why you should use it?	Tegan Kukulies (DAF)
Lunch	
Theme 3 – Supply chain management	
· Crown End Rot of Banana: Our learnings from the first year of data collection	Peter Trevorrow (DAF) via skype
· 3 year strategic marketing plan for Australian bananas	Elisa King (HIA)
· Evaluations	Tegan Kukulies (DAF)
1:30 PM - Program finish	

BANANA NUTRITION WORKSHOP	Matt Weinert

COFFS HARBOUR, Showgrounds – Norm Jordan Pavilion,
Tuesday 5th July 2016

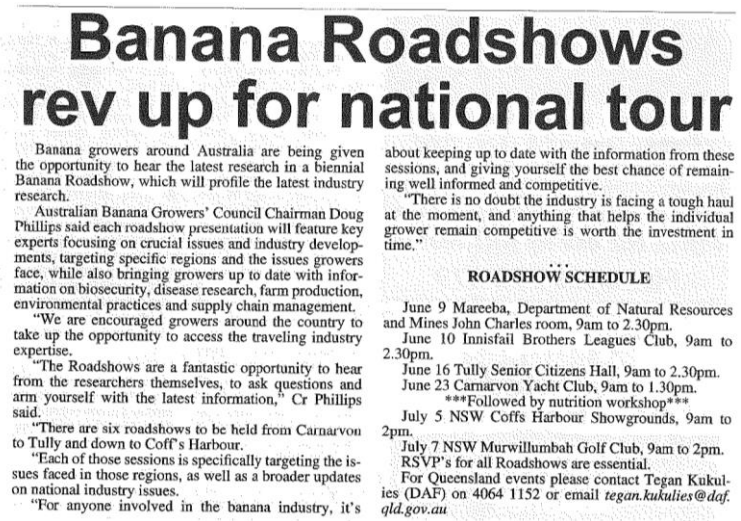
9.00 AM - Welcome, overview of the day	Tegan Kukulies (DAF)
Theme 1 – Panama disease tropical race 4	
· Using Zoning to protect your farm: Grower examples	Sarah Simpson (ABGC)
· Biosecurity Queensland Panama TR4 Program – what's new	Stewart Lindsay (DAF)
· Banana farming with TR4: Lessons from the Philippines and Taiwan	VIDEO
Morning Tea	
· The down and dirty on disinfectants for Race 1 Panama disease	Kathy Grice (DAF)
· Remote sensing technology: exploring a new method for early disease detection and for the evaluation of plant health	Aaron Aeberli (UNE)
· Shortlist of varieties for the subtropics	David Peasley (Peasley Horticulture)
· Varieties Update from north Queensland – 2 years on	Jeff Daniells (DAF)
Theme 2 – Production and environmental practices	
· Beating beetle – Will mass annihilation trapping work?	Matt Weinert (NSW DPI)
· Fungi & bacteria: the yin & yang of banana soils	Dr Anna McBeath (DAF)
· Introduction to Matt Abbott's Nuffield Scholarship Experiences	VIDEO
· Slow release nitrogen management	Jeff Daniells (DAF)
· Reducing gaseous emissions	Matt Weinert (NSW DPI)
· Banana BMP – What's new and why you should use it?	Tegan Kukulies (DAF)
Lunch	
Theme 3 – Supply chain management	
· Crown End Rot of Banana: Our learnings from the first year of data collection	Kathy Grice (DAF)
· Implementation of the 15kg 1-Piece Carton	VIDEO
· 3 year strategic marketing plan for Australian bananas	Elisa King (HIA)
· Evaluations	Tegan Kukulies (DAF)
2.00 PM - Program finish	

MURWILLUMBAH, Golf Club, Thursday 7th July 2016

9.00 AM - Welcome, overview of the day	Tegan Kukulies (DAF)
Theme 1 – Panama disease tropical race 4	
· Using Zoning to protect your farm: Grower examples	Sarah Simpson (ABGC)
· Biosecurity Queensland Panama TR4 Program – what's new	Stewart Lindsay (DAF)
· Banana farming with TR4: Lessons from the Philippines and Taiwan	VIDEO
Morning Tea	
· The down and dirty on disinfectants for Race 1 Panama disease	Kathy Grice (DAF)
· Remote sensing technology: exploring a new method for early disease detection and for the evaluation of plant health	Aaron Aeberli (UNE)
· Shortlist of varieties for the subtropics	David Peasley (Peasley Horticulture)
· Varieties Update from north Queensland – 2 years on	Jeff Daniells (DAF)
Theme 2 – Production and environmental practices	
· Beating beetle – Will mass annihilation trapping work	Matt Weinert (NSW DPI)
· Fungi & bacteria: the yin & yang of banana soils	Dr Anna McBeath (DAF)
· Introduction to Matt Abbott's Nuffield Scholarship Experiences	VIDEO
· Slow release nitrogen management	Jeff Daniells (DAF)
· Reducing gaseous emissions	Matt Weinert (NSW DPI)
· Banana BMP – What's new and why you should use it?	Tegan Kukulies (DAF)
Lunch	
Theme 3 – Supply chain management	
· Crown End Rot of Banana: Our learnings from the first year of data collection	Kathy Grice (DAF)
· Implementation of the 15kg 1-Piece Carton	VIDEO
· 3 year strategic marketing plan for Australian bananas	Elisa King (HIA)
· Evaluations	Tegan Kukulies (DAF)
2.00 PM - Program finish	

Appendix 3.3: Print media promoting the 2016 National Banana Roadshow Series

Figure 1: Example of paid advertisement which ran for the 2016 roadshow series in the Mid West Time (WA), Coffs Harbour Advocate (NSW), Tweed Daily News (NSW), Innisfail Advocate (QLD), Tully Times (QLD), and the Mareeba Express (QLD). Size M3 x 3 (92mm x 129mm)



Banana Roadshows rev up for national tour

Banana growers around Australia are being given the opportunity to hear the latest research in a biennial Banana Roadshow, which will profile the latest industry research.

Australian Banana Growers' Council Chairman Doug Phillips said each roadshow presentation will feature key experts focusing on crucial issues and industry developments, targeting specific regions and the issues growers face, while also bringing growers up to date with information on biosecurity, disease research, farm production, environmental practices and supply chain management.

"We are encouraged growers around the country to take up the opportunity to access the traveling industry expertise.

"The Roadshows are a fantastic opportunity to hear from the researchers themselves, to ask questions and arm yourself with the latest information," Cr Phillips said.

"There are six roadshows to be held from Carnarvon to Tully and down to Coff's Harbour.

"Each of those sessions is specifically targeting the issues faced in those regions, as well as a broader updates on national industry issues.

"For anyone involved in the banana industry, it's about keeping up to date with the information from these sessions, and giving yourself the best chance of remaining well informed and competitive.

"There is no doubt the industry is facing a tough haul at the moment, and anything that helps the individual grower remain competitive is worth the investment in time."

...

ROADSHOW SCHEDULE

June 9 Mareeba, Department of Natural Resources and Mines John Charles room, 9am to 2.30pm.
June 10 Innisfail Brothers Leagues Club, 9am to 2.30pm.
June 16 Tully Senior Citizens Hall, 9am to 2.30pm.
June 23 Carnarvon Yacht Club, 9am to 1.30pm.
Followed by nutrition workshop
July 5 NSW Coffs Harbour Showgrounds, 9am to 2pm.
July 7 NSW Murwillumbah Golf Club, 9am to 2pm.
RSVP's for all Roadshows are essential.
For Queensland events please contact Tegan Kukulies (DAF) on 4064 1152 or email *tegan.kukulies@daf.qld.gov.au*

Figure 2: Example of print media promoting the Roadshows in north Queensland – Tully Times

Banana Roadshow reaches Coast

BANANA growers can hear the latest research during the National Banana Roadshow in Coffs Harbour and Murwillumbah next week.

The roadshow will keep growers up to date with biosecurity, pest and disease research, farm production, environmental practices and supply chain management.

Presentations will feature key experts focusing on crucial issues and industry developments, targeting the north coast region and the issues growers face.

NSW Department of Primary Industries banana industry development officer Matt Weinert said the short presentations allowed growers to hear direct from researchers, to ask questions and arm themselves with the latest industry information.

"It's a great chance to remain informed and competitive. The discussions will cover three themes – Panama Disease Tropical Race 4, Production and Environmental Practices and Supply Chain Management.

"The industry is experiencing some tough times at the moment so anything that can help growers to remain competitive is worth the investment of their time," Mr Weinert said.

Roadshow events will be held on: July 5 at Coffs Harbour Showgrounds, Norm Jordan Pavilion 9am–2pm; July 7 Murwillumbah Golf Club, 9am–2pm.

RSVP to 6626 1352 or matt.weinert@dpi.nsw.gov.au

THRIVING: But even Coffs grower Headley Gleave may benefit from the roadshow. PHOTO: TREVOR VEALE

Figure 3: Example of print media promoting the Roadshows in New South Wales– Rural Weekly Lismore

Appendix 3.4: Evaluation of the 2014 and 2016 National Banana Roadshow events.

Attendance

Overall 117 people (excluding researchers) attended the 2014 National Banana Roadshow series and 147 people (excluding researchers) attended the 2016 National Roadshow Series. The success and learnings from the first National Banana Roadshow series in 2014 led to the 25% increase in total attendance. Table 1 details the breakdown of the number of participants at each location in both 2014 and 2016. Table 2 shows the percentage distribution of attendees across the 2014 and 2016 Roadshow events for each of the 6 locations.

Table 1: Attendance at the 2014 and 2016 National Banana Roadshows (excluding researchers)

Location	2014	2016
Tablelands	25	32
Tully	25	31
Innisfail	29	33
Coffs Harbour	16	19
Murwillumbah	11	15
Carnarvon	11	17
Total Attendance	117	147

Table 2: Percentage distribution of attendees at the 2014 and 2016 National Banana Roadshow events in each of the 6 locations

**researchers presenting answered this question as it was the very first event*

Location	Growers		Resellers		Service Providers		Post Farm Gate Member		Researchers		Other	
	2014	2016	2014	2016	2014	2016	2014	2016	2014	2016	2014	2016
Tablelands	30%	32%	7%	20%	26%	20%	11%	4%	15%	4%	11%	20%
Innisfail	61%	64%	0%	9%	16%	21%	0%	0%	6%	0%	16%	6%
Tully	59%	61%	7%	13%	7%	13%	7%	3%	11%	0%	7%	10%
Carnarvon	82%	71%	0%	0%	9%	0%	0%	0%	0%	12%	9%	18%
Coffs Harbour	69%	79%	0%	5%	0%	0%	0%	0%	13%	0%	19%	16%
Murwillumbah	36%	59%	0%	6%	4%	12%	0%	0%	46%*	12%	14%	12%

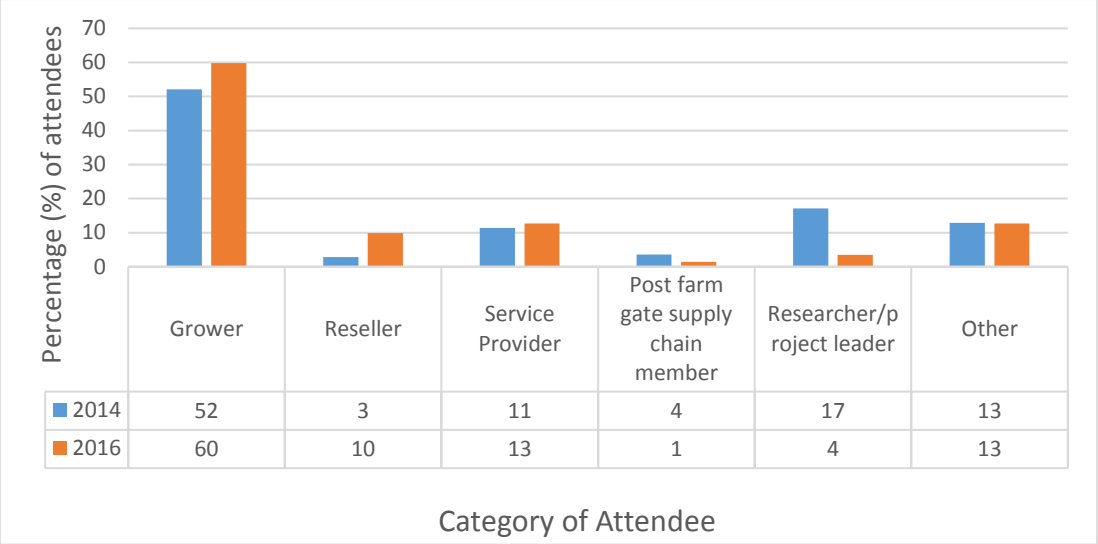


Figure 1: Comparison of the percentage of each stakeholder group which attended the 2014 and 2016 National Roadshow events

Evaluation

Turningpoint™ which is an electronic polling system was used to ask attendees at the Roadshows questions to both improve future roadshow events and also evaluate their impact. Questions were asked both prior to the commencement of the day to determine how they found out about the events and what their current level of understanding of R & D projects was and at the completion of the day to evaluate the impact.

How people found out about the National Banana Roadshows: Table 3 summarises how attendees found out about the events in 2016. Interestingly on the Tablelands a written letter did not encourage anyone to attend. Growers mainly found out about the event via e-mail. This might be representative of the generally younger demographic of growers on the Tablelands who more readily embrace technology, compared to Coffs Harbour where over 50% of those that attended found out about the event via a letter in the mail. The success of Murwillumbah event was attributed to growers being encourage to attend by the Industry Development Officer Matthew Weinert. Printed newspaper advertisements which are proportionally more costly than the other means listed did not encourage any growers to attend the events. Therefore paid print advertisements would not be recommended to promote future events. Overall this evaluation demonstrates that there is a range of demographics in the industry that varies between growing regions, however the use of personalised letters, ABGC e-bulletins, e-mails, government staff and word of mouth are all key avenues to continue to encourage growers and industry stakeholders to attend future National Banana Roadshow events, as well as other extension activities.

Impact of the National Banana Roadshows on attendee's knowledge of R & D projects: Using the electronic keypads and the Turningpoint™ system the attendees were asked at the commencement of the day: how much they knew about the R & D projects currently funded by the banana industry. Attendees were asked to rate their knowledge on a 1-5 scale:

- 1 being nothing at all,
- 2 being very little,
- 3 being some idea,
- 4 being good understanding and

- 5 being I'm across them all.

This same question was asked at the completion of each of the day-long events. The percentage difference at the completion of the day to the commencement of the day is shown in figures 2, 3 and 4. Figure 3 shows a comparison of the percentage change of attendees that answered a 4 or 5. At the Tablelands, Tully, Innisfail and Carnarvon roadshows the percentage change in these categories is less in 2016 compared to 2014. This emphasises the relatively low R & D knowledge base prior to the first roadshow series in 2014 and how these events meant those attending again had a higher level of understanding at the commencement of the 2016 events. Coffs Harbour and Murwillumbah are the anomalies to this. However growers which didn't attend the 2014 events were present at the 2016 events in these locations, which is likely to have contributed to this trend or proportionally more knowledge gain in 2016 compared to 2014. Figures 3 and 4 show the categorical break down of the percentage change of attendees in each of the respective categories for 2014 and 2016 respectively. Those indicating their knowledge was less than a 4/5 at the beginning of the day and after attending was now a 4/5 was the largest category shift at all locations in both years.

Indication of practice change as a result of attending the National Banana Roadshows: Overall 90% and 79% of attendees at the 2014 and 2016 events respectively indicated they would or might change something on their farms as a result of attending the roadshow events. Although this difference between years is only just more than 10% it may have been attributed to the greater emphasis on Panama disease R & D following the detection of the disease in Tully only 15 months earlier and proportionally less emphasis on other research areas. There was no obvious trend in responses at each location between years (Figure 6 & 7). Overall however the evaluation shows that a majority of people gained knowledge which may translate into practice change on their farms as a result of attending.

Overall rating: In 2014, 72% of attendees rated the events an 8 or higher out of 10. With 25% more attendees in 2016 this only fell slightly to 65% of attendees rating the events an 8 or higher out of 10. This is a very positive response in both years. The format of both years was very similar, therefore without deviating too much from the successful format of the day additional tools/activities/media may be considered for future events.

Table 3: Summary of how attendees of the National Banana Roadshow events in 2016 found out about the events

Location	Letter in the mail	ABGC e-bulletin	e-mail	Newspaper	Government staff	Word of mouth
Tablelands	0%	8%	69%	0%	0%	23%
Innisfail	30%	12%	21%	0%	9%	27%
Tully	29%	13%	42%	0%	3%	13%
Carnarvon	7%	7%	47%	0%	27%	13%
Coffs Harbour	56%	11%	17%	0%	11%	6%
Murwillumbah	24%	6%	18%	0%	41%	12%
Overall % for each way of finding out about the event	24%	10%	36%	0%	12%	17%

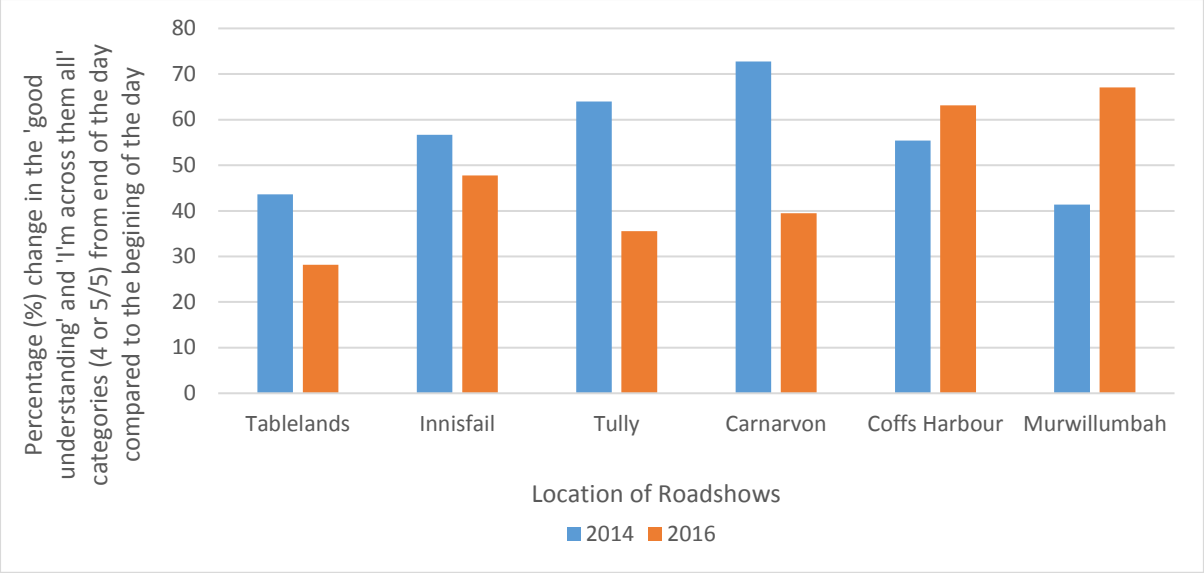
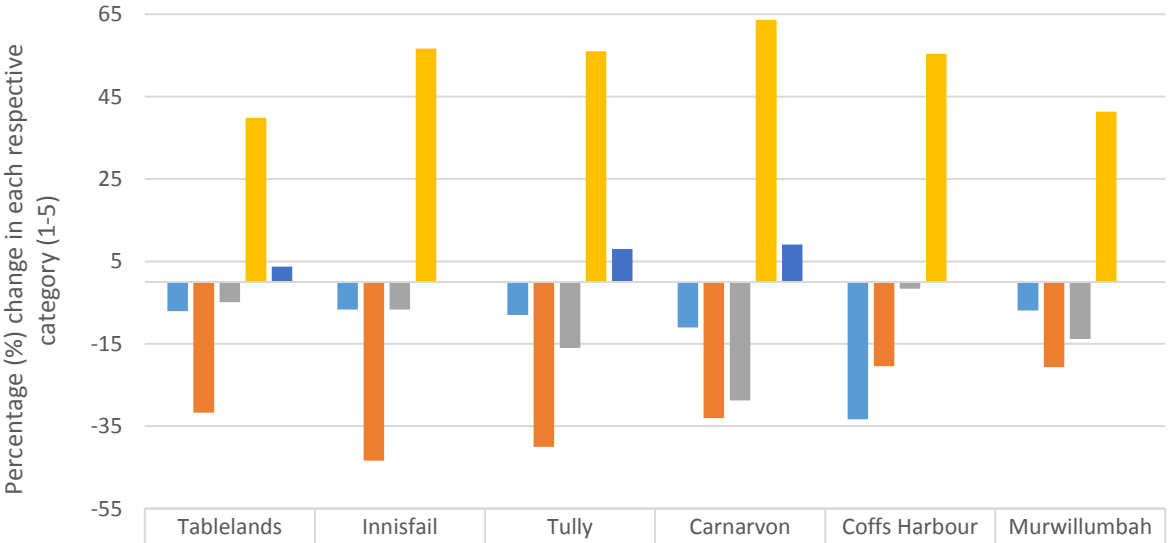
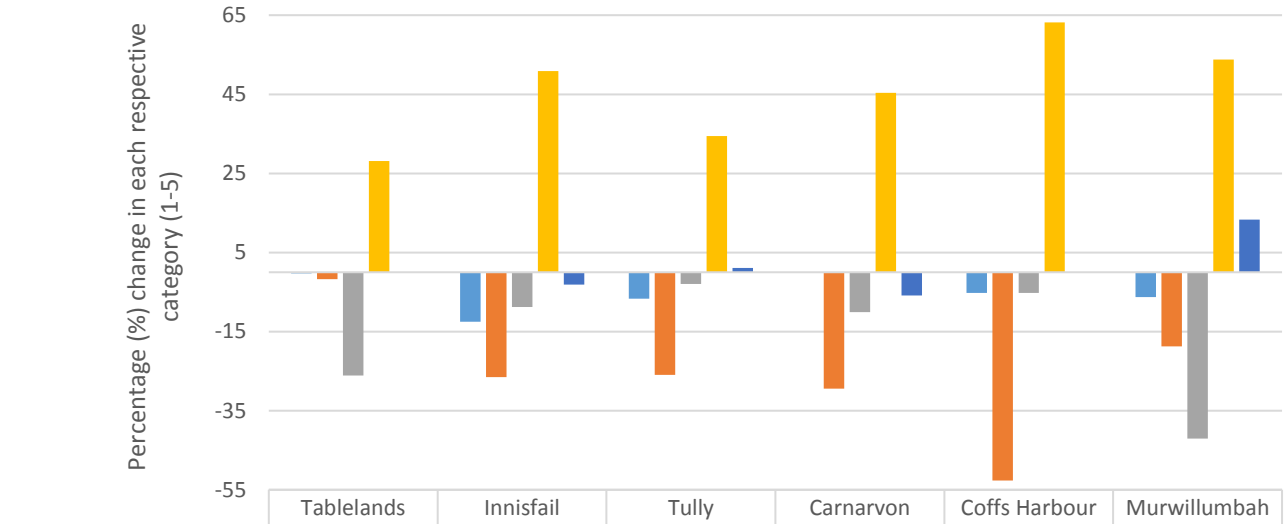


Figure 2: Comparison of the percentage change of attendees that answered 4 or 5/5 to the question: How much do you know about R & D projects currently funded by the banana industry? At the completion of the day-long events to the commencement of the events between the 2014 and 2016 National Roadshow events



	Tablelands	Innisfail	Tully	Carnarvon	Coffs Harbour	Murwillumbah
1 - Nothing at all	-7	-7	-8	-11	-33	-7
2 - Very little	-32	-43	-40	-33	-20	-21
3 - Some idea	-5	-7	-16	-29	-2	-14
4 - Good understanding	40	57	56	64	55	41
5 - I'm across them all	4	0	8	9	0	0

Figure 3: Category breakdown of the comparison of the percentage change of attendees that answered the question: How much do you know about R & D projects currently funded by the banana industry? At the completion of the day-long events to the commencement of the events at the 2014 National Roadshow events.



	Tablelands	Innisfail	Tully	Carnarvon	Coffs Harbour	Murwillumbah
1 - Nothing at all	0	-13	-7	0	-5	-6
2 - Very little	-2	-26	-26	-29	-53	-19
3 - Some idea	-26	-9	-3	-10	-5	-42
4 - Good understanding	28	51	34	45	63	54
5 - I'm across them all	0	-3	1	-6	0	13

Figure 4: Category breakdown of the comparison of the percentage change of attendees that answered the question: How much do you know about R & D projects currently funded by the banana industry? At the completion of the day-long events to the commencement of the events at the 2016 National Roadshow events.

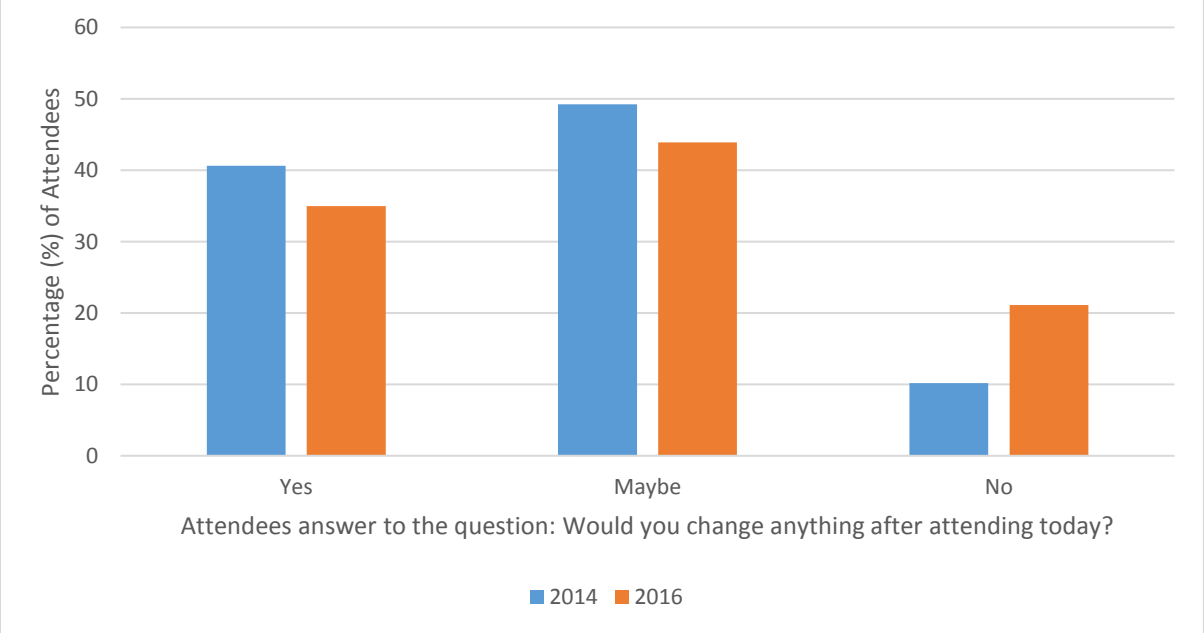


Figure 5: The percentage of attendees which would change something, might change something or would not change something on their farms after attending the events in 2014 compared to 2016

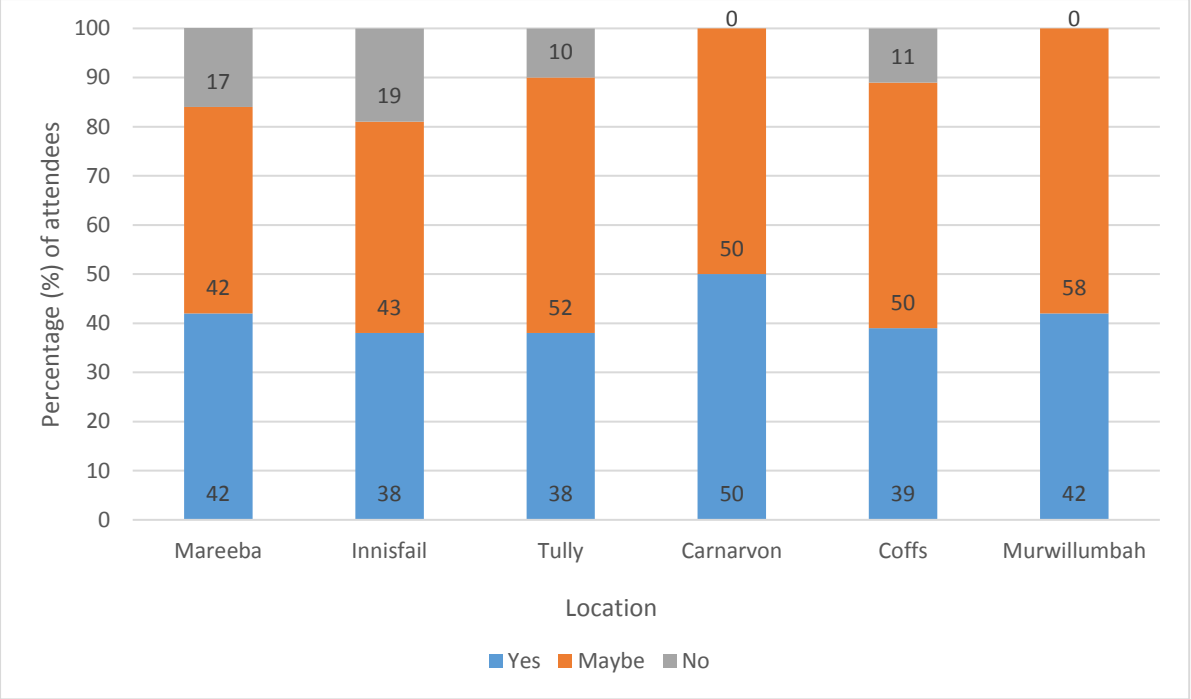


Figure 6: Breakdown of the percentage of attendees which would change something, might change something or would not change something on their farms after attending each of the 2014 Roadshow events

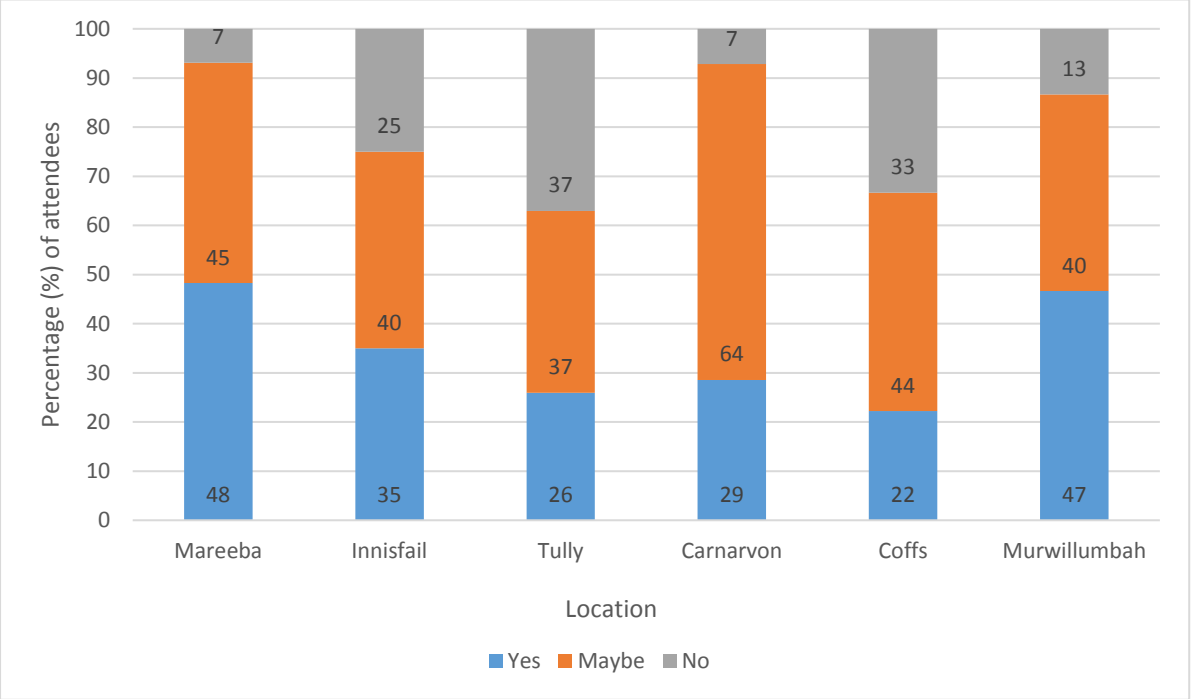


Figure 7: Breakdown of the percentage of attendees which would change something, might change something or would not change something on their farms after attending each of the 2016 Roadshow events

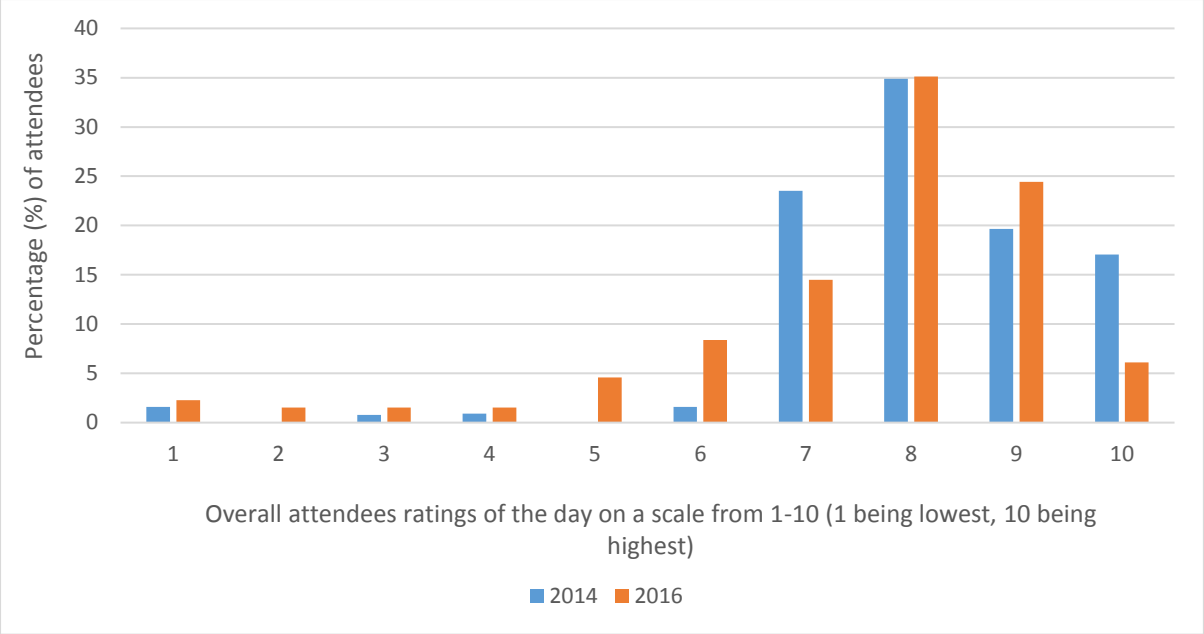


Figure 8: Breakdown of overall satisfaction ratings (1-10) of the National Roadshow events in 2014 compared to 2016

Appendix 3.5: Banana Projects booklet (A5) which was distributed at the 2016 National Roadshow Series

Banana projects

Supporting the Australian banana industry

Horticulture Innovation Australia | NSW Department of Primary Industries | Queensland Government

Supporting the Australian banana industry

The 2016 National Banana Roadshow events in Queensland, New South Wales and Western Australia are designed to deliver the latest practical research to growers and industry stakeholders. This booklet provides a summary of the scope and range of research, development and extension projects throughout Australia.

This booklet was produced as part of the National Banana Development and Extension Program and is funded by Horticulture Innovation Australia (using banana industry levy funds), with co-investment from the Department of Agriculture and Fisheries (Queensland) and the Australian Government.

So here's a quick run-down of the projects currently underway to support the Australian banana industry.

Projects

Banana Plant Protection Program

Funding: Horticulture Innovation Australia and Australian Government

Service providers: The University of Queensland, Department of Agriculture and Fisheries (Queensland), and Northern Territory Department of Primary Industry and Fisheries

Start date: 19 September 2011

End date: 30 September 2016

Project summary:

This project brings together core banana plant health activities and streamlines various aspects of plant protection research to ensure economic delivery of effective outcomes for the industry on a national basis. The program imports new varieties through its quarantine-approved facilities, runs post-entry quarantine and indexing of germplasm, and evaluates the imported varieties for fusarium wilt and leaf-disease resistance in various trial sites around Australia.

The project investigates integrated pest management for yellow Sigatoka, fusarium wilt management, soil health properties and strategic pesticide needs, and supports young banana researchers.

Another important component concerns the development and use of diagnostic assays for early detection of exotic and emerging pathogens (e.g. banana freckle in the Northern Territory and Panama disease tropical race 4 in Far North Queensland).

Contact: Professor Andre Drenth
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Call (07) 3255 4391

Panama TR4 Program

Funding: Queensland Government

Service provider: Biosecurity Queensland, Department of Agriculture and Fisheries (Queensland)

Start date: 1 September 2015

End date: Ongoing

Program summary:

The detection of Panama disease tropical race 4 (TR4) on a property in the Tully Valley, North Queensland, during March 2015 resulted in one of Queensland's biggest ever plant pest responses.

For Biosecurity Queensland, the initial detection was a call to action to implement a quick and effective emergency response to contain a disease that had the potential to severely affect Australia's $600 million banana industry. The team moved quickly to quarantine the infested property and prevent spread of the disease to other farms.

TR4 is a serious threat to the industry and poses a socio-economic issue for the region. In addition to surveillance and quarantine of the infested property, teams conducted surveillance across the Far North Queensland production districts, prioritising any farms with identified links to the infested property.

The scientific staff are highly skilled in plant pathology, molecular biology, diagnostic testing, soil-borne plant diseases, disease management and horticultural science.

To ensure the community understands the importance of the need for surveillance, sampling and on-farm biosecurity, Biosecurity Queensland continues to implement community engagement initiatives.

They are also working with industry and conducting research aimed at finding ways of managing TR4 in the years ahead. This research focuses on longer term measures to allow growers to continue to operate in the presence of the disease and reduce its impact if it cannot be contained.

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ABGC Panama TR4 On-farm Biosecurity Extension Project

Funding: Queensland Government and Australian Government

Service provider: Australian Banana Growers' Council

Start date: 27 April 2015

End date: 23 November 2016

Project summary:

Following the detection of Panama disease tropical race 4 (TR4) in Tully on 3 March 2015, state and federal funding was provided to the Australian Banana Growers' Council to train and advise banana growers in good on-farm biosecurity practices, so that the incursion of the pathogen causing TR4 could be contained.

This project focused on on-farm biosecurity strategies as the best option available to stop the spread of TR4 through infested soil, water or planting material.

The Australian Banana Growers' Council and Department of Agriculture and Fisheries (Queensland) extension staff developed best practice biosecurity workshop modules and delivered them to banana growers in North Queensland. The extension team also conducted a TR4 field day, one-on-one farm visits, on-farm biosecurity reports and communication with industry.

Contact: Sarah Simpson
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Fusarium Wilt Tropical Race 4—Biosecurity and Sustainable Solutions

Funding: Horticulture Innovation Australia and Australian Government

Service provider: Department of Agriculture and Fisheries (Queensland), The University of Queensland and South Australian Research and Development Institute

Start date: 9 June 2015

End date: 30 September 2017

Project summary:

This project looks at short-to-medium term strategies for biosecurity practices. It consists of small research areas that fall into five broad categories:

1. improve on-farm biosecurity practices—effectiveness of disinfectant products, understanding how to manage waste (water and soil) and developing tools for early identification
2. improve access to new cultivars—reviewing current capacity to increase access to resistant varieties and cultivars
3. develop resilient disease-management options—assessing the use of cover crops to reduce inoculum, and understanding the role that plant stress plays in relation to the disease
4. update banana biosecurity protocols—assessing the economics of biosecurity in bananas and the development of an industry biosecurity best management practices resource
5. adoption of research findings—engagement and communication with key stakeholders.

Contact: Stewart Lindsay
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Fusarium Wilt Tropical Race 4 Research Program

Funding: Horticulture Innovation Australia

Service provider: Department of Agriculture and Fisheries (Queensland), The University of Queensland, Department of Primary Industry and Fisheries (Northern Territory), South Australian Research and Development Institute, and James Cook University

Start date: 29 June 2015

End date: 15 August 2019

Project summary:

This project addresses longer term strategies to manage Panama disease tropical race 4. The key part of this project is developing improved varieties, by starting with varieties that have some resistance and adapting them to improve their market acceptability and production characteristics. This will be initially performed by mutating tissue culture plantlets of GCTCV119 and goldfinger.

In addition to this, the project is looking to screen varieties with genetic markers for fusarium wilt resistance.

Other activities include further investigation of the role soil biology plays in disease suppression, developing a replacement system for the Quality Banana Approved Nursery (QBAN) scheme for clean planting material, developing digital tools to assist adoption of best management practice for on-farm biosecurity, and continued extension of research findings.

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Integrated Management of Fusarium Wilt of Bananas in the Philippines and Australia

Funding: Australian Centre for International Agricultural Research

Service provider: Department of Agriculture and Fisheries (Queensland)

Start date: 20 June 2014

End date: 31 December 2017

Project summary:

Panama disease tropical race 4 (TR4), which affects Cavendish bananas, is currently impacting small to medium-size growers in the Philippines. They have limited land resources on which to move or expand, and have restricted fallow and rotation options. Clones have been identified that are resistant; however, these are constrained by gradual susceptibility to the disease and inferior post-harvest characteristics.

This project aims to identify practices for smallholder banana growers to reduce the spread of the disease through soil movement, understand mechanisms that suppress the symptoms and identify effective disposal of infected plant residue. It also aims to profile current knowledge of banana growers and the barriers to adopting relevant practices. The knowledge gained from experiences managing TR4 will be relayed to the Australian banana industry.

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Fusarium Research at The University of Queensland

Funding: The University of Queensland and Bill & Melinda Gates Foundation

Service provider: The University of Queensland

Start date: 1998

End date: Ongoing

Project summary:

This project examines the diversity of Foc (*Fusarium oxysporum* f.sp. *cubense*), the fungus that attacks bananas, by comparing the different races as well as strains that do not attack bananas. The project has discovered that the profile of the SIX (secreted in xylem) genes is distinct for each race of Foc. This information will be used to develop a reliable diagnostic for each race, as well as conduct further experiments to determine what the SIX gene products are doing in the plant and identify ways to potentially stop the fungus attacking banana plants.

In addition, genetic resistance to Panama disease tropical race 4 has been identified in a line of wild-seeded bananas (*Malaccensis*) and the project is developing molecular markers to identify this resistance, which can be used in breeding programs. There is also potential to clone the gene for future use.

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Generating Cavendish with Resistance to Fusarium Wilt Tropical Race 4

Funding: Private industry

Service provider: Queensland University of Technology

Start date: 2011

End date: Ongoing

Project summary:

Panama disease tropical race 4 (TR4) is the greatest threat to the continued viability of Cavendish production worldwide. It is already present in Australia, Asia and Africa, and wherever it occurs it has a massive impact on production—either through lost production or the impact of changed management practices.

There is no 'off the shelf' resistant replacement for Cavendish. Therefore, the options for resistance are developing a Cavendish replacement by conventional breeding or adding resistance to Cavendish by genetic modification. Cavendish has been modified with a range of potential resistance genes through three years of field trials in the Northern Territory. Very promising lines have been identified and will be further tested in new field trials.

Contact: Professor James Dale
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Call 0410 520 269

National Banana Development and Extension Project

Funding: Horticulture Innovation Australia, Australian Government and the Department of Agriculture and Fisheries (Queensland)

Service provider: Department of Agriculture and Fisheries (Queensland)

Start date: 16 September 2013

End date: 30 September 2016

Project summary:

This national project is responsible for delivering information from past, current and future research projects to growers. The project delivered the national technical information updates (roadshow) in 2014 and is coordinating them again in 2016.

Other activities include conducting small research/demo trials, reviewing the *Banana best management practices: environmental guidelines*, producing videos and fact sheets on priority topics, and maintaining links with next-generation growers, industry service providers, grower associations and supply-chain members.

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Call (07) 4064 1152

Communications Project for the Banana Industry

Funding: Horticulture Innovation Australia and Australian Government

Service provider: Australian Banana Growers' Council

Start date: 3 March 2014

End date: 31 January 2017

Project summary:

Banana growers and other key industry stakeholders receive information about industry issues, events and research via materials produced by this project. Activities and outputs support the objectives of the *Banana industry strategic investment plan* by providing growers with information on essential initiatives, such as research and development adoption. The project produces, manages and distributes electronic and printed publications and other materials, and provides services to communicate industry work and achievements.

The project also assists with public comment required on industry issues and helps convene major industry events, such as the Australian Banana Industry Congress. The project's major printed publication is the Australian banana industry's flagship publication, *Australian Bananas* magazine. It also produces other news-focused publications, such as the banana growers' e-bulletin, electronic alerts and information materials such as industry videos and fact sheets. The project also manages and provides content for the industry website, and facilitates posting and management of online content for extension-focused industry projects.

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NSW Banana Industry Development Officer

Funding: Horticulture Innovation Australia (with co-investment from Department of Primary Industries (New South Wales), the Banana Industry Committee and the Coffs Harbour Banana Growers' Association) and Australian Government

Service provider: Department of Primary Industries (New South Wales)

Start date: 1 July 2014

End date: 30 June 2017

Project summary:

The New South Wales banana industry has both regional and national importance, even though it comprises only 4% of total Australian banana production. The New South Wales industry safeguards the supply of bananas to Australian markets when severe weather events adversely affect the production areas of North Queensland.

This project works in conjunction with levy-funded projects such as the National Banana Development and Extension Project and the Banana Plant Protection Program. Through a survey of the whole New South Wales banana supply chain, solutions to production constraints will be identified that will reinvigorate the industry. This involves the development of training programs, information packages and management strategies. The industry development officer plays a key role in the introduction and development of promising new varieties identified through the Banana Plant Protection Program.

Contact: Matthew Weinert
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Call 0438 644 136

Coordination of Banana Industry Research and Development (Panama TR4)

Funding: Horticulture Innovation Australia and Australian Government

Service provider: Australian Banana Growers' Council

Start date: 3 August 2015

End date: 2 August 2018

Project summary:

This project helps ensure the Australian banana industry makes research and development investments that are relevant, well coordinated and have tangible and useful outcomes for growers.

The main priority is ensuring an effective strategy directs research into the fungal disease, Panama disease tropical race 4 (TR4). The project helps growers and the broader Australian banana industry acquire the knowledge and capacity to contain and manage TR4. Because TR4 cannot be eradicated, an effective, long-term containment strategy is needed so the industry can minimise spread and work towards major goals—such as identifying resistant germplasm that can lead to the development of resistant banana plant varieties.

The banana industry must manage a range of disease threats, so the project also assists with actions addressing other key pests and diseases.

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Banana Strategic Industry Development

Funding: Horticulture Innovation Australia and Australian Government

Service provider: Australian Banana Growers' Council

Start date: 1 May 2014

End date: 20 July 2017

Project summary:

The Australian Banana Growers' Council runs a strategic industry development project, which addresses two main strategic areas for growers—biosecurity strategy and environmentally responsible farming.

From a biosecurity perspective, advice has been provided to the banana industry on the Panama TR4 Program response, the Banana Freckle Eradication Program, changes planned in Queensland and New South Wales Biosecurity regulations, and the review of the *Biosecurity imports risk analysis guidelines*.

In terms of the environment, this project has advised industry on the various Great Barrier Reef water quality initiatives and secured funding to deliver extension services for the industry as a way of helping growers implement best practice guidelines that reduce sediment and nutrient run-off from farms.

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Integrated Management of Yellow Sigatoka

Funding: Horticulture Innovation Australia and Australian Government

Service provider: Australian Banana Growers' Council

Start date: 4 January 2016

End date: 31 December 2018

Project summary:

Yellow Sigatoka must be effectively controlled because of its impact on the cost of banana production and its potential to mask an outbreak of the similar, but far more destructive exotic disease, black Sigatoka. Queensland banana growers are required by state legislation to keep leaf spot (yellow Sigatoka) and leaf speckle on their plantations below prescribed levels.

This project supports the work of the Australian Banana Growers' Council yellow Sigatoka liaison officer to help growers achieve compliance voluntarily. The liaison officer undertakes leaf spot inspections and provides information to growers, researchers and supply-chain businesses to improve integrated leaf spot control, and alerts Biosecurity Queensland when any other suspected banana diseases are found.

The liaison officer also supports farmers by advising them on best practice disease management and biosecurity matters relating to other important pest and disease issues, such as Panama disease tropical race 4.

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Cause and Management of Crown Rot of Banana

Funding: Horticulture Innovation Australia and Australian Government

Service provider: Department of Agriculture and Fisheries (Queensland)

Start date: 30 May 2015

End date: 31 March 2018

Project summary:

Summer growing conditions in the wet tropics bring a raft of pest and disease problems. One such disease is crown end rot (CER) of banana fruit, with a range of organisms implicated as the cause. CER has re-emerged as an important problem in the supply chain, with an increase in the incidence of affected consignments received at southern markets. Management is largely dependent on in-field crop hygiene, shed sanitation and the use of registered post-harvest fungicides.

Growers thought the currently registered post-harvest fungicides were not effectively controlling CER, and a loss of sensitivity to these fungicides has been suggested as a possible cause. This project aims to:

- develop a greater understanding of the factors contributing to CER
- improve post-harvest treatments
- provide growers with more management options to increase marketable yields.

Contact: Peter Trevorrow
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Call (07) 4048 4677

National Bunchy Top Project Phase 3

Funding: Horticulture Innovation Australia and Australian Government

Service provider: Peasley Horticultural Services

Start date: 15 June 2015

End date: 15 June 2019

Project summary:

Banana bunchy top disease is only found in Australia, from Byron Bay in northern New South Wales to Noosa in South East Queensland. Phase 3 of the 10-year project aims to remove the disease from commercial farms and protect farms from further outbreaks. The task is difficult due to airborne spread and the presence of the disease in backyard and feral banana plants, particularly in the Sunshine Coast region of South East Queensland.

Eradication is possible in New South Wales, where bunchy top is well under control in commercial plantations and any outbreaks are dealt with swiftly by trained inspectors. South East Queensland has fewer commercial plantations, but eradication is no longer feasible because of widespread infection in non-commercial plantings. The major objective now is stopping the spread of bunchy top to the growing region of Bundaberg, 250 km to the north.

Contact: David Peasley
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Call 0427 126 245

BBTV Mitigation: Community Management in Nigeria, and Screening Wild Banana Progenitors for Resistance

Funding: Bill & Melinda Gates Foundation

Service provider: Queensland Alliance for Agriculture and Food Innovation, The University of Queensland

Start date: November 2015

End date: December 2020

Project summary:

Banana bunchy top virus causes the most serious virus disease of bananas worldwide. Infection results in failure to produce a bunch and hence almost total yield loss. The disease is spread by the banana aphid and by the uncontrolled movement and use of infected planting material. Disease control is difficult and no natural immunity is known. Losses in the developing world can be very high, and in many areas of Sub-Saharan Africa they range from 50–100%.

This project has two major aims:

1. search for natural resistance sources in *Musa* germplasm from the centre of origin of the crop and pathosystem (South-East Asia)
2. develop and implement strategies for disease control at the community level in areas of high disease incidence in Nigeria and Benin, where bananas are grown for subsistence and local markets.

In addition, improvement of diagnostics will be investigated, including in-field applications.

Contact: Dr John Thomas
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Call (07) 3255 4393

Scoping Herbicide Impacts on Banana Production and Soil Health

Funding: Horticulture Innovation Australia and Australian Government

Service provider: Department of Agriculture and Fisheries (Queensland)

Start date: 28 February 2014

End date: 30 August 2016

Project summary:

As banana producers reduce inputs, such as nitrogen-based fertilisers and agrochemicals, the functions of soil become increasingly important to retain productivity. The objective of this project is to characterise the impacts of registered herbicides used in the banana industry on soil ecology, soil functions and plant productivity. The potential functional impacts of herbicides on soil and plant health are being characterised using state-of-the-art molecular microbiological techniques, microbe-mediated functional rate assays and glasshouse experiments.

The information gathered on the effects of different herbicides will facilitate the preparation of a draft herbicide risk analysis tool. This may lead to alternative weed management strategies that maximise the contribution of soil micro-organisms to the maintenance of healthy soils and productive banana plantations.

Contact: Tony Pattison
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Validation of Greenhouse Gas Reduction Methods in Banana and Mango Tree Crops across Tropical Queensland, Northern Territory and Western Australia

Funding: Australian Government, as part of the Action on the Ground initiative

Service providers: Department of Agriculture and Fisheries (Queensland), Northern Gulf Resource Management Group, Department of Natural Resources and Mines (Queensland), James Cook University and Terrain NRM

Start date: December 2013

End date: December 2017

Project summary:

Management changes that can help growers store carbon and reduce greenhouse gas emissions will result in significant improvement to the adaptability of agriculture to climate change across northern Australia. This project will trial and demonstrate farm practices—including the use of precision agriculture, ground covers and nitrification inhibitors—to reduce nitrous oxide emissions and increase soil carbon in banana and mango cropping systems in North Queensland, the Northern Territory and Western Australia.

The banana component of the project will focus on monitoring changes in nitrous oxide emissions and soil biology when ground cover is allowed to grow around the base of plants, and nitrification inhibitors and different rates of fertiliser are used.

Contact: Dr Geoff Dickinson
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Call (07) 4048 4762

Reef Rescue Phase 2

Funding: Australian Government

Service provider: Australian Banana Growers' Council (through Terrain)

Start date: 10 October 2013

End date: 30 June 2016

Project summary:

The federal government funded this project as part of the Reef Rescue program. The Australian Banana Growers' Council worked with Terrain to provide banana growers access to a grants and extension program that delivered best practice in nutrient and sediment management for improved water quality outcomes on the Great Barrier Reef.

Over three years, the extension effort has encouraged growers to adopt contouring, permanent beds and efficient fertigation systems, and match nutrient application with crop requirements. The program has also helped banana growers access 80 incentive grants. The grants have complemented the extension effort and specifically targeted management practices that reduce nutrient and sediment loss.

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Tools and Extension for Adoption of the Banana Best Management Practice

Funding: Department of Environment and Heritage Protection (Queensland)

Service provider: Australian Banana Growers' Council

Start date: 20 June 2015

End date: 30 August 2017

Project summary:

This project aims to provide economic benefits for growers, provide safeguards for farms against Panama disease tropical race 4 and improve water quality outcomes for the Great Barrier Reef. It will develop an app that growers can use in the paddock to record and manage information about farm practices, such as applications of nutrients and crop care chemicals.

It will be a quick and easy way to implement best management practices on farm. The app will be supported by an extension program that will provide practical advice about fertigation systems, correct matching of fertiliser to leaf and soil tests, and the best way to manage ground covers to prevent run-off from paddocks.

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Call 0447 000 203

Multi-scale Monitoring Tools for Managing Australian Tree Crops: Industry Meets Innovation

Funding: Horticulture Innovation Australia and the Australian Government Rural Research and Development for Profit program

Service providers: Collaborators on this project include University of New England, The University of Queensland, Central Queensland University, The University of Sydney, Department of Agriculture and Fisheries (Queensland), Department of Science, Information Technology and Innovation (Queensland), AGtrix, Simpson Farms, Australian Mango Industry, Association Australian Macadamia Society and Avocados Australia

Start date: 1 April 2015

End date: 30 June 2018

Project summary:

This is a multi-stakeholder, multi-industry, collaborative project that will deliver Australia's tree crop industries with:

1. a national audit capability framework identifying the location, area and tree population of every commercial avocado, mango and macadamia orchard across Australia
2. a farm-level decision support tool utilising satellite image data streams and novel on-ground sensor systems, including machine vision and robotic platforms for mapping fruit yield and quality, tree health and inflorescence counts.

A raft of sub-projects will also be conducted under this initiative. One such project will involve an evaluation of non- invasive technologies (satellite imagery and field-based spectroscopy) for tree health and Panama disease tropical race 4 in bananas. This research will be conducted in the Lakelands and Tully growing regions.

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Nuffield Australia Farming Scholarships

Funding: Horticulture Innovation Australia, Australian Government and the Australia Banana Growers' Council

Service provider: Nuffield Australia Farming Scholarships

Start date: 2016

End date: 2018

Project summary:

Nuffield Australia awards scholarships each year to people in the agricultural and horticultural industries. Successful applicants travel overseas on a research scholarship relating to primary production. It's a 16-week program consisting of group and individual travel, spread over an 18-month period. The objectives are to increase production knowledge and personal and management skills. It's a unique opportunity to stand back from day-to-day business operations and study a relevant primary industry subject.

Banana growers Matthew Abbot and Paul Inderbitzen have been successful recipients of scholarships.

Scholarships are open to men and women between 28 and 40 years of age, who must ordinarily be a resident of Australia and engaged in farming as an owner, manager or active member of a farm business. Applications open on 1 April and close on 30 June annually.

Contact: Jim Geitch
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Call (03) 5480 0755

The Fruit Salad Project: Soil Amendments in Fertigated Melons, Blueberries and Banana Production

Funding: Department of Agriculture and Water Resources (Australia)

Service providers: Department of Primary Industries (New South Wales), Department of Agriculture and Fisheries (Queensland) and Southern Cross University

Start date: 1 October 2013

End date: 4 April 2017

Project summary:

Horticultural industries are searching for effective ways to increase soil carbon, as it provides many benefits such as extra soil moisture, better nutrient cycling and improved soil structure. Biochar is a charcoal-like material that is very high in stable carbon, and compost is made up of a range of carbon compounds.

Both soil amendments have shown promise in early trials—but how effective are they on farm? The project was designed to test this and the effectiveness of reducing the greenhouse gas nitrous oxide when fertilisers are applied to the soil. Soil properties, gas, bunch weights and nutrients are monitored at two sites in New South Wales. Early results show biochar significantly reduces nitrous oxide.

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Market Development of Recycled Organics in Bananas and Blueberries

Funding: Environment Protection Authority (New South Wales) as part of the Waste Less, Recycle More initiative (funded by the waste and environment levy)

Service provider: Department of Primary Industries (New South Wales)

Start date: 1 November 2015

End date: 30 June 2017

Project summary:

Almost half of household waste destined for New South Wales landfills consists of food and garden organic waste—and space in landfills is rapidly running out. Burying organic material is a waste of valuable resources. Many facilities are now taking this food and garden waste and turning it into compost, so this project hopes to complete the cycle and re-use it in horticulture.

Despite much evidence that shows increasing soil organic matter levels in banana and blueberry production systems can improve productivity, application on the steep production systems in New South Wales has been impractical. This project will investigate new compost application technologies and collect further information on the benefits of compost.

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Call 0438 644 136

Micronutrient Biofortified Cooking Bananas for East Africa

Funding: Bill & Melinda Gates Foundation

Service providers: Queensland University of Technology and the National Agricultural Research Organisation of Uganda

Start date: July 2005

End date: 2020–2021

Project summary:

Micronutrient deficiencies are rated as the third most important public health problem in the world, despite extensive investment in food fortification and supplements. An additional strategy, biofortification, is to provide those micronutrients in staple foods.

In Uganda, the staple food is cooking bananas known as East African Highland bananas. Importantly, clinical vitamin A deficiency is running at around 30% in children under five and women of child-bearing age. The objective of the project is to develop East African Highland bananas with sufficient pro-vitamin A to meet 50% of daily requirements.

The Queensland University of Technology developed the technology in Cavendish through to field trials in North Queensland. This technology has been transferred to Uganda, where advanced field trials are currently being harvested and analysed. The target release date to Ugandan farmers is 2021.

Contact: Professor James Dale
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Call 0410 520 269

Carton Management in the Banana Industry

Funding: Horticulture Innovation Australia and Australian Government

Service provider: Kitchener Partners

Start date: September 2014

End date: December 2015

Project summary:

It is estimated that fruit waste at retail stores can be reduced from current levels of 5–8% down to 2–5%. If waste can be reduced by 2.5%, this presents industry with a potential annual saving of $23 million and an opportunity for this volume of fruit to transfer into additional retail sales.

The project confirmed that the 15 kg 1-piece carton is the most cost-effective means for transporting bananas while minimising fruit damage, as long as the following criteria are met:

- The appropriate carton is used in terms of materials and construction, with particular focus upon side wall strength, moisture resistance and ability to be cross-stacked.
- The appropriate amount and type of secondary packaging is used, including corner posts, pallet strapping, slitted bags and sap paper.
- The appropriate packing methodology is employed, ensuring fruit is packed tightly to avoid rub marking and extra-large fruit are packed in the bottom row and placed on their side.
- The ripening process is closely monitored and a minimum 6-day ripening cycle is used.

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Strategic marketing plan

The 2015–2016 Australian banana marketing plan will build on snacking moments by establishing the benefits of 'purposeful energy' in the current lifestyles of consumers. The new vision for the marketing plan is 'one more banana'—it targets people aged 25 to 39 and families with at least one child under 13.

Appendix 4: Demonstration sites

Appendix 4.1: Use of soil amendments to promote soil biological activity and suppression of plant parasitic nematodes in bananas (NQ)

Background

Soil amendments have been shown to change soil physical, chemical and or biological characteristics in banana production. However, the availability and cost of the amendments can restrict their use so there needs to be a clear return on the investment from the use of amendments either in the terms of productivity or suppression of pests and diseases. The use of amendments that were high in carbon has been shown to reduce populations of burrowing nematode in bananas in glasshouse trials. Furthermore, use of mill-ash, a by-product from sugar process, was demonstrated to improve soil physical conditions in small plot trials. The use of compost is also gaining interest within the banana industry, although quality of compost produced may be variable between sources. The aim of this grower demonstration field trial was to use available soil amendments to develop soil biological conditions that suppress plant-parasitic nematodes through changes to soil biological activity with no negative effects on banana productivity.

The trial used large un-replicated pots to demonstrate impacts of the amendments on banana growth and production. Assessments of soil biological activity and suppression of plant-parasitic nematodes commonly found on bananas in Australia were made throughout the trial.

Methods

A field trial was established on a grower's property in north Queensland consisting of large un-replicated plots (100m double row plots) to demonstrate the impacts of soil amendments on banana growth, production and soil biological characteristics. Image 1 shows the trial layout. Eight different soil amendment treatments were applied to each respective plot:

T1 = Hay mulch applied to surface
T2 = Japanese millet (or other grass) grown as companion crop with the plant bananas
T3 = Control (no compost, no additional amendments, soil as is).
T4 = Compost soil surface application
T5 = Mill-ash surface application
T6 = Mill-ash incorporated
T7 = Select carbon (compost + biochar mix) 5 t/ha surface application
T8 = Select carbon (compost + biochar mix) 5 t/ha incorporated

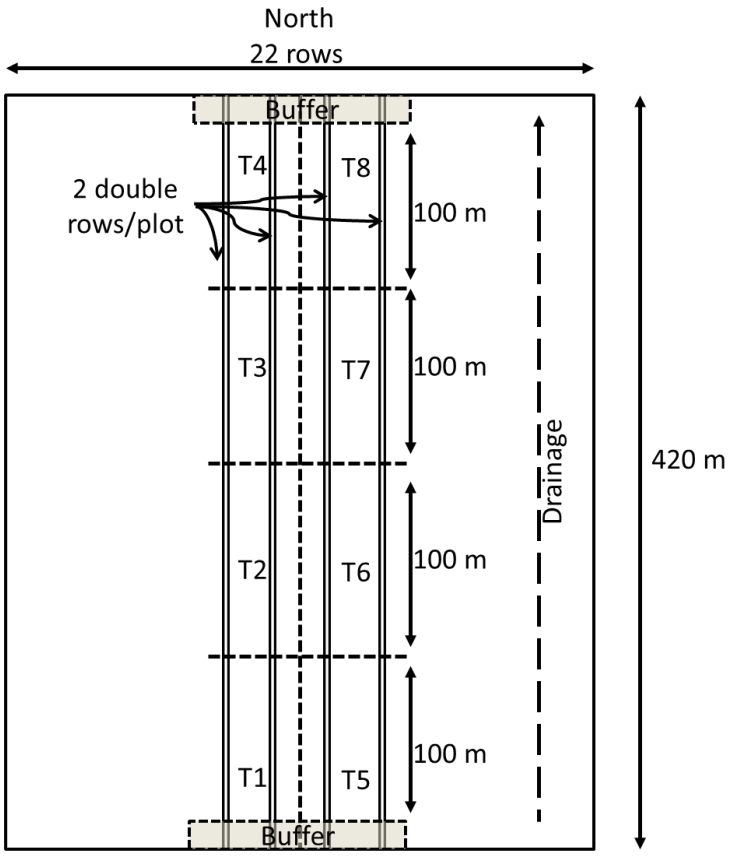

Figure 1: Field demonstration trial layout

The initial plan was to monitor soil physical (particle size analysis, water infiltration, bulk density, penetrometer), chemical (available nutrients, pH, EC, organic C – IncitecPivot), biochemical (Labile C, FDA, β-glucosidase, MicroResp) and biological (Soil nematode community analysis) on a six monthly basis. There was also a plan to conduct plant-parasitic nematode bioassays (*Radopholus similis, Pratylenchus goodeyi, Meloidogyne javanica, Rotylenchulus reniformis)* on an annual basis. In terms of monitoring the agronomic and production characteristics 10 plants were randomly selected from each plot (5 on the east and 5 on the west side of the double row) and the height (monthly), leaf emergence rate (monthly), time to bunching, time to harvest, finger number and bunch weights were to be recorded. Normalized Difference Vegetation Index (NDVI) assessment was also planned to be measured using a hand held GreenSeeker® on the third most recently unfurled leaf on a monthly basis.

The trial was planted using tissue culture plants on the 4th of September 2014. It was anticipated that this trial would run for almost the duration of the project (till July/Aug 2016) and that several crop cycles could be monitored. Unfortunately Panama disease tropical race 4 was detected on the 3rd of March 2015. Due to growers implementing strict on-farm biosecurity practices to minimise the risk of the disease entering their properties access to this trial site ceased. However, some initial soil results were captured and are presented. Similarly the agronomic characteristics (height, leaf emergence and NDVI) were measured from the 26/11/2014 – 25/02/2015).

Results

Soil physical characteristics: The soil was determined to be a clay loam, dermosol. The percentage of soil fractions are shown in table 1.

Table 1: Soil particle fraction percentage with standard errors		
Soil fraction	%	± SE
Clay	37	± 0.8
Silt	29	± 0.4
Sand	35	± 1.2

Soil Moisture: Mill-ash applied to the surface as well as incorporated had significantly higher soil moisture at nearly all 6 time points in which soil moisture was measured. The surface application on four occasions has significantly higher soil moisture than treatments with the incorporated mill-ash (Table 2).

Table 2: Soil moisture between soil amendment treatments.
*Values with different letters are significantly different from one another.
**Green highlighted amendment is significantly higher than the bare control.

	Soil Moisture (%) 26/11/2014	Soil Moisture (%) 23/12/2014	Soil Moisture (%) 9/01/2014	Soil Moisture (%) 14/01/2015	Soil Moisture (%) 23/01/2015	Soil Moisture (%) 25/02/2015
Hay mulch applied to surface	16.1b	13.11ab	27.4a	17ab	12.3ba	13.5c
Japanese millet	14.2ab	12.6a	26a	15.3a	7.2a	4.41a
Control	12.3ab	8.28a	24.2a	19.8bc	8a	6.3ab
Compost soil surface application	13.5ab	11.54a	22.2a	14a	8.9ab	7.6b
Mill-ash surface application	30.3d	27.2c	47.7b	22.8c	18.3d	18.4d
Mill-ash incorporated	25c	19.4b	29a	23.3c	14.9cd	16.9d
Select carbon (compost + biochar mix) 5 t/ha surface application	12.1ab	9.57a	22.3a	14.7a	7.6a	8.4b
Select carbon (compost + biochar mix) 5 t/ha incorporated	10.9a	8.69a	23a	16ab	6.7a	7.7b

Growth (height difference): In the first month, plants which had mill ash application (both surface and incorporated) grew significantly faster than all other treatments in this period. This was again the case for the mill-ash which was incorporated as it grew significantly quicker than all other treatments in the second month. The hay mulch applied to the surface also grew significantly quicker than the bare control in this period and

again in the third month. In the third month the mill-ash applied to the surface and also the select carbon incorporated amendment also grew faster than the bare earth control (Table 3).

Table 3: Growth characteristics between soil amendment treatments.
*Values with different letters are significantly different from one another.
**Green highlighted amendments are significantly higher than the bare control.

	Growth between 26/11/2014 and 23/12/2014 (cm/week)	Growth between 23/12/2014 and 23/01/2015 (cm/week)	Growth between 23/01/2015 and 25/02/2015 (cm/week)
Hay mulch applied to surface	11.7ba	11.3d	8.7c
Japanese millet	11.9bc	10.2cd	7.6ab
Control	10.2ab	10.0c	7.0a
Compost soil surface application	10.2ab	10.0bc	7.6abc
Mill-ash surface application	12.5cd	8.7a	8.3bc
Mill-ash incorporated	14.2d	12.8e	8.0abc
Select carbon (compost + biochar mix) 5 t/ha surface application	10.8abc	9.3abc	7.1a
Select carbon (compost + biochar mix) 5 t/ha incorporated	9.1a	8.8ab	8.4bc

Leaf Emergence (LER): There was more subtle differences in the LER of banana plants under different soil management practices. In the first month the mill-ash incorporated treatment produced significantly more leaves than the control. The only other significant difference was noted in the 3rd month in which the mill ash applied to the surface produced significantly more leaves than the control (Table 4).

Table 4: Leaf emergence between soil amendment treatments.
*Values with different letters are significantly different from one another.
**Green highlighted amendments are significantly higher than the bare control.

	Leaf emergence between 26/11/2014 and 23/12/2014 (leaves/week)	Leaf emergence between 23/12/2014 and 23/01/2015 (leaves/week)	Leaf emergence between 23/01/2015 and 25/02/2015 (leaves/week)
Hay mulch applied to surface	1.4c	1.1a	0.9a
Japanese millet	1.4bc	1.2ab	0.9ab
Control	1.4abc	1.2b	0.9ab
Compost soil surface application	1.4bc	1.2ab	0.9ab
Mill-ash surface application	1.4ab	1.2b	1.0c
Mill-ash incorporated	1.5d	1.2b	0.9a
Select carbon (compost + biochar mix) 5 t/ha surface application	1.4abc	1.2ab	0.9ab
Select carbon (compost + biochar mix) 5 t/ha incorporated	1.3a	1.2b	1.0bc

Normalized Difference Vegetation Index (NDVI): There was only one significant difference in the NDVI of the third fully emerged leaf. This occurred on the 26/11/2014 at the beginning of the trial where plants in the plots with the incorporated mill-ash produced a significantly higher value than plants in the bare control (Table 5).

Table 5: NDVI between soil amendment treatments.
*Values with different letters are significantly different from one another.
**Green highlighted amendment is significantly higher than the bare control.

	NDVI (26/11/2014)	NDVI (23/12/2015)	NDVI (23/1/2015)	NDVI (25/02/2015)
Hay mulch applied to surface	0.69cde	0.69	0.70c	0.72ab
Japanese millet	0.69cde	0.68	0.69abc	0.72ab
Control	0.66bcd	0.69	0.71c	0.75c
Compost soil surface application	0.72de	0.70	0.66a	0.74bc
Mill-ash surface application	0.59ab	0.66	0.70bc	0.73abc
Mill-ash incorporated	0.74e	0.75	0.71c	0.71a
Select carbon (compost + biochar mix) 5 t/ha surface application	0.64abc	0.70	0.67ab	0.74abc
Select carbon (compost + biochar mix) 5 t/ha incorporated	0.57a	0.66	0.66ab	0.72ab

Results and discussion

Although this trial was cut very short due to the detection of Panama disease TR4 in north Queensland, and the subsequent on-farm biosecurity practices that growers implemented immediately following the detection, several important results and observations were made. Mill-ash as shown in previous trials again showed the capacity to alter the physical properties of the soil and enhance its water holding capacity. The mill-ash reduced the peaks and troughs in soil moisture fluctuations. In fact the lowest soil moisture content observed over the 6 time periods wasn't much lower than the highest soil moisture content observed under the control treatment. The mill-ash treatments also at times resulted in faster growth and slightly faster leaf emergence. The data suggests that there is a larger internode distance between leaves therefore the plants growing in soil amended with mill-ash have more vigour. When the trial was ended the only treatments with emerged bunches were both the mill-ash treatments, although this was an observation only due to the trial being cut short. Hay mulch applied to the surface also produced some significant changes in growth and soil moisture throughout the trial period. Biochar and compost applied to the surface at 5t/ha did not produce any significant results. Biochar is an expensive amendment and therefore unless the price reduces it would not be economically viable to apply this at a higher rate with no demonstrable return on investment in terms of productivity based on the short period of assessment in this trial. Of these soil amendments it would be interesting to demonstrate the use of mill-ash and hay mulch for longer into the cropping period. However consideration would need to be taken to determine the biosecurity risks associated with bringing these external inputs onto the farm.

Acknowledgements

Thank you to Shayne and Danny Cini who allowed this demonstration trial to be conducted on their property. Also thank you to Tony Pattison (Queensland Department of Agriculture and Fisheries) who established and ran the trial in conjunction with Tegan Kukulies (Queensland Department of Agriculture and Fisheries).

Appendix 4.2: Demonstration trial comparing agronomic and quality characteristics of 4 Cavendish varieties with reported Panama disease TR4 resistance to the industry standard variety Williams.

Background

This report presents the results of a 2.5 year observation trial comparing the performance of four Panama disease TR4 tolerant varieties to the industry standard Williams Cavendish under commercial production conditions in Tully (Figure 1.).

Banana production in the presence of Panama disease TR4 requires genetic resistance to ensure production is feasible. While some banana varieties have been identified with high or very high resistance to Panama disease TR4 they do not produce fruit that is readily accepted in the Australian market. A range of Cavendish varieties with varying levels of resistance have been identified as possibly suitable but their agronomic and production characteristics were not well known under commercial conditions. This observation sought to compare a range of agronomic and quality characteristics of 4 alternative Cavendish varieties with reported resistance or tolerance to Panama disease TR4 to the industry standard variety Williams.

Methods

Tissue-cultured plants of 4 different Cavendish varieties and Williams Cavendish were planted on 22nd October 2012 at Leahy Bananas, Tully. High levels of off-types in some varieties meant that not all of the 50 plants intended for planting were available. The 5 varieties planted were:

- GCTCV 218 (Taiwan)
- GCTCV 119 (Taiwan)
- CJ 19 (Indonesia)
- DPM25 (Australia)
- Williams – industry standard variety

Figure 1. Demonstration trial at Leahy Bananas, Tully

Data was collected on agronomic and production characteristics; for bunch weight and fruit length from 10 datum plants for plant and first ratoon crops for most varieties, and from the whole plant population for cycle times, hand number, finger number and plant height, until the Panama disease TR4 incursion in Tully in March 2015 precluded further access to the site. Data collected included:

- Crop cycle data - time from planting to bunch emergence and harvest
- Bunch size data – hand number (untrimmed), finger count for hand 3, bunch weight at harvest (10 datum plants)
- Fruit size data – finger length for each hand at harvest (10 datum plants)
- Plant size data – plant height at bunching

The different varieties displayed differing crop cycle times which meant that not all varieties had completed the same number of crop cycles when the trial was concluded. The Panama disease TR4 incursion meant that banana producers needed to secure their farms to manage the risk of disease incursion. All non-essential access was ceased and not resumed until biosecurity protocols and infrastructure were implemented. As such data collection from the trial was ended in March 2015.

Results

Crop cycle times

Williams and DPM25 were the fastest cycling of the 5 varieties grown with very similar results in the plant and first ratoon crop cycles. CJ19 had the next fastest cycle time, followed by GCTCV 218 and then GCTCV 119 with a crop cycle exceeding 60 weeks (Figure 2.). No data was collected for GCTCV 119 beyond the plant crop due to the destruction of the plot during a thunderstorm in December 2014. First ratoon data for GCTCV 218 and second ratoon data presented for Williams were not complete at the time of the Panama disease TR4 incursion.

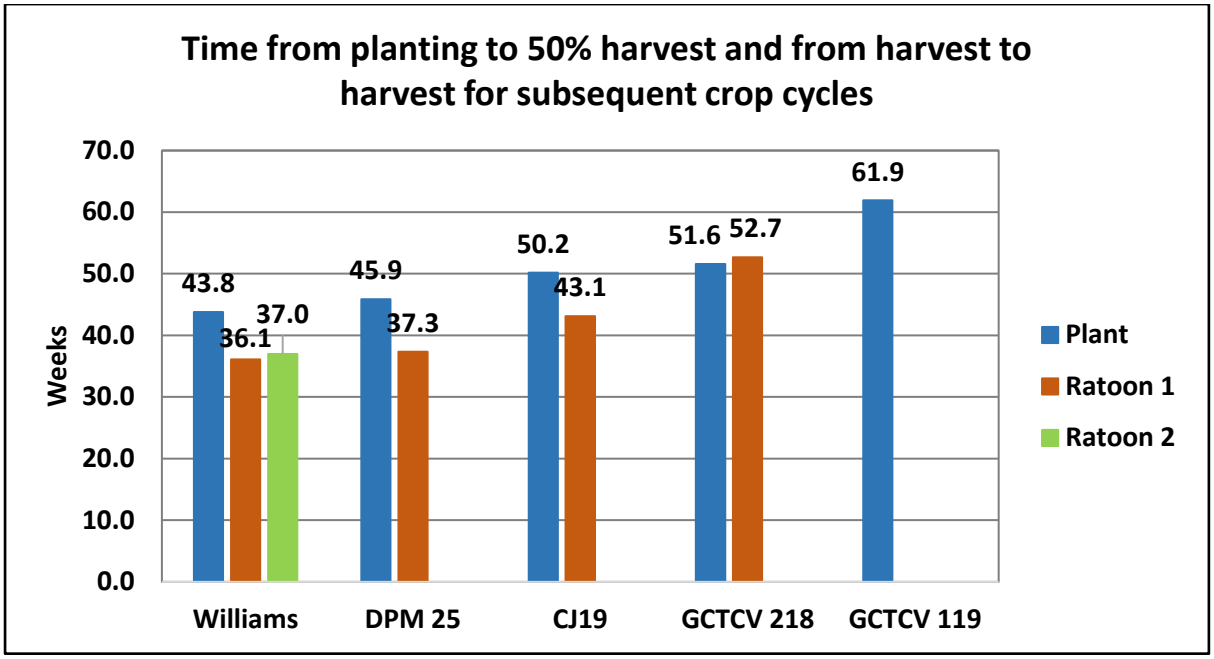

Figure 2: Comparison of the time from planting to 50% harvest and from harvest to harvest of subsequent crop cycles of 5 Cavendish varieties with varying levels of Panama disease TR4 tolerance

Bunch size data

Bunch weights in the plant crop were similar across all the varieties with GCTCV 218 and Williams mean values over 19 kg and CJ19 next highest averaging 18.7 kg. GCTCV 119 averaged the smallest bunches at 17.3 kg (Figure 3). In the first ratoon crop the difference in bunch sizes was very pronounced with Williams having the highest mean of 32 kg, closely followed by GCTCV 218 with 27.4 kg and then DPM25 with 24 kg. CJ19 and GCTCV 119 both produced small bunches in their ratoon crops, although a full data set for GCTCV 119 was not obtained due to storm damage.

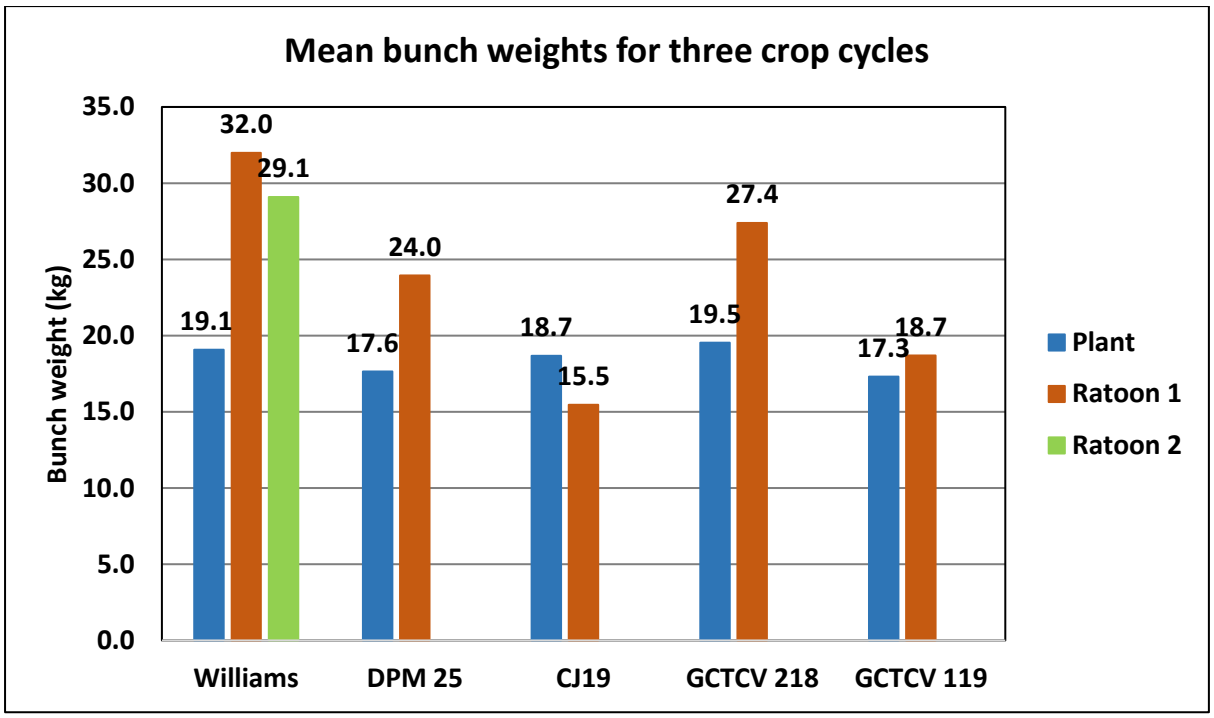

Figure 3: Mean bunch weights for three crop cycles of 5 Cavendish varieties with varying levels of Panama disease TR4 tolerance

Generally the smaller bunch weights for these varieties were a product of shorter fruit and fewer hands per bunch (Figure 4). First ratoon bunch weights, hand number and third hand finger length for CJ19 reduced significantly from the plant crop. This reflects the effect of very poor plant growth of this variety during persistently cool, cloudy and wet conditions during the autumn and winter period (Figure 5). DPM25 and GCTCV 218 both produced bunches with third hand fruit length comparable to or better than Williams during the first 2 crop cycles. GCTCV 119 consistently produced bunches with fewer hands and shorter fingers than Williams, DPM25 or GCTCV 218 in each respective crop cycle.

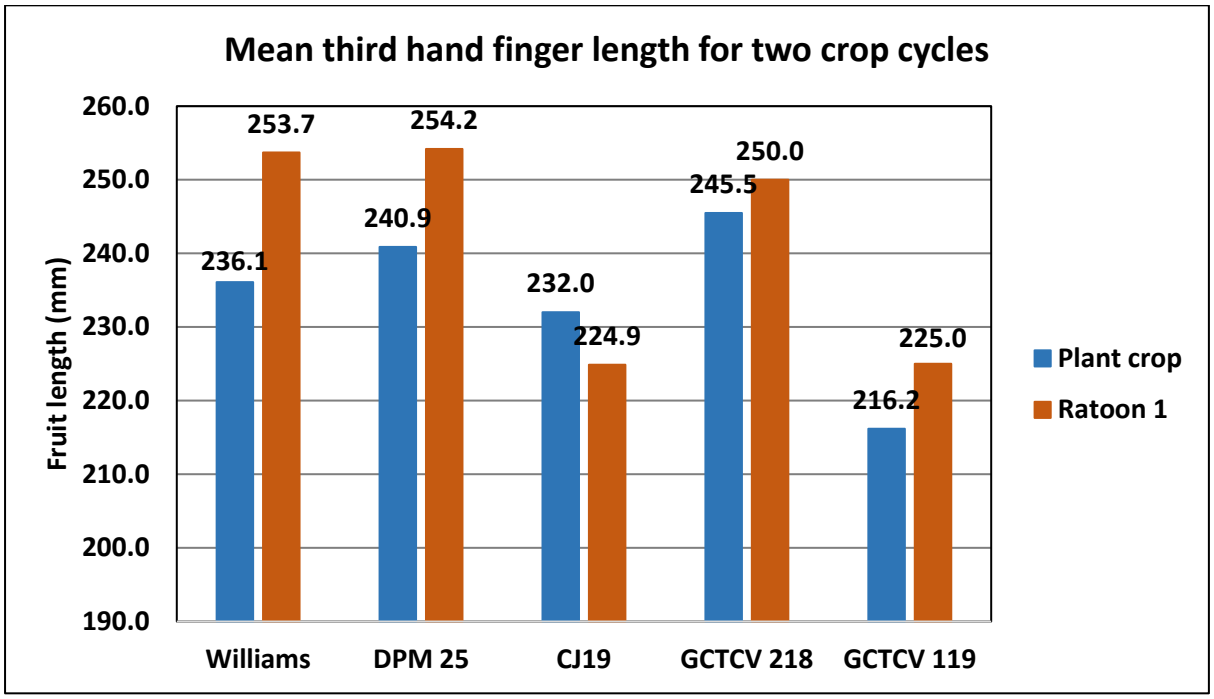

Figure 4: Mean third hand finger length for three crop cycles of 5 Cavendish varieties with varying levels of Panama disease TR4 tolerance

Figure 5: CJ19 plants in their first ratoon crop showing severe choking of the leaf canopy due to sub-optimal environmental conditions

Plant stature

As a dwarf variety CJ19 had the shortest plants in each of the crop cycles (Figure 6 & 7). Around 10% of the CJ19 plants presented as somaclonal variants with taller plants and improved bunch size and shape (Figure 8). Williams and DPM25 were virtually indistinguishable as the next tallest varieties. GCTCV 218 had a mean height about 20 cm taller than Williams and DPM25 in the plant and first ratoon crops. GCTCV 119 was significantly taller than the other varieties in both the plant and ratoon crops although most plants did not survive for the first ratoon assessment. GCTCV 119's plant height, slender pseudostem and tendency to shallow root anchorage resulted in effectively 100% plant loss in December 2014 when the plot experienced strong winds associated with a thunderstorm (Figure 9). The extreme susceptibility of GCTCV 119 to losses due to strong winds has been reported internationally as well.

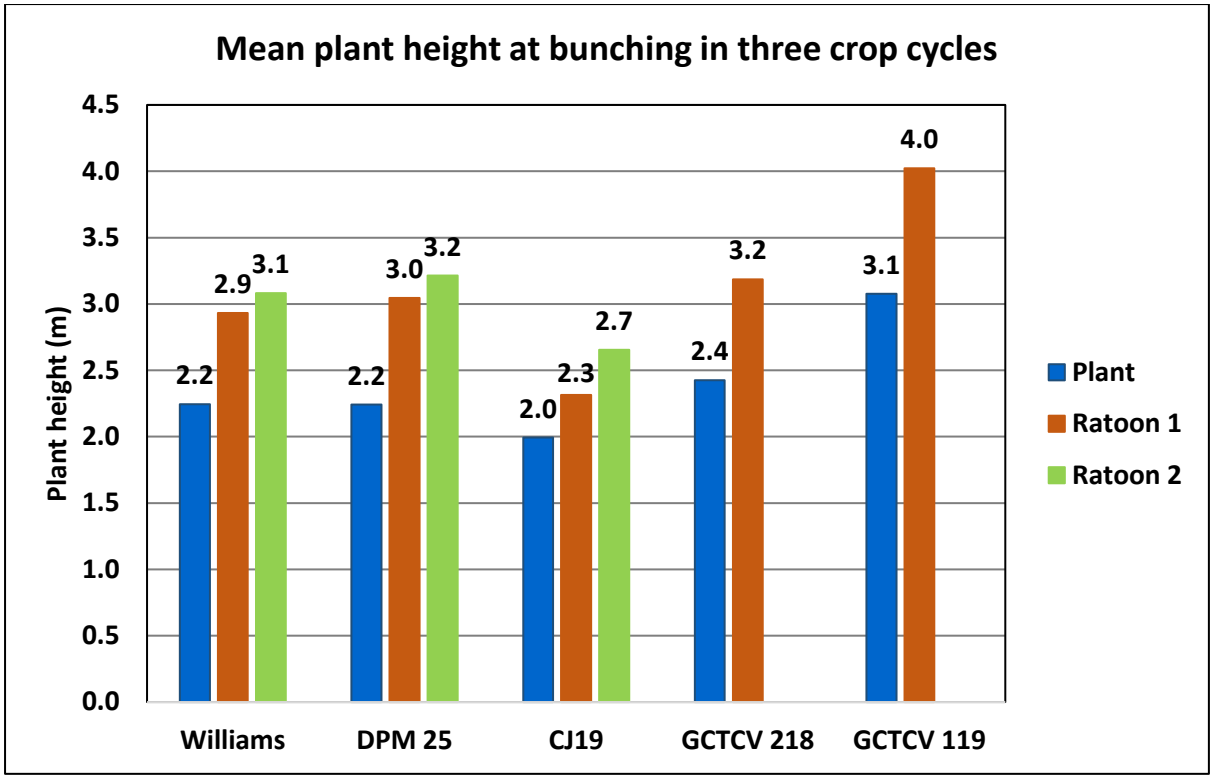

Figure 6: Mean plant height at bunching for three crop cycles of 5 Cavendish varieties with varying levels of Panama disease TR4 tolerance

Figure 7: CJ19 in the plant crop demonstrating the dwarf stature of this variety

Figure 8. One of the somaclonal variants of CJ19 characterised by taller plants with bigger bunches

Figure 9: The trial plot of GCTCV 119 was destroyed by wind damage from a thunderstorm in December 2014 during its first ratoon cycle. Note plots of CJ19 and Williams in the background were unaffected by the same winds.

Observations and conclusions

Williams was the most productive variety because of its faster cycle times and larger bunches. Productivity data calculated as tonnes per hectare per year (assuming plant density of 1700 plants per hectare for all varieties except GCTCV 119 at 1200 plants per hectare) is presented in Table 1. This comparison takes account of the difference in crop cycle times and bunch sizes.

Table 1. Comparison of productivity as gross yield per hectare per year

Variety	Gross yield (t/ha/yr)	
	Plant crop	First ratoon
Williams	38.5	78.3
DPM25	34.0	56.7
CJ19	32.9	31.7
GCTCV 218	33.5	46.0
GCTCV 119	17.4	N/A

The faster cycle times for Williams may have been influenced by the plot position on an outside row where shading was significantly reduced compared to other plots within the small block.

CJ19 responded very poorly to cold weather and prolonged wet and overcast conditions. The reductions in growth rates were reflected in very significant reductions in bunch size and finger length in the first ratoon crop. The identification of tall off-types with improved bunch characteristics in the plot suggests it is worth identifying improved somaclones of this variety for further screening against Panama disease TR4 to see if they retain or improve their current resistance.

DPM25 was virtually identical to Williams for the measured characteristics. While the data suggests it may have a slightly slower crop cycle this may be the result of shading within the block. An observation made during the first ratoon crop was that the DPM25 seemed to have less maturity bronzing than Williams, although this was not quantitatively assessed.

GCTCV 218 had bunch weights and finger length comparable to Williams and DPM25 but demonstrated a much longer crop cycle period. The 50 sample plants demonstrated a high level of unfavourable off-types and the leaf canopy tended to choke in the ratoon crop. Harvest data for the first ratoon crop was not completed when the trial ceased.

GCTCV 119 was very tall, spindly and exceedingly slow to bunch compared to all the other varieties. This resulted in the plants being very susceptible to wind damage which resulted in the loss of the plot during the first ratoon crop cycle. The bunches of GCTCV 119 were small with shorter finger lengths than the other varieties. A number of off-types affecting bunch characteristics both favourably and unfavourably were evident in the plot. Some plants demonstrated improved bunch and hand shape and formation while others presented with “false” or transition hands for the entire bunch.

The observation trial confirmed the view that none of the alternative Cavendish varieties is as productive as Williams in an uninfected situation. This reinforces the value of biosecurity practices that exclude the disease to maintain productivity. There is value in continuing to assess alternative varieties in commercial production to compare their relative performance under a range of agro-climatic conditions. Reports from a producer on the Atherton Tablelands has indicated that DPM25 has faster crop cycles that Williams under their cooler and drier conditions which emphasises the need for producers to undertake this kind of assessment. Importantly, the accurate measurement and recording of key parameters is fundamental to extracting maximum value from any on-farm activity. It is also important for regular inspection to identify any off-types with favourable attributes as this offers the opportunity to improve a range of characteristics through recurrent selection. This approach forms the basis of the improvement program at the Taiwan Banana Research Institute that produced the GCTCV selections and has produced improved lines from these in Indonesia, China and the Philippines. Any improved selections could be assessed for their disease resistance through the industry-funded plant protection program.

Appendix 4.3: Soil amendment demonstration trials in NSW

Introduction

Poor soil health, due to physical, chemical or biological constraints, is a significant limitation to sustainable banana production in northern New South Wales (NNSW).

In April 2012, Tony Pattison from QDAF, as part of a soil health review for the Banana Plant Protection Program (BA10020) in conjunction with NSW DPI researchers and extension staff, held a field day at Tullera, near Lismore. This filed day detailed the theory of soil health, current research and recent research findings. A survey conducted at this field day identified Panama disease as a major constraint for the majority of the Ladyfinger growers. Managing soil pH was also identified as a constraint. The impact of nematodes on crop production however was largely unknown and a significant proportion of growers did not regard nematodes as a problem.

An immediate recommendation from the soil health review was to establish a farming systems experiment to improve orchard floor ground covers around the base of Ladyfinger bananas to determine if this could reduce Panama disease incidence, reduce erosion and improve nutrient recycling. Long-term recommendations were for the industry to establish farming system experiments and demonstrations with the aim of managing multiple soil constraints, with an emphasis on the suppression of soil borne diseases.

Based on these recommendations, two soil health trials were established in NNSW. The first in a Ladyfinger plantation at Palmwoods, in the Brunswick production area, compared the addition of compost and groundcovers to the grower's standard treatment of synthetic fertilisers and managing the interrow weeds with herbicides. The second in a Cavendish plantation at Woolgoolga compared the addition of compost and chicken manure to the grower's standard practice of synthetic fertilisers only. There is evidence that compost and other organic amendments reduces nematodes and improves soil health in northern Queensland production regions.

Methods

Palmwoods

The Palmwoods site was chosen due to its proximity to Panama infected Ladyfinger bananas. The site had a relatively uniform aspect and slope (Figure 1) and the soil texture was a silty loam. The planting was a single row with rows 4m apart and plants 3m apart within the rows. Three treatments were applied; 1) no amendments, 2) surface applied compost and 3) seeded groundcover species. There were three replicates of each treatment. Each replicate consisted of two rows 30m long and contained 10 plants per row. Buffer rows were included between treated rows. Compost was sourced from Mara Seeds at Mallanganee and applied at a rate of 30t/Ha as a strip 1m either side of the plants on 11 April 2014 (Figure 2). An analysis of the compost is in appendix 1.1. For the ground covers a mix of annual ryegrass (*Lolium rigidum*) at 40 kg/ha and prilled, inoculated Haifa white clover at 25 kg/ha (*Trifolium repens*) was hand sown onto the entire plot area of the groundcover treatment to cover the entire row and inter row area (Figure 4). The ground cover species were selected for site suitability, as Haifa white clover was recommended by the grower and was already growing at the site and Annual ryegrass is compatible with clover in improved pasture situations.

Figure 1: Trial site at Palmwoods.

Figure 2: Groundcover species growing at Palmwoods.

Figure 3: Compost applied along the row at Palmwoods.

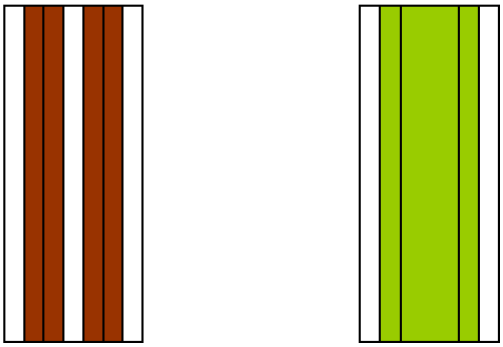

Figure 4: Treatment design at Palmwoods.

Soil sampling and analyses

Soil was sampled just prior to trial establishment on 4 April 2014 and subsequently on 21 April 2015. Ten random soil samples were taken from the 0-10cm soil layer, across both rows of each plot with an auger, then thoroughly mixed and a subsample used for analysis. All soils were kept cool prior to analysis. Soil chemical properties analysed were total carbon and total nitrogen (Dumas), available phosphorus (Bray P), pH ($CaCl_2$), EC, CEC and exchangeable cations at the NATA accredited laboratory at Wollongbar Primary Industries Institute. Water holding capacity was determined by the addition of a known volume of water to a known mass of soil then the calculation of the total amount of water that is absorbed by the soil (Alef & Nannipieri 1998). Soil biological properties monitored were available (labile) carbon, microbial activity and nematode community structure. Labile C, nitrate-N and ammonium-N were determined only after 12 months.

Microbial activity was determined by the Fluorescein Diacetate (FDA) method (Schnurer and Rosswall 1982). The method is based on the ability of several enzymes (e.g. esterases, lipases, proteases), produced by bacteria or fungi, to split the FDA molecule, releasing fluorescein which can be measured fluorometrically (Fontvieille et al, 1991). Each soil sample was measured in triplicate and an average FDA result used.

Nematode numbers were measured from both soil and roots samples. Samples were taken on 10 June 2014, 2 months after application (winter), 27 October 2105, 18 months after application (Spring) and 21 March 2016, 23 months after application (early autumn) to determine if there was a seasonal effect on nematode prevalence. A soil cube 20 x 20 cm x 20cm deep was dug 30cm away from an unbunched follower sucker and the roots were bulked for analysis. Ten individual soil samples from close to the root in each plot were bulked, mixed well and a subsample collected for analysis. Soil and root samples were kept cool and nematode species and numbers were counted by Jenny Cobon at QDAF in Brisbane. Counts of plant parasitic nematodes were recorded from 200 mL soil and 100 g root samples.

Overall nematode diversity indices were calculated incorporating the parasitic and all of the free living nematodes. The diversity indices Shannon-Weiner diversity (H'), enrichment index (EI), structure index (SI) and the channel index (CI) were calculated for each plot for the 18 and 23 month samples. As well as diversity indices, nematode community structure was calculated as an effective, integrated indicator of soil fertility and health (Pattison et al., 2008). Counts of bacterial feeding nematodes, fungal feeding nematodes, plant parasites, predatory and omnivores were recorded and percentages of each were calculated. Treatments effects were determined using analysis of variance (ANOVA).

Woolgoolga

The Woolgoolga trial site was in a Cavendish planting on a farm where compost had not been applied for several years. The aspect and slope of the block were relatively uniform and the soil was silty loam (Figure 5). There were no rows in this block due to the management of the block. Three treatments were applied; 1) no amendment, 2) surface applied compost and 3) surface applied poultry manure. There were three replicates of each treatment. 15 plants were chosen from around a central stake to create a circular plot and each plant marked with flagging tape. Compost and poultry manure were applied around the base to 60cm out from each stem on 1 July 2014. Compost was sourced from Biomass Solutions, Coffs Harbour, poultry manure was sourced locally and with both applied at 30t/ha (Figure 6). An analysis of the compost and poultry manure is in appendix 1.2

Figure 5: Trial site at Woolgoolga.

Figure 6: Compost application around the base of each plant at Woolgoolga.

Soil and nematode sampling

Soil sampling occurred after establishment on 2 July 2014 and on 16 July 2015, 12 months after amendment application. Ten random soil samples were taken from the 0-10cm soil layer across each plot, bulked and a subsample taken for analysis. Soil chemical and biological properties were analysed as above. Initial nematode sampling occurred on 22 July (soil and roots) three weeks after establishment and samples were sent to Brisbane QDAF for parasitic nematode counts.

Bunch sampling

The bunch weight of plants identified in each plot occurred from 3 Feb 2015 to 17 October 2016, and were recorded by the owner on farm.

Results

Palmwoods

Both groundcover species established well at the Palmwoods site (Figure 7).

Figure 7: Ground cover treatment (left) and grower's standard treatment (right).

Soil chemistry

Total soil analyses before and after application are detailed in appendix 1.3. Compost changed several soil properties 12 months after surface application, improving soil health. There was less of an effect on soil properties under the groundcover treatments. The compost treatment increased soil pH and available phosphorous, nitrate N and Calcium and reduced aluminium availability. Surface application of compost had no effect on EC, Total C, Total N, K, Mg or ammonium-N. Compost also had no effect on microbial activity and labile C, or the water holding capacity of the soil. Ground cover treatments increased soil pH, Ca, nitrate-N and reduced Al availability.

After one year, pH in the soil under the compost increased to 5.3 from 5.1 initially, compared to the control of 4.7 which had fallen from 4.8 (Figure 8). This increase also explains the significant reduction in aluminium availability in the soil (Figure 10). Compost increased the soil available phosphorous to nearly double control levels (Figure 9) and doubled nitrate concentrations (Figure 11). Nitrate-N was also higher in the ground cover treatment. Water holding capacity ranged from 64-70% at the initial sampling time and after 12 months ranged from 70-78% but there were no significant effects due to the treatments (Appendix 1.3).

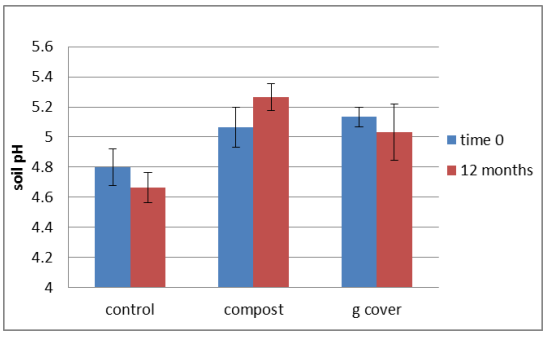

Figure 8: Soil pH at Palmwoods at time of establishment and after 12 months for the soil treatments.

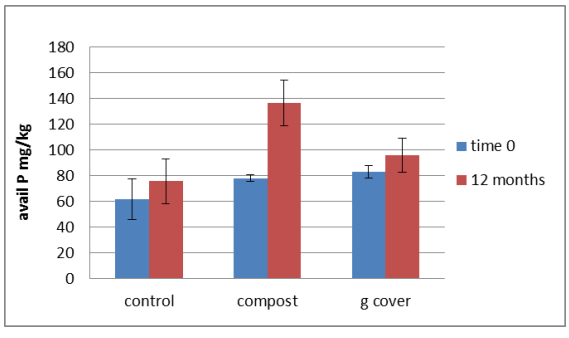

Figure 9: Soil available P (Bray) at Palmwoods at time of establishment and after 12 months for the soil treatments.

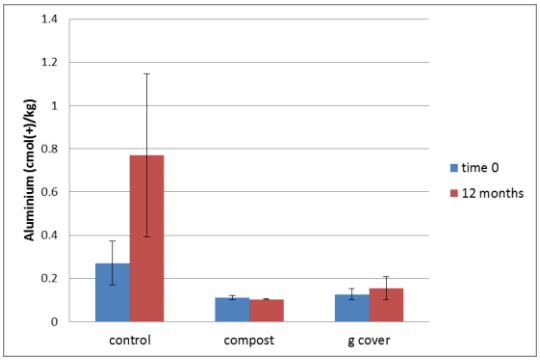

Figure 10: Soil Aluminium at Palmwoods at time of establishment and after 12 months for the soil treatments.

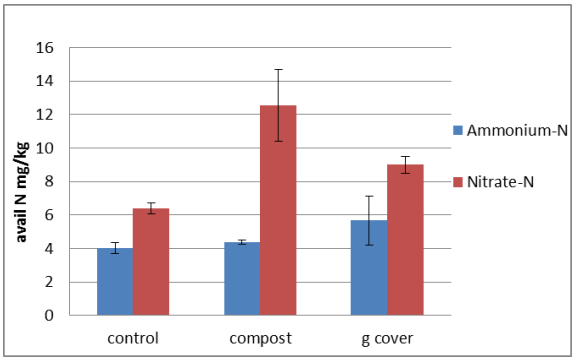

Figure 11: Soil available N at Palmwoods at 12 months after establishment for the soil treatments.

Nematodes

Two months after establishment

Four species of parasitic nematodes were identified, Spiral (*Helicotylenchus multicinctus*), Lesion (*Pratylenchus goodeyi*), Burrowing (*Radopholus similis*) and Stubby (*Paratrichodorus* sp.). Analyses of the data for all the nematode sampling times are shown in appendix 1.4.

The highest nematode levels were two months after establishment, in the winter of 2014. At this time, Spiral nematodes were most abundant in the soil samples (average of 4183), while Lesion nematodes were most abundant in the roots (7713). Burrowing nematodes were extremely low in the soil (9-43) and roots (0-23) and Stubby nematodes were also low in soil (75-160) and roots (38-97).

Spiral nematodes in the soil under the compost treatment, were 3.2 times higher than the control (Figure 12). However, Spiral nematodes in the banana roots under the compost treatment were the same as those in the control (Figure 14). There were 3.2 times more Spiral nematodes in the banana roots in the groundcover treatment compared with the control.

Lesion nematode numbers in the soil were similar for all treatments (Figure 13), but were 2.4 times higher in banana roots from the ground cover treatment compared to the control (Figure 15).

Stubby nematodes were much lower than Spiral and Lesion nematodes and quite variable across treatments, with no obvious treatment effects.

Burrowing nematodes were orders of magnitude lower than Spiral and Lesion nematodes and were highest in the soil of the compost treatment but highest in the roots of the groundcover treatment.

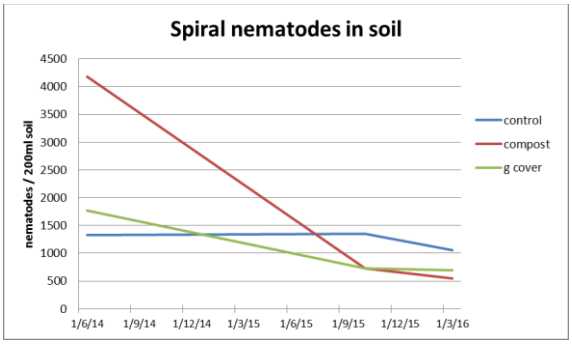

Figure 12: Spiral nematodes in the soil at Palmwoods at 2, 18 and 23months after establishment for the soil treatments

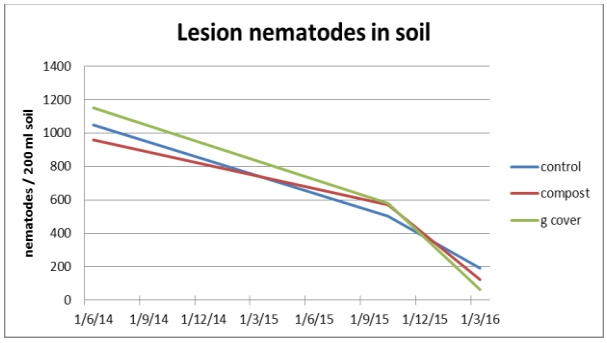

Figure 13: Lesion nematodes in the soil at Palmwoods at 2, 18 and 23months after establishment for the soil treatments

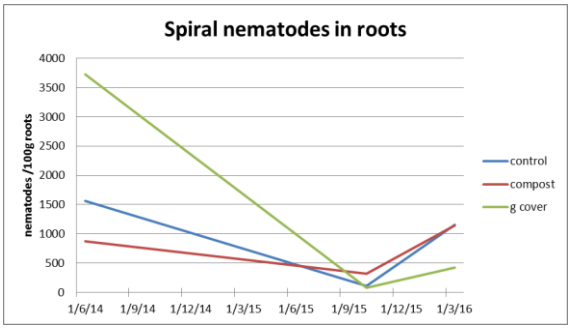

Figure 14: Spiral nematodes in the roots at Palmwoods at 2, 18 and 23months after establishment for the soil treatments

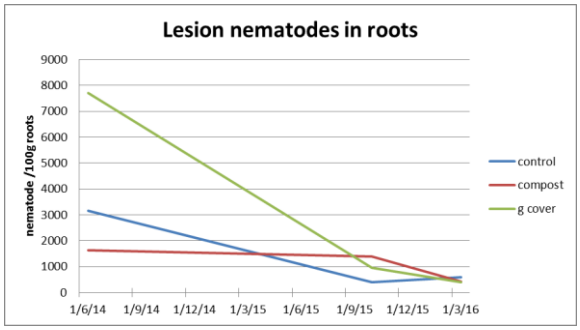

Figure 15: Lesion nematodes in the roots at Palmwoods at 2, 18 and 23months after establishment for the soil treatments

18 months and 23 months after establishment

For Spiral nematodes results are inconsistent between the soil and root samples (Figures 12 and 13). In the soil samples there were significantly more Spiral nematodes in the control plots. In the root samples there was no significant difference in Spiral nematode counts between treatments, but the March 2016 root samples had significantly more than the October 2015 root samples.

There were no significant effects in the root samples for Lesion nematodes (Figure 15) but a significant interaction of month and treatment was found for the soil samples. Significantly fewer Lesion nematodes were found in the compost and groundcover soil samples in March 2016 compared to October 2015. In October 2015 there was no significant difference between the three treatments, but in March 2016 the groundcover soil samples had significantly fewer Lesion nematodes than the control soil samples.

A significant interaction of sampling month and treatment was found in the soil for Stubby nematodes, however there were no significant pairwise differences. The predicted means suggest fewer Stubby nematodes were found in the March 2016 soil samples. In October 2015 the control plots had the highest predicted mean, but in the March 2016 samples, no stubby lesions were found in the three control plots.

Table 1: P values for effects of treatment and date on nematode counts (total and feeding groups) at Palmwoods.

	Counts				
Fixed Terms	Total	Bacterial Feeding	Fungal Feeding	Plant Parasites	Predatory and Omnivores
Month	0.169	0.453	0.673	0.190	0.365
Treat	0.018	0.847	0.033	0.460	0.054
Month.Treat	*	*	*	*	*

* Term is not significant and dropped from the model.

There were no significant treatment effects and date in nematode diversity across all four of the tested diversity indices meaning all treatments had similar nematode diversity. The analysis of the counts suggests a significant treatment effect was found for the total nematode and fungal feeding counts (Table 1). Significantly more nematodes in total were found in the control plots compared to the compost and groundcover plots. For the fungal feeding analysis, significantly more were found in the control plots compared to the compost plots. The number of predatory and omnivore nematodes in the control plots was the highest but not at a significant 95% level.

Woolgoolga

Soil chemistry and biology

All soil analyses are shown in appendix 1.5. Compost and manure were effective at changing several soil properties after 12 months on the surface, improving soil health. The soil amendments (one or both) increased soil pH, EC, available P, Ca, Mg, CEC, total N, total C and reduced aluminium availability. They had no effect on K, labile C, microbial activity or water holding capacity. Soils under manure had a significantly higher pH (5.7) than the control (4.7) after 12 months, while compost only raised it slightly to 4.9 (Figure 16). These increases explain the significant reduction in aluminium availability in the soil by both compost and manure (Figure 18) and the increase in Ca. After 12 months, manure was the only amendment to increase soil available phosphorous (31%) but both amendments increased total N by 36% (Figure 17). The soil under the amendments had a higher total C (5.8-5.9%) compared to the control (4.6%) (Figure 19). The CEC of the control soil after 12 months was 12.0 cmol(+)/kg whereas the compost amended soil was higher at 16.7 and manure amended soil was much higher at 21.7 cmol(+)/kg . Water holding capacity ranged from 85-89% at the initial sampling time and after 12 months ranged from 82-87% but there were no significant effects due to the treatments.

Nematode distribution across the plantation was not even. As the nematode numbers were only sampled three weeks post treatment, there was little time for nematode populations to change. These baseline numbers (Table 2) show that Spiral nematode numbers were very high and ranged from 6,210 - 24,120 /200ml in the soil and 5,879 – 33,208/ 100g in the roots. Root knot nematodes numbers were similar in all treatments in the soil (range 45 – 540) and ranged from 0-1759 in the roots under the compost and from 104 – 3014 in the manure treated plants. Burrowing nematodes were very variable and no treatment difference was observed in either the soil or roots. Stubby nematodes were only seen in two compost plots and one control (3 of the 9 plots).

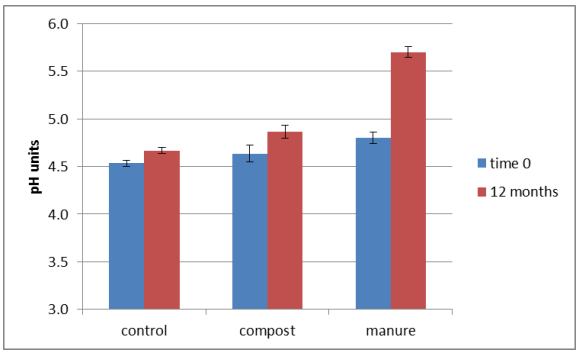

Figure 16: Soil pH at Woolgoolga at time of establishment and after 12 months for the soil treatments.

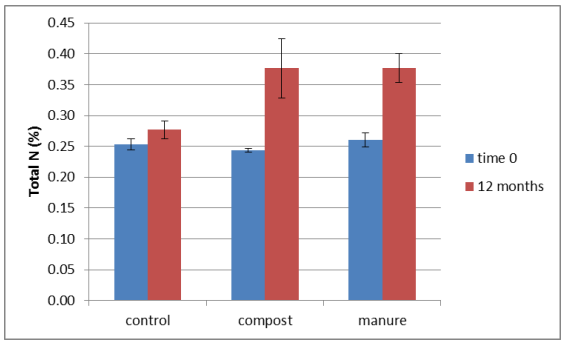

Figure 17: Soil total N at Woolgoolga at time of establishment and after 12 months for the soil treatments.

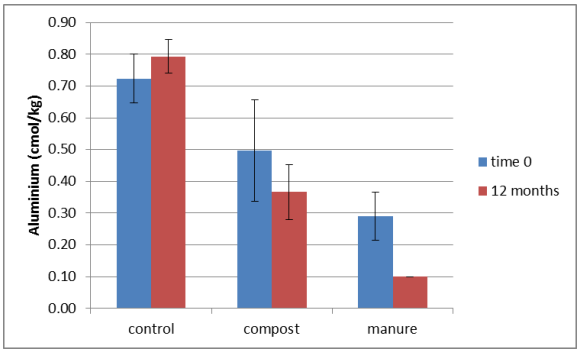

Figure 18: Soil Aluminium at Woolgoolga at time of establishment and after 12 months for the soil treatments.

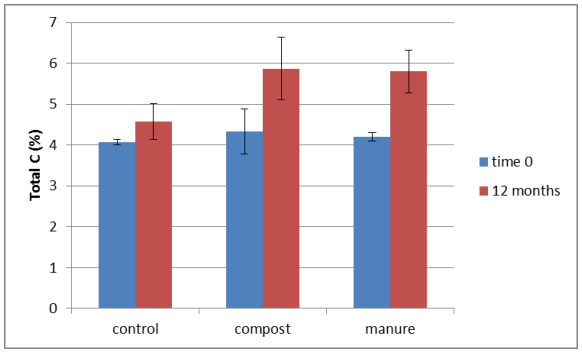

Figure 19: Soil total C at Woolgoolga at time of establishment and after 12 months for the soil treatments.

Nematodes

Nematode distribution across the plantation was not even. As the nematode numbers were only sampled three weeks post treatment, there was little time for nematode populations to change. These baseline numbers (Table 2) show that Spiral nematode numbers were very high and ranged from 6,210 - 24,120 /200ml in the soil and 5,879 – 33,208/ 100g in the roots. Root knot nematodes numbers were similar in all treatments in the soil (range 45 – 540) and ranged from 0-1759 in the roots under the compost and from 104 – 3014 in the manure treated plants. Burrowing nematodes were very variable and no treatment difference was observed in

either the soil or roots. Stubby nematodes were only seen in two compost plots and one control (3 of the 9 plots).

Table 2: Average nematode numbers at Woolgoolga for 4 species of nematodes in the soil and roots for the soil treatments

Nematode	Spiral	Root-knot	Burrowing	Stubby
Soil (200ml)				
control	14160	210	105	30
compost	15555	240	30	90
manure	15825	315	15	0
Roots (100g)				
control	25898	132	59	0
compost	16293	610	34	0
manure	10488	1339	77	0

Bunch weight

There were no differences between treatments for bunch weights over the 20 month monitoring period. Average bunch weight was 18 kg with a range of 12.5 – 29kg (Figure 20).

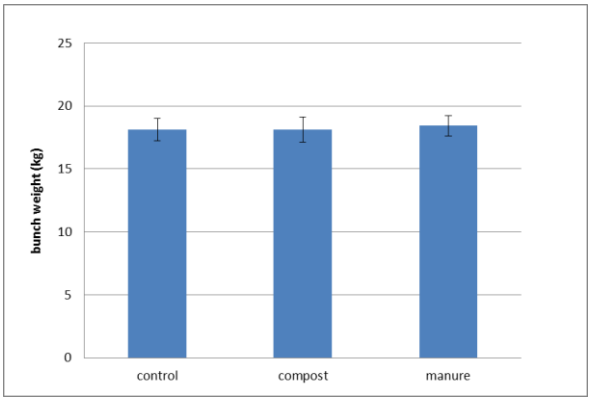

Figure 20: Banana bunch weight at Woolgoolga from 3 Feb 2015 to 17 October 2016 in the treated soils.

Discussion

Palmwoods

Soil effects

Compost application modified the soil chemistry more than groundcover species did, as expected. Although the groundcover roots would have contributed exudates and modified the environment in the area immediately adjacent to the roots, the sampling of the bulk soil at 0-10cm would not have been sensitive enough to measure some of these changes. The application rate of 30t/ha of compost would have contributed significant soluble nutrients and then more through the decomposition of organic forms of these nutrients.

The soil pH was significantly higher in both of the treatments, with compost increasing pH to 5.3 and groundcover to 5.0. A pH closer to neutral increases soil nutrient availability and therefore plant uptake. Aluminium is more available at pH 5 and below and is toxic to root growth. Both amendments reduced available aluminium to low levels. Calcium levels were increased by compost, with a corresponding increase in CEC, improving the cation balance and the ability of the soil to maintain a higher pH.

Only compost increased available P in the soil after 12 months, through the breakdown of organic P compounds in the compost to mineral phosphate forms, and the stimulation of native soil microorganisms in the turnover of soil bound P. This is despite being lower in P than the manure. Both compost and groundcover increased nitrate N at 12 months but not ammonium N. Compost as a source of organic N would have supported the mineralisation to nitrate, through nitrification by soil bacteria. The nitrogen-fixing bacteria (Rhizobia) in root nodules of the clover convert atmospheric N to ammonium, which is susceptible to conversion to nitrate in the soil.

The addition of compost did not increase the microbial activity in the soil as expected although the sample variation was high, making conclusions based on treatments difficult. Microbial activity is often found higher close around the root zones, and often very near the surface, which may be diluted in a bulk 0-10cm sample.

Water holding capacity was not affected by either compost or groundcover plants in the 12 months. Structural properties of soil change slowly, so the timing of this measurement may be too soon to determine any changes. Silty loams have good water holding capacity and any improvements are found when soil amendments like compost are added to sandy soils. The presence of inter row plants in an orchard has been shown to trap and hold more moisture than bare soil in many orchard studies, but may not inherently change the water holding capacity of the mineral soil.

Nematodes

There were no obvious seasonal patterns to the nematode prevalence in the trial. Trial results show that both Spiral and Lesion nematodes are in levels high enough to cause economic damage at the site at Palmwoods and Burrowing nematodes are less of a constraint. Little is known about the biology and alternative hosts and pest status of these two species. Levels were initially higher at the two month sampling time, both the compost and groundcover reduced Spiral nematodes in the soil and ground cover reduced them in the roots.

Woolgoolga

Soil chemical and physical properties

Both compost and manure application resulted in significant changes in soil chemistry but not in soil biological properties or water holding capacity, similar to the results from the Palmwoods site. At Woolgoolga however the compost application did not result in the increase in soil pH seen at Palmwoods, but the manure treatment did. The addition of manures has been shown to increase pH in acidic soils due to buffering from bicarbonates and organic acids (Whalen et al., 1999). The compost used at this site had a higher C:N ration and an alkaline pH, so was expected to increase soil pH, but other factors that may help explain the difference. This compost had a larger particle size and would be expected to take longer to break down and contribute the benefits to the soil through the decomposition and mineralisation of organic nutrients. This compost was less mature and had undergone minimum composting and a limited maturation phase. This material may have not provided the benefits expected from a well-matured compost as seen at the Palmwoods site. The effect of the higher soil pH under the manure treatment significantly reduced aluminium levels. The compost did, after 12 months, reduce aluminium availability compared to the unamended soil, so compost did eventually contribute to improved soil fertility.

Both soil amendments increased total N in the soil similarly after 12 months, despite the differences in the initial form of the N. The nutrients in poultry litter are in mineral and organic forms and a proportion of the N, P and K are immediately available to plants while the organic form must react in the soil to change into a form available for plant use. Most of the nitrogen in poultry litter is available soon after application with approximately 10% (range 6%–30%) in the ammonia form readily lost to the atmosphere unless cultivated or washed into the soil (Griffiths 2011). Most of the other nitrogen in poultry litter becomes urea within a short time after application and then acts similarly to urea fertiliser. The compost N is mostly in the organic form and requires mineralisation by bacteria, which does occur in the first year after application (Eghball 2002). The increase in soil P from the manure was expected as the P content was 3.3% compared with 0.38% in compost. Approximately 92% (range 81%–95%) of the phosphorus in poultry litter is available for plant use and on average 38% is in a water soluble form, which means it is immediately available for plant use, with the remainder slowly released within a year of application (Griffiths 2011). There are environmental risks

associated with manure use however, with the potential of for nitrate leaching into groundwater and surface movements of manure into waterways leading to eutrophication.

Soil C was significantly increased with both compost and manure treatments, to 5.8% after 12 months, with both amendments starting with a similar C level. Although in this trial microbial activity was not influenced by inputs after 12 months, this measurement is highly variable, dependant on moisture levels and may not be sensitive enough to capture small changes around roots. Water holding capacity also did not show any difference under the amendments treatments. Several studies have shown that organic amendments have not increased water holding capacity due to the competing effect the amendments can have on pore size and soil aggregation (Zebarth et al., 1999; Liu et al., 2012) but soil moisture retention increased due to the properties of the amendment itself (e.g. humus content). As this trial had surface applied amendments, the time taken for these to influence soil properties would be longer than this study ran.

Nematodes

No samples were collected from the Woolgoolga site post treatment sample however, like the samples from the Palmwoods site, the baseline samples shows Spiral nematode is the major pest species here. Root knot (*Meloidogyne* sp.) nematodes were also at levels expected to cause economic damage.

General discussion

A key outcome from the trials is that Spiral and Lesion nematodes appear to be the major nematode pest species at the two sites. Stubby and Root knot were also in numbers expected to cause economic damage, however the major pest species of tropical banana production was in lower numbers at both sites. The recently funded, Improved plant protection for the Australian banana industry (BA16001) will undertake surveys to determine the distribution and extent of the nematode species in subtropical production areas, identify alternative hosts and non-host species for interrow plantings and trial new treatment options.

Data from the soil analyses from the trials lead to the development and delivery of a plant nutrition workshop, a soil health field day at Burringbar 17 February 2016 and organised as part of the NSW Banana IDO project (BA130025) and the publication of the Subtropical banana nutrition booklet published by the National banana extension program (BA14000). The booklet can be downloaded from http://www.dpi.nsw.gov.au/agriculture/horticulture/tropical/growing-bananas/sub-tropical-banana-nutrition

Improving soil health in NSW bananas remains elusive. Despite the benefits, adding compost to and introducing ground covers into bananas grown on steep slopes in NSW is going to be difficult. The ground cover remained wet longer during the day, resulting in saturated boots for growers and their staff when working in that plot. The ground cover also hid any obstacles, rocks or gullies making it dangerous to work in the rows. A comment was made that the grower and his staff worked from the rows with no ground cover to work around these issues. The possibility of having every second row vegetated may be an option or finding other species with a more prostrate habit. As most plantations are not mechanised, the steep slopes make adding compost or other amendments, extremely difficult.

These trials highlight the need for growers to better monitor soil physical, biological and chemical properties to improve production.

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Appendix 1.1 Compost properties used at the Palmwoods experiment

	Units	compost
pH	na	5.48
Electrical Conductivity	dS/m	7.42
Soluble Phosphorus in solution	mg/L	782
Soluble Phosphorus dry mass equivalent	mg/kg	3,908
Ammonium-N in solution	mg/L	64
Ammonium-N dry mass equivalent	mg/kg	318
Moisture Content	%	52
Total Organic Carbon	%	24.5
Organic Matter	%	41.7
Total Nitrogen	%	2.3
Carbon: Nitrogen Ratio	%	11
Sodium	%	0.25
Calcium	%	4.46
Magnesium	%	0.56
Potassium	%	1.13
Sulfur	%	0.96
Phosphorus	%	1.9
Zinc	mg/kg	254
Iron	mg/kg	14839
Manganese	mg/kg	1510
Copper	mg/kg	55
Boron	mg/kg	21
Molybdenum	mg/kg	3.3
Selenium	mg/kg	1.5
Cadmium	mg/kg	<0.5
Lead	mg/kg	6
Arsenic	mg/kg	<2
Chromium	mg/kg	9
Nickel	mg/kg	11
Mercury	mg/kg	<0.1
Polychlorinated Biphenyls	mg/kg	<0.1
Organochlorines - DDT, DDD, DDE	mg/kg	<0.2
Organochlorines - Other see note 9	mg/kg	<0.2
Salmonella	number/50 g	Absent
E coli	cfu/gm	..
Faecal Coliforms	mpn/g	10-99
Particle Size Grading - >16mm Sieve	%	1.9
Particle Size Grading - >5mm<16mm Sieve	%	19.4
Particle Size Grading - <5mm Sieve	%	78.8
Plastics Light Flexible or film >5mm	%	<0.01
Stones and Lumps of Clay >5mm	%	1
Glass, metal and rigid plastics > 2mm	%	<0.1
Wettability	minutes	0m 56s
Nitrate-N in solution	mg/L	1358
Nitrate-N dry mass equivalent	mg/kg	6788
Ammonium:Nitrate Ratio	Ratio	0.05

Appendix 1.2 Poultry manure and compost properties used at the Woolgoolga experiment

Sample ID	Unit	poultry manure	compost
EC	Ds/m	7.6	4.7
pH (CaCl2)	pH units	7.4	7.6
Total Nitrogen+	%	2.49	1.84
Total Organic Carbon	%	16	27
Ammonium-N	mg/kg	1100	13
Nitrate-N	mg/kg	2300	38
Total Phosphorus	%	3.3	0.38
Water Soluble Phosphorus	mg/kg	3000	410
Exchangeable Cations			
Aluminium	cmol(+)/kg	<0.1	<0.1
Calcium	cmol(+)/kg	17	34
Potassium	cmol(+)/kg	28	24
Magnesium	cmol(+)/kg	24	15
Sodium	cmol(+)/kg	8.6	10
CEC	cmol(+)/kg	78	84
Calcium/Magnesium Ratio		0.69	2.2
ICP Elements and Metals			
Aluminium	%	0.17	0.43
Arsenic	mg/kg	<5	9
Boron	mg/kg	26	19
Calcium	%	17	1.9
Cadmium	mg/kg	0.3	0.32
Cobalt	mg/kg	3	3.1
Chromium	mg/kg	6.6	65
Copper	mg/kg	74	47
Iron	%	0.44	0.92
Potassium	%	1.4	1.1
Magnesium	%	0.78	0.33
Manganese	mg/kg	770	400
Molybdenum	mg/kg	5.2	1.2
Sodium	%	0.38	0.29
Nickel	mg/kg	6.7	11
Lead	mg/kg	3	28
Sulfur	%	0.49	0.22
Selenium	mg/kg	<4	<4
Zinc	mg/kg	600	220

Appendix 1.3 Palmwoods soil chemistry, biology and physics just before establishment and 12 months after.

		EC	pH (CaCl2)	Bray P	Total N	Total C	Al	Ca	K	Mg	Na	CEC	WHC	Microb activ	Amm-N	Nitrate-N	Labile C
		dS/m	pH units	mg/kg	%	%	cmol(+)/kg	cmol(+)/kg	cmol(+)/kg	cmol(+)/kg	cmol(+)/kg	cmol(+)/kg	%	ugfl/g/hr	mg/kg	mg/kg	g C/kg
T0	control	0.04	4.80	61.67	0.26	3.00	0.27	14.33	0.92	6.17	0.15	22.00	68.19	2.68			
ave	compost	0.05	5.07	78.00	0.26	3.27	0.11	17.67	0.95	7.33	0.15	25.67	69.88	1.99			
	g cover	0.05	5.13	83.00	0.26	3.13	0.13	16.67	1.14	6.50	0.13	24.67	64.28	2.24			
	control	0.00	0.10	15.77	0.02	0.26	0.10	0.67	0.11	0.81	0.01	1.53	6.34	0.10			
se	compost	0.00	0.09	2.52	0.03	0.45	0.01	1.86	0.09	1.41	0.01	3.38	3.39	0.35			
	g cover	0.00	0.19	4.73	0.01	0.07	0.03	2.67	0.17	1.76	0.00	4.18	3.10	0.56			
T1																	
	control	0.06	4.67	75.67	0.27	3.50	0.77	14.33	0.89	5.63	0.14	21.67	72.98	5.64	4.03	6.40	0.76
ave	compost	0.07	5.27	136.67	0.28	3.70	0.10	18.67	0.91	6.90	0.14	26.67	78.07	4.35	4.37	12.53	0.90
	g cover	0.06	5.03	96.00	0.24	3.17	0.15	17.00	0.91	5.00	0.11	23.00	70.07	4.87	5.67	9.00	0.83
	control	0.00	0.12	17.19	0.02	0.35	0.38	0.67	0.07	0.94	0.01	1.45	3.57	0.35	0.32	0.32	0.03
se	compost	0.01	0.13	17.64	0.02	0.38	0.00	2.40	0.06	1.71	0.03	4.48	6.57	0.89	0.12	2.15	0.07
	g cover	0.00	0.07	13.08	0.01	0.15	0.05	2.00	0.07	0.72	0.01	2.52	4.09	1.09	1.45	0.51	0.04

Appendix 1.4. Parasitic nematode averages (and standard errors) for the four parasitic s species at three sampling times at Palmwoods.

	June 2014				**Oct 2015**				**Mar 2016**			
	spiral	lesion	burrow	stubby	spiral	lesion	burrow	stubby	spiral	lesion	burrow	stubby
SOIL												
average												
control	1323	1048	9	87	1351	503	4	45	1056	189	0	0
compost	4183	960	43	75	728	570	0	15	550	124	0	11
g cover	1767	1150	14	160	728	578	0	26	691	62	0	2
s.e.												
control	566	436	5	32	303	67	4	22	228	50	0	0
compost	1588	211	35	40	189	106	0	8	50	32	0	7
g cover	686	634	7	100	195	263	0	10	237	9	0	2
ROOT												
average												
control	1560	3164	0	38	106	397	0	4	1152	600	0	99
compost	874	1642	0	74	318	1402	0	48	1143	412	0	19
g cover	3724	7713	23	97	81	961	0	14	419	401	0	5
s.e.												
control	1288	1390	0	35	75	173	0	2	513	268	0	99
compost	399	860	0	32	35	368	0	48	92	117	0	19
g cover	2238	1074	23	97	67	271	0	14	242	162	0	4

Appendix 1.5. Woolgoolga soil chemistry biology and physics at establishment and 12 months after

		EC	pH (CaCl2)	Bray #1 P	Total N	Total C	Labile C	Al	Ca	K	Mg	Na	CEC	WHC	microb activ
		dS/m	pH units	mg/kg	%	%	g C/kg	cmol(+)/kg	cmol(+)/kg	cmol(+)/kg	cmol(+)/kg	cmol(+)/kg	cmol(+)/kg	%	ugfl/g/hr
T0	**control**	0.14	4.53	403.33	0.25	4.07	0.56	0.72	9.17	0.99	1.70	0.18	12.67	84.57	2.00
ave	**compost**	0.15	4.63	373.33	0.24	4.33	0.59	0.50	10.27	0.90	1.73	0.21	13.67	85.14	2.16
	manure	0.16	4.80	346.67	0.26	4.20	0.64	0.29	12.00	1.11	1.87	0.21	15.67	88.73	2.22
	control	0.00	0.03	21.86	0.01	0.07	0.03	0.08	0.38	0.18	0.15	0.02	0.33	2.30	0.12
se	**compost**	0.03	0.09	8.82	0.00	0.55	0.03	0.16	1.38	0.06	0.13	0.02	1.67	3.15	0.13
	manure	0.02	0.06	3.33	0.01	0.10	0.06	0.08	0.58	0.14	0.27	0.02	0.67	2.90	0.10
T1	**control**	0.11	4.67	386.67	0.28	4.57	0.65	0.79	8.80	0.91	1.67	0.12	12.00	82.43	2.74
ave	**compost**	0.14	4.87	386.67	0.38	5.87	0.80	0.37	12.67	0.89	2.53	0.21	16.67	86.97	2.65
	manure	0.20	5.70	506.67	0.38	5.80	0.83	0.10	16.67	1.03	3.80	0.16	21.67	87.11	2.41
	control	0.01	0.03	23.33	0.01	0.44	0.03	0.05	0.40	0.14	0.20	0.02	0.58	3.27	0.28
se	**compost**	0.01	0.07	8.82	0.05	0.77	0.10	0.09	1.20	0.05	0.28	0.01	1.67	2.46	0.22
	manure	0.04	0.06	23.33	0.02	0.53	0.10	0.00	0.88	0.19	0.31	0.03	1.45	1.41	0.39

Appendix 5: Innovation Trials

Appendix 5.1: Summary of chemical flower removal trial/s

Background

Bananas are susceptible to a wide range of pests and diseases which can have major impacts on fruit quality. Crown end rot (CER) caused by a complex of fungi, is considered to be one of the most severe post-harvest diseases of banana. The fungi initiate disease development by progressing from the crown into the pedicels and eventually into the fingers as a black rot. Banana flower remnants and leaf trash are known to be sources of inoculum for CER fungi such as *C.musae* and *Fusarium spp*, (De Lapeyre de Bellaire and Mourichon, 1997). Furthermore, when dry banana flower remnants rub against above hands, fruit can become unmarketable due to excessive point scarring and cosmetic damage. Due to the low cost of labour, deflowering the tips of fingers and bunch stalk before bagging is an economical practice for many developing countries. However, deflowering in highly mechanised and developed countries such as Australia is neither practical nor economical and alternative methods of flower removal need to be explored.

Very little research has been conducted on how to chemically remove the flower remnants from the tips of fingers of banana fruit. Using the apple industry as an example, this report will provide an overview of chemical thinners used in the apple industry, past studies which have investigated the effects of growth hormones on banana, and preliminary research conducted at the South Johnstone DAF research facility to chemically remove banana flower remnants.

Chemical thinners used in the apple industry

Flower and fruit thinning reduces the number of fruits per tree and provides regular and annual crops with high internal and external quality. Traditionally, thinning of apple trees was undertaken by hand, however, due to high labour costs, hand thinning is not a viable practice today. The use of chemical thinners to regulate crop load in the apple industry is a customary practice for many countries, including Australia. Table 1 outlines some chemical thinners that have been used in the apple industry and may be suitable candidates for chemical removal of banana flower remnants.

Table 1: Some chemical thinners that have been used to thin flowers and fruits in the apple industry, (Bound, 2014, Dennis, 2000, Janoudi and Flore, 2005, Stopar, 2004, Stopar and Lokar, 2003, Wertheim, 2000)

Ethephon	- an ethylene and a widely used plant growth regulator for a range of crops - can reduce biennial bearing and excess vigour, increase return bloom, enhance colour development and bring forward maturity
Abscisic acid	- naturally occurring plant hormone known to increase ethylene production - can cause abscission of flowers and young developing fruit
Benzyladenine	- synthetic plant hormone (Cytokinin) that can stimulate cell division in plants, increase fruit size and firmness - can have a greater effect following treatment with carbaryl, naphthalene acetic acid or ammonium thiosulfate
Naphthalene acetic acid	- synthetic plant hormone (Auxin) that can stimulate cell division, elongation, abscission of leaves and fruit, fruit set, flowering etc. - the addition of carbaryl or benzyladenine has shown to improve thinning activity for some apple cultivars

Naphthalene acetamide	-	acts similarly to naphthalene acetic acid however, its effect is milder and slower acting in some cultivars
Ammonium thiosulfate	-	applied on just opened flowers
	-	desiccant which burns flower parts and disrupts pollination and fertilisation
Lime sulfur	-	desiccant which burns flower parts and disrupts pollination and fertilisation
	-	lime sulfur with the addition of oil formulations can enhance thinning effect
DNOC	-	desiccant which burns flower parts and disrupts pollination and fertilisation

Effect of growth hormones on banana

There is limited published literature on the influence of growth hormones on banana plants and how they affect the development of the plant and fruit. Much of the documented literature is preliminary, and access to journals is limited. The following preliminary findings of the effects of growth hormones on banana have been documented by Lahav and Gottreich (1984).

Auxins – chlorophenoxy compounds, NAA, NOA, IAA

Spray application of various chlorophenoxy compounds (e.g. 2,4-D) to young fruit (0-100ppm) caused excessive elongation, abnormal bending, curling, twisting, swelling, rapid ripening and rotting of fruit. These fruit responses were similar with spray applications of 1-naphthalene acetic acid (NAA) and 2-naohthoxy acetic acid (NOA) at concentrations of 500ppm or greater. When indole acetic acid (IAA) was applied in lanolin to young fruit, it stimulated growth, prevented upward bending on the treated side, caused fruit to take a bow shape and small protrusions developed on the bunch stalk. When the chlorophenoxy compounds were applied in lanolin to young flowers it resulted in persistence of the flower remnants. Application of NAA and NOA to flower remnants also resulted in persistence of the flowers.

Gibberellins - GA_3 and A_4A_7

When gibberellins were applied in lanolin to the stalk of young bunches it caused retarded fruit development. Gibberellins sprayed on mature bunches enabled the attached fruit to remain firm and green two weeks longer than untreated fruit. Sprays of GA_3 and A_4A_7 on fresh flowers immediately after bunch emergence delayed abscission of the perianth of an abscising cultivar.

Cytokinins - Benzyladenine

Mature bunches sprayed with BA at 100ppm delayed full ripeness for two days compared with untreated bunches. Moreover, spray application of BA before or after flower opening had no effect on flower abscission.

Ethephon - Ethylene

Ethylene is a major plant hormone known to be involved in flower abscission. Ethephon (an ethylene) sprayed on bunches at 5000ppm caused banana fruit to turn yellow and dry within a few days of application. Sprays of Ethephon at 500-1000ppm on very young flowers accelerated drying up of the perianth, however, the style was not affected and senesced normally.

Growth inhibitors

Growth inhibitors such as 2-Chloroethyltrimethylammonium chloride (CCC) sprayed on very young flowers at 1000ppm had no effect on flower abscission. Similarly spray application of abscisic acid (ABA) and Triiodobenzoic acid (TIBA) on very young flowers (50-1000ppm and 1000ppm respectively) both had no effect on flower abscission.

Preliminary research conducted at South Johnstone DAF research facility

Preliminary research into chemically removing flower remnants off the tips of fingers is underway at the DAF South Johnstone research facility. A total of 65 Cavendish cv. Williams banana bunches were treated with various chemicals and plant growth hormones. As there is limited literature on chemical removal of banana flower remnants, a number of different chemical application methods and bunch management practices were conducted to determine the most suitable method.

Method

Initially, chemical treatments were applied by spray application to emerged bunches at the bract fall growth stage (Figure 1). As the flower remnants were treated by spray application, the peel of fruit had come into contact with the chemical. For some chemical treatments (e.g. Ethephon, vinegar and lime sulfur), this application method had caused phytotoxicity to fruit, causing some fruit to blacken and rot (Table 2). Due to the damage caused by spray application, a more targeted application method was required. As a result, chemical treatments were applied to the tips of flower remnants by using a paint brush to specifically target flower remnants (Figure 2). Although this practice would not be economical for commercial banana farms, it was important to undertake this application method to determine whether there was a chemical effect or not.

In the initial stages of this research, bunches were uncovered and visual observations of chemical effects were undertaken. As bunches were uncovered considerable damage had been caused to fruit, making it difficult to determine whether flower remnants had potentially fallen off due to chemical effects or from animal activity (e.g. birds, flying foxes, rodents etc.). Furthermore, by undertaking visual observations as a method of assessment, it was difficult to quantify the number of flower remnants that had continued to persist or had fallen off. An assessment technique to quantify the number of flower remnants persisting or falling off had been developed. This technique included chemically treating the first 5 female hands at bract lift, counting the number of fingers per treated hand and the number of flower remnants intact at treatment. Bunches were covered and assessments were conducted at 2 and 4 weeks after treatment. Each assessment consisted of counting the number of flower remnants that had persisted or fallen off, as well as taking images and visual observations of any other chemical effects (e.g. chemical phytotoxicity).

Another treatment application method conducted during this research included undertaking a bell injection with various plant growth regulators (i.e. abscisic acid, benzyladenine and gibberellic acid). The bell injection consisted of 2x 20ml injections (of plant growth regulator) at the time of bunch emergence. At bract lift bunches were covered, and the number of fingers and flower remnants on female hands were counted. Further assessments were conducted two weeks after bunch covering to determine whether there was a treatment effect from the bell injection.

Figure 1: *Chemical treatments applied by spray application using a spray bottle*

Figure 2: *Chemical treatments applied by targeted application using a paint brush*

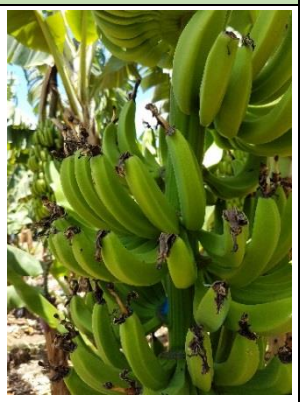
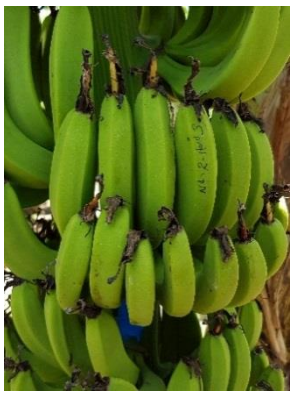
Results

Preliminary results of the chemicals and plant growth regulators which have been trialled at the DAF South Johnstone research facility on Cavendish cv. Williams bunches include:

Table 2: *Preliminary research conducted at DAF South Johnstone research facility using various chemicals, concentrations and application methods*

Treatment type: Spray application, uncovered bunches, visual observations only		
Ethephon (3600ppm) - Sprays of Ethephon to flower remnants and young fruit caused some fingers to blacken and rot - Flower remnants continued to persist		
Ethephon (1800ppm) - Sprays of Ethephon to flower remnants and young fruit caused some fingers to blacken and rot - Flower remnants continued to persist		

Ethephon (1000ppm) - Sprays of Ethephon to flower remnants and young fruit caused some fingers to blacken and rot - Flower remnants continued to persist		
Vinegar (undiluted supermarket grade) - Sprays of vinegar to flower remnants and young fruit caused phytotoxicity to the skin of some fingers (dark circular marks) - Flower remnants continued to persist		
Sodium Chloride (5% active) - Flower remnants continued to persist with sprays of sodium chloride - No visual phytotoxicity to skin		
Lime sulfur (4% active) - Majority of flower remnants continued to persist with sprays of lime sulfur - Chemical residue stuck to fruit		

Lime sulfur (8% active) - Majority of flower remnants continued to persist with sprays of lime sulfur - Chemical residue on fruit and potentially causing phytotoxicity to skin (dark circular marks)		
Treatment type: Targeted application, bunches uncovered, ratings conducted		
Naphthalene acetic acid (20ppm) - Approximately 75% of flower remnants continued to persist - As bunches were uncovered, animal activity e.g. birds and rodents may have caused flowers to fall off - Visual observations show no phytotoxicity to fruit		
Naphthalene acetic acid (40ppm) - Approximately 80% of flower remnants continued to persist - As bunches were uncovered, animal activity e.g. birds and rodents may have caused flowers to fall off - Visual observations show no phytotoxicity to fruit		
Treatment type: Targeted application, bunches covered and ratings conducted		
Ethephon (500ppm) - Approximately 65% of flower remnants continued to persist - Visual observations show no phytotoxicity to fruit with this concentration and application method		

Ethephon (1000ppm) - The majority of flower remnants continued to persist - Visual observations show no phytotoxicity to fruit with this concentration and application method		
Gibberellic acid (20ppm) - The majority of flower remnants continued to persist - Visual observations show no phytotoxicity to fruit with this concentration and application method - Mould was present on flower remnants		
Abscisic acid (1000ppm) - The majority of flower remnants continued to persist - Visual observations show some phytotoxicity to the peel which may be a result of treatment dripping onto lower hands - Visual observations show deformed growth has developed at the tips of fingers where the flower remnants were treated with ABA - Mould was present on flower remnants		
Benzyladenine (190ppm) - The majority of flower remnants continued to persist - Visual observations show some phytotoxicity to the peel which may be a result of treatment dripping onto lower hands - Mould was present on flower remnants		

Indole butyric acid (8g/L) - The majority of flower remnants continued to persist - Visual observations show some phytotoxicity to the peel, this may be a result of treatment dripping onto lower hands - Mould was present on flower remnants		
Water (control) - The majority of flower remnants continued to persist - Visual observations show no damage to the peel - Mould was present on flower remnants		
Treatment type: Bell injection (2x 20ml), bunches covered and ratings conducted		
Gibberellic acid (10ppm) - The majority of flower remnants continued to persist - Visual observations show no phytotoxicity to fruit with this concentration and application method		
Abscisic acid (1000ppm) - The majority of flower remnants continued to persist - Visual observations show no phytotoxicity to fruit with this concentration and application method		

Benzyladenine (190ppm) - The majority of flower remnants continued to persist - Visual observations show no phytotoxicity to fruit with this concentration and application method		
Water (control) - The majority of flower remnants continued to persist - Visual observations show no phytotoxicity to fruit		

Conclusions and recommendations

Overall, the results of this research has shown that none of the chemicals, concentrations and application methods have been effective at removing the flower remnants from the tips of fingers of banana fruit. As the flower remnants persisted for the majority of chemicals without causing phytotoxicity to the fruit, the next steps of this research is to increase concentrations and continue testing different chemicals. It's recommended that treatments are applied via targeted application to flower remnants and bell injection using ethephon, naphthalene acetic acid and other potentially suitable chemicals. Furthermore, it's suggested that alternative approaches to the removal of flower remnants such as mechanical flower removal is also explored.

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Appendix 5.2: Summary of Novel Nitrogen injection trial/s

Background

The effective use of fertiliser particularly in environmentally sensitive banana production areas around Innisfail and Tully is often one of the focus points of environmental sustainable farming. A reaction to a unique application method was observed at the South Johnstone research station. A small number of harvested mother plants were injected with a urea solution to speed up the rate of stem decay. In this process it was observed that the following sucker produced bright green leaves and increased growth. The benefit of this could potentially be efficient use of fertiliser and the ability to speed up growth of suckers to obtain a more uniform crop schedule.

Methods

Trial 1: Forty harvested mother plants were treated with 30mLs of different urea solutions by injecting 2 x 15mls into the pseudostem, 1 week after they were harvested, at approximately 1m and 1.5m from the ground using a Phillips vaccinator gun (see figure 1). Ten plants were each treated with water (control), 50% (500g:1000ml of water), 30% (300g:1000ml of water) and 15% (150g:1000ml of water) urea solutions respectively. The height of the following sucker was determined before application (between 100cm – 200cm) and urea solutions were applied based on height to ensure a fair comparison (blocked according to height). Height and leaf emergence were monitored on a monthly basis for 2 months (22-11-2016, 22-12-2016, 20-01-2017). The chlorophyll, flavonols, anthocyanins and the nitrogen balance index for each plant was measured on the 3rd fully emerged leaf using a Dualex Scientific^{TM} meter at the latter of these two time points. Two small suckers at the end of the row were injected with 15mLs of 50% urea solution at the base of the plants (10cm from the ground) for observational purposes which led to the development of trial 2

Trial 2: Following observations in Trial 1 a second small trial was established. In this trial 21 suckers were treated with 15mL of different urea solutions by injecting 15mLs into the pseudostem approximately 10cm above the base of the plant (Figure 2). Seven plants were treated with water (control), 25% (250g:1000mL water) and 50% (500g:1000mL of water) respectively. The height of the sucker was determined before application (between 150cm – 200cm) and treatments were applied based on height to ensure a fair comparison (blocked according to height). Height and leaf emergence were monitored 3, 6, and 12 weeks following injection. In addition to this 3 suckers at the end of the row were injected with 2 x 15mL of 50% urea solution for observational purposes. Height and leaf emergence measurements were also taken on these additional plants.

Statistical analysis was undertaken with GenStat on both trials using one way analysis of variance.

Figure 1: Method of injecting harvested mother plants with urea solutions (trial 1)

Figure 2: Method of injecting suckers with urea solutions (trial 2)

Results

Trial 1: There was no significant differences in any of the plant parameters that were measured (growth, leaf emergency, chlorophyll, flavonols, anthocyanins, nitrogen balance index) over the two months of the experiment. Table 1 and table 2 details the average measurements which were taken for each respective parameter.

Trial 2: Similar to trial 1 there was no significant differences in the growth and leaf emergence rates over the three months of the experiement. Table 3 details the average measurements which were taken at each of the time points. Although statistical analysis cannot be carried to compare, looking at the averages there appears to be a trend for plants injected with 2 x 15mL 50% urea solution to increase growth and leaf emergence in the first three weeks. Following that there appears to be no effect.

Table 1: Plant parameters measured one month (22-12-2016) following treatment application.

Treatment	Growth (cm)	Leaf Emergence	Chlorophyll	Flavonols	Anthocyanins	Nitrogen Balance Index
Water	52.4	4.3	50.9	2.0	0.002	26.2
15%	53.3	4.5	54.0	1.8	0.002	31.5
30%	58.4	4.2	52.4	1.7	0.003	31.9
50%	53.8	4.1	50.2	1.9	0.001	27.5

Table 2: Plant parameters measured in the second month (20-01-2017) following treatment application.

Treatment	Growth (cm)	Leaf Emergence	Chlorophyll	Flavonols	Anthocyanins	Nitrogen Balance Index
Water	50.6	4.3	46.5	1.7	0.002	31.9
15%	53.7	4.3	48.3	1.9	0.001	26.3
30%	46.3	4.4	48.7	1.9	0	25.6
50%	50.9	4.3	48.8	1.4	0.004	43.1

Table 3: Plant parameters measured throughout the second nitrogen injection trial

	0-3 weeks after injection		3-6 weeks after injection		6-12 weeks after injection	
Treatment	**Growth (cm)**	**Leaf Emergence**	**Growth (cm)**	**Leaf Emergence**	**Growth (cm)**	**Leaf Emergence**
Water	23.8	2.7	27.8	2.7	21.0	3.6
25%	20.1	2.5	27.0	2.7	21.3	3.7
50%	21.0	2.6	22.5	2.6	23.0	3.9

Table 4: Observation of differences between 3 plants injected with 30mL of 50% urea solution to the average growth and leaf emergence of plants injected with water (control)

	0-3 weeks after injection		3-6 weeks after injection		6-12 weeks after injection	
Treatment	**Growth (cm)**	**Leaf Emergence**	**Growth (cm)**	**Leaf Emergence**	**Growth (cm)**	**Leaf Emergence**
Water	23.8	2.7	27.8	2.7	21.0	3.6
2 x 50%	34.5	3.3	27.7	2.7	24.7	4.5

Discussion and recommendations

Overall these trials showed that injecting urea solutions into plants has very little impact on the growth characteristics. Injecting liquid solutions into both harvested mother plants as well as suckers was more problematic than anticipated. In the first trial the urea solutions were injected into the mother plants one week after the tops were removed. The pseudostems were still full of moisture at this point which made injection of even more liquid quite difficult and some backflow was unavoidable. Waiting a longer time period before injection may overcome this issue. Similarly in the second trial since it was conducted over a wet period of the year the ground was saturated and as result the suckers were also full of moisture. The commencement of trial 2 was delayed until the plants were not at maximum turgour pressure and injection was possible without backflow. This learning is particularly important as any potential direct injection of nutrients to avoid environmental losses especially during wet period of the year will be complicated by the fact that plants are already at high or maximum turgour pressure. This means that nutrients would hypothetically need to be soluble enough to dissolve in small volumes to avoid losses in backflow during an injection application. Although the nitrogen application in the form of urea did not show positive results in these trials future work using a similar application method could potentially be investigated for other nutrients such as calcium.

Appendix 5.3: Summary of scoping the use of gibberellic acid as an alternative approach to desuckering

Background

Desuckering is an important practice of removing unwanted suckers that compete for water and nutrients. Desuckering helps control crop cycle, maintain plant densities, maximise yield and growth of the mother plant and following sucker, however, it can be a costly and labour intensive practice. Finding an alternative approach that would reduce the amount of desuckering required as well as facilitate targeted sucker selection would be a significant benefit for the Australian banana industry. This trial investigated Gibberellic acid (GA) as an innovative approach for managing suckers. The concept is that by applying GA to a small sucker it could induce apical dominance of that sucker which may potentially supress the growth of all the other suckers.

Method

A field trial was established at the South Johnstone research station which consisted of 148 Cavendish cv. Williams banana plants which were treated with different concentrations of GA (ProGibb®SG 400g/kg). In this trial, three different concentrations of GA (50, 300 and 600ppm) were compared to a water control (deionised water). This equated to 37 plants per treatment. Using a 5mL syringe, the GA was applied to young developing suckers by trickling 4mL of the solution into the leaf axils of each plant, (Figure 1 and 2). To ensure a fair comparison, the height of the plants were determined before treatment application (heights of suckers ranged between 5cm – 178cm) and the GA solutions were applied to plants based on height (blocked based on height). The sucker height, leaf emergence and number of suckers produced from the treated plants were monitored on a monthly basis for a period of 4 months, (19.12.2016 – 26.04.2017).

Figure 1: Application method of GA

Figure 2: GA trickled into leaf axil of sucker

Results

Statistical analysis was conducted using GenStat. Analysis of variance (ANOVA) was used to analyse the number of suckers produced at week 16, as well as the sucker height and leaf emergence rate (LER) at each time point.

The results show that there was no significant difference in the mean number of suckers produced at week 16 between treatments (Table 1). Moreover, there was no significant differences in the mean height for each treatment at any of the assessments (Table 2). Results suggest that there was a significant difference in the mean LER at week 12 ($p=0.008$), where the mean LER for plants treated with 600ppm was significantly higher

than plants treated with 50 and 300ppm GA. Overall, although the 600ppm rate had the highest mean LER throughout the trial, it was not significantly higher than the other treatments including water (Table 3). As expected the results of this trial show that there were significant differences in the mean LER between time points, although there was no treatment effect, or interaction of treatment and time (Table 4). An interesting observations which was observed 3 weeks after treatment following 3 days of heavy rainfall (average of 670mm) was that the mother plants of the suckers which received GA treatment appeared to have an increase in root vigour (Figure 3). An increase in root vigour of the mother plants was also observed in plants treated with water, however, the mother plants of suckers treated with GA appeared to have more vigorous roots.

Table 1: Mean number of suckers produced at week 16 for each treatment (p>0.05)

Treatment	Mean number of suckers
Water	1.87
50ppm	1.87
300ppm	1.95
600ppm	1.89
p-value	0.984
SED	0.235
95% LSD	0.467

Table 2: Mean heights for treatments at each time point of the experiment (p>0.05)

Treatment	Week 0	Week 4	Week 8	Week 12	Week 16
Water	94.9	135.7	172.6	206.0	236.3
50ppm	95.0	138.0	173.3	199.1	225.9
300ppm	94.4	136.1	169.6	198.8	228.9
600ppm	94.9	139.1	177.1	210.4	241.4
p-value	0.980	0.806	0.557	0.192	0.140
SED	1.74	3.90	5.24	6.33	7.31
95% LSD	3.44	7.74	10.39	12.56	14.50

Table 3: Mean LER for each treatment at weeks 8, 12 and 16. Means that have the same letter are not significantly different from each other at a 5% significance level.

Treatment	Week 8	Week 12	Week 16
Water	2.68	3.31 bc	3.58
50	2.82	2.99 ab	3.65
300	2.62	2.90 a	3.70
600	2.85	3.42 c	3.82
p-value	0.528	**0.008**	0.396
SED	0.182	0.170	0.143
95% LSD	0.362	0.338	0.283

Table 4: Mean LER for all plants over time. Means that have a different letter are significantly different from each other at a 5% significance level.

Time	Mean LER rate
Week 8	2.738a
Week 12	3.160b
Week 16	3.698c

Figure 3: Observation of increase root growth after application of GA. Left: sucker applied with 300ppm GA. Right: sucker applied with water (control).

Discussion and recommendations

Overall, the results of this trial indicate that trickling Gibberellic acid (50, 300 and 600ppm) into the leaf axils of developing suckers had no significant effect on the number of following suckers produced over a 16 week period. Similarly GA did not influence the growth and leaf emergence rates. As there was no significant differences between treatments, and no visual observations of retarded growth of the treated sucker or following suckers, it may be useful to undertake further research using stronger concentrations of GA. Furthermore, it is suggested that alternative application methods are investigated such as trickling a higher amount of solution into the leaf axils (e.g. 8mL instead of 4mL) or by directly injecting GA into the pseudostem of the developing sucker (these application methods may become difficult for suckers that have not yet developed functional leaves).

Appendix 5.4: Scoping the use of barcode-style technology for yield mapping

Background

There is currently no simple, labour efficient way to accurately measure yield of bananas down to the block or even row level. There are several benefits to understanding how different areas of a property are performing. Yield mapping information of this nature would assist decision making on when to knock out a block, when to nurse sucker a block, if areas of the farm require different fertiliser requirements, crop forecasting etc. Technology, namely the use of barcodes or RFID tags could potentially enable fast, reliable and accurate yield mapping information to be generated.

The system

It is anticipated that RFID tags could be added to the bunch (at the top of the bunch stalk) at the same time the bunch covers are applied. At this point the block ID and the date would be recorded for each bunch (this could help with crop forecasting). For sheds set up with an endless chain system all bunches pass individually through a nominated point. It is anticipated that an automatic scale system integrated into this process would allow the weight of each bunch to be recorded against its respective barcode.

Barcodes or RFID tags?

Discussions held with commercial barcode companies have shown that for this application RFID tags would be preferential to barcodes, although they are generally more expensive. Two main reasons for this are a) barcodes are considered 'line of site' technology and need to be in the correct position to be read by a barcode scanner whereas RFID's don't and can be read from a greater distance (5-10m). b) They are geo-locatable therefore it is possible to identify location within a block without manual input.

What does it cost?

Generally speaking the cost associated with setup of a bunch recording system consists of hardware, software (web based interface), and consumables. For the hardware which would consist of RFID reader's accessories, server and backup system is estimated at $23 000. The cost of programing the web interface system to collect and interpret data is estimated at $22 500. RFID tags range in price and are presumably dependant on quantity but are estimated at $0.55 each. Allowing for an installation and training allowance of $5500 the total estimate for implementing a system comes in at $51 000.

*All estimated costs excluding GST.

* Costs based on quotation obtained from QLD based company which is only an estimate based on information provided.

Appendix 5.5: Investigating bunch bag colour options to improve visual appeal of winter grown subtropical Cavendish bananas

Introduction

Under peel chilling, often referred to as dull or stale fruit, remains a significant problem for Cavendish bananas grown through the winter months in northern New South Wales (NNSW) and cooler production areas of north Queensland. When fruit are subject to temperatures below 13°C, the resultant underpeel chilling gives the fruit a greyish colour and reduces the visual appeal of the bananas and consumer acceptance of this fruit. Some research has been conducted on underpeel chilling in Australia, however much of this has occurred in the cooler areas of the tropics and no objective measurements of the effect of bag colour on fruit peel colour has been conducted in the subtropics. Uneven fruit colouring can also be an issue with one ripener having to re-sort ripened fruit prior to despatch to ensure even colouring in cartons to meet supermarket specifications. Anecdotal evidence exists of the effect of bag colour on fruit colour and quality, however little research has been published.

Reports from Brazil (David Peasley pers. comm.), where bananas are grown under a similar subtropical climate to Australia, have suggested that using black bags through the winter months can reduce the incidence of underpeel chilling and therefore improve fruit visual appeal.

A trial to compare the effect of black bags to standard grower treatments on skin colour was established at Uralba in NSW in May 2016 and harvested November 2016.

Methods

Trial design

The trial was a randomised block design with five replicates. Each block consisted of a double row of Cavendish bananas, cv. Williams, approximately 100m long. Treatments were randomised along these rows. Four bunches of similar age were selected in each block as the treatment bunches. There were five replicate blocks. Trial treatments are shown in Table 1 and trial layout in Table 2. The black/silver bag treatment was half-black and half-silver split vertically with the silver side of the bag placed facing outwards. The yellow silver bags had the top third of the bag silver.

Bunch emergence in the blocks was not synchronised and plants were not sequential in each block. The trial was bagged on 28/05/16 and harvested on 01/11/16. All bunches were pruned to seven hands at the time of bagging, as this is the grower's standard practice at this time of year. A Tiny Tag Ultra 2 data logger was placed in each bag, set to measure temperature and relative humidity every 20 minutes..

Table 1: Four bunch bag colours used in the trial

Treatments	
1	Yellow/silver single bag plus liner
2	commercial half black half silver bag plus liner
3	homemade black bag plus liner
4	double yellow/silver bag plus liner

Table 2: Trial layout, randomised block design

1	4	3	3	4
2	3	1	2	1
4	1	2	4	3
3	2	4	1	2

The third hand from each bunch was selected for trial analysis. Bunch assessments included; total bunch weight, peduncle weight, number of fingers and finger length and diameter on the fourth finger from the left on hand three and the last hand (seven). The third hand from each treatment was then equally divided in two. One half of the hand was ripened with ethylene and CO_2 at 12.5-14.5°C for 7 days and the remaining fruit stored at 12.5-14.5 without ethylene to prevent ripening. Fruit was then driven in an air-conditioned vehicle, to the NSW DPI Ourimbah laboratory, where the temperature remained around 22°C, then stored overnight at laboratory temperatures prior to assessment.

Fruit quality assessments

Peel colour, uniformity of degreening, time to eating ripe and fruit firmness was assessed on eight ripened fruit and eight unripened fruit per treatment. Peel colour was objectively measured on the middle part of the fruit with a Minolta CR-400 Chroma meter, using the CIELAB (L*, a*, b*) colour space abbreviation and expressed as hue angle (H°). Flesh firmness was measured on a 1 cm transversal slice of banana pulp (peel removed) on four of the ripened fruit on 11/11/16 with an Effegi penetrometer (8 mm diam. probe) mounted on a drill press. Uniformity of ripening was rated on scale of: 1 = completely uniform, 2 = some non-uniform, 3 = medium non uniform, 4 = 50% green & 50% yellow

Results

Bunch and fruit quality assessments

Trial results were analysed using an analysis of variance. There was no statistical difference in any of the bunch assessments between any of the treatments except for the weight of the eight fingers. The average weight of eight fingers from the black/silver treatment was significantly less than the other treatments, however there was no significant difference in bunch weights between treatments. Fruit on the top hand of the black bag treatment was sunburnt and split so this may have affected final bunch weights.

Peel colour ratings for both the unripened and ripened fruit the fruit colour, represented by hue angle, did not differ significantly for the black and black/silver bags and for the yellow single and yellow double bags, however the hue angle was significantly different between the black bag and yellow bag treatments (Figures 1 2 and 3). The higher hue angle numbers show the fruit colour is more green than yellow for both ripe and unripe fruit.

Figure 1: Differences in colour were evident in the freshly harvested fruit. Treatments were, from left to right, double yellow bag, single yellow bag, black/silver bag, heavy black bag. All treatments included a cloth liner between the bag and the fruit.

Figure 2: A comparison of unripe and ripe fruit from each treatment 10 days after harvest. Treatments were, from left to right, double yellow bag, single yellow bag, black/silver bag, heavy black bag. All treatments included a cloth liner between the bag and the fruit.

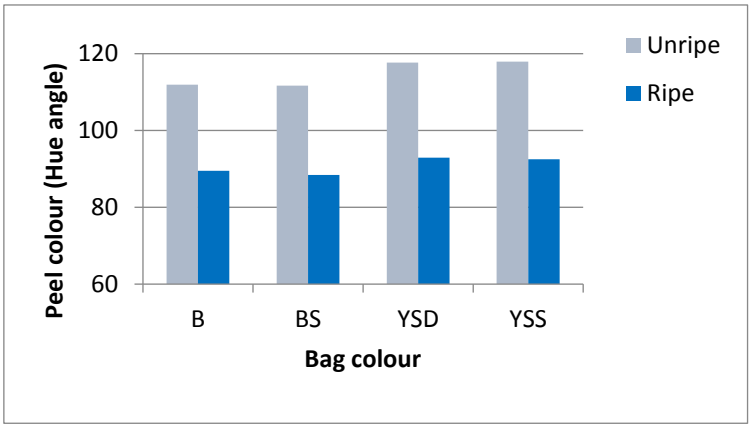

Figure 3: Peel colour, represented by hue angle, differed significantly with bag colour between the different bag colours, but was not significantly different when bag colour was the same. The higher hue angle number indicates fruit is more green than yellow.

Fruit from the black bag treatments were also duller than the fruit from the yellow bag treatments. LSD was 1.27 for unripe fruit and 2.8 for ripe fruit at P≤0.05.

Days to eating ripe (Stage 6, Image 4) was significantly longer for the black/silver treatment than for the each of the other three treatments, which did not differ (Figure 4).

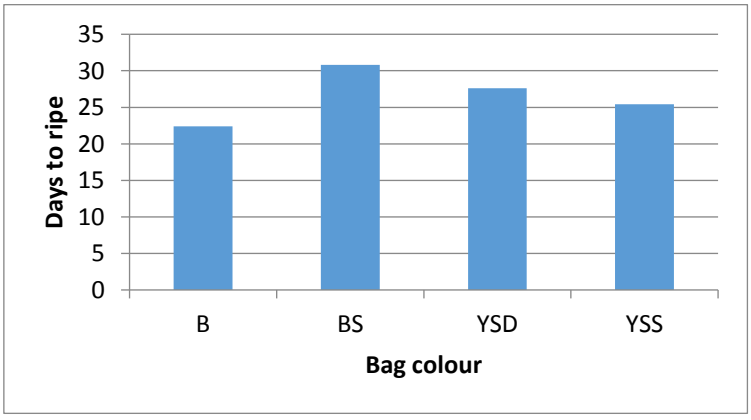

Figure 4: Days to eating ripe was similar for all treatments except the black silver bag, which took significantly longer to reach eating ripe. LSD = 5.11 at P≤0.05

Uniformity of ripening (degreening) was greatest in the black and black/silver treatments (rating 1) and worst in the yellow bag treatments (rating 3). There were no significant differences between the treatments with the same bag colour however; the different bag colours were significantly different (Images 2 and 3, Figure 5).

Figure 5: Fruit excess to quality rating requirements were boxed and treatments ripened separately. The different treatments affected the uniformity of degreening and are, from left to right double yellow bag, single yellow bag, black/silver bag, heavy black bag. All treatments included a cloth liner between the bag and the fruit.

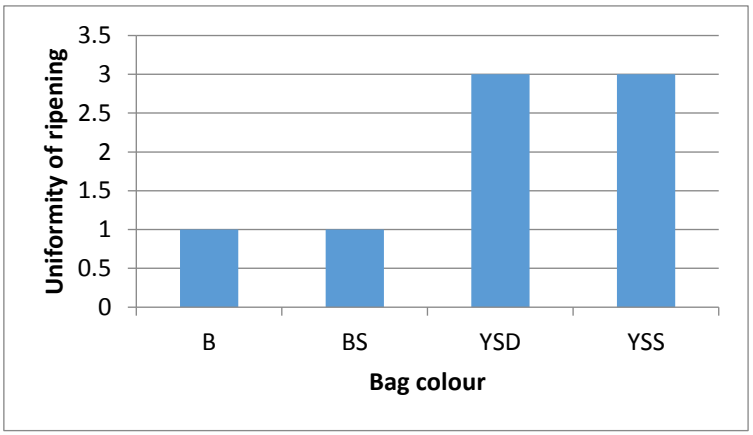

Figure 6: Fruit from the black and black/silver treatments degreened much more evenly than from the yellow bag treatments. LSD = 0.93 at P=0.5.

Temperature and humidity

Temperature and relative humidity trends were evident inside the bags for the different bag colour treatments. Temperatures in the black/silver bag treatment were consistently lower throughout the trial. During July and August, the coldest months of the trial, where temperatures ranged between 6.5 and 25 °C, the black bag treatment temperatures were consistently higher both day and night (Figure 7).

As daytime temperature rose from mid-September through October, the temperature was higher from late afternoon and remained higher until early morning in the double yellow bag treatment, after which the temperature in the black bag was higher (Figure 8). The effect of temperature on relative humidity was reflected in the trial with the treatments with higher temperature having lower relative humidity (Figures 7 and 8).

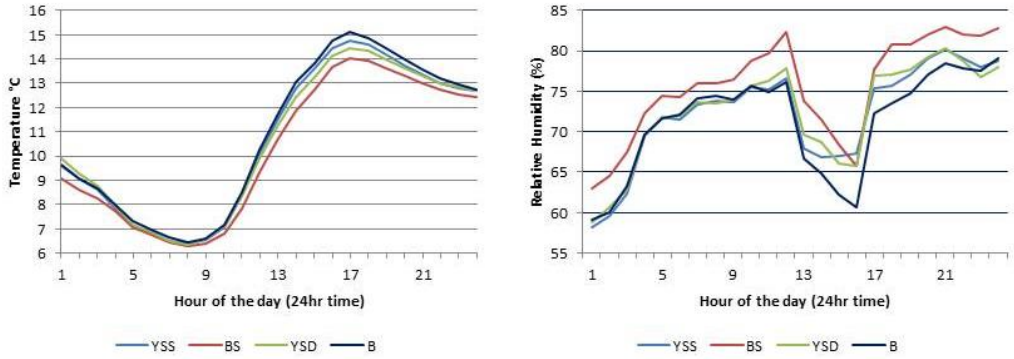

Figure 7: Average hourly temperature and relative humidity for the four different bagging treatments for the coldest day of the trial, 26/06/16.

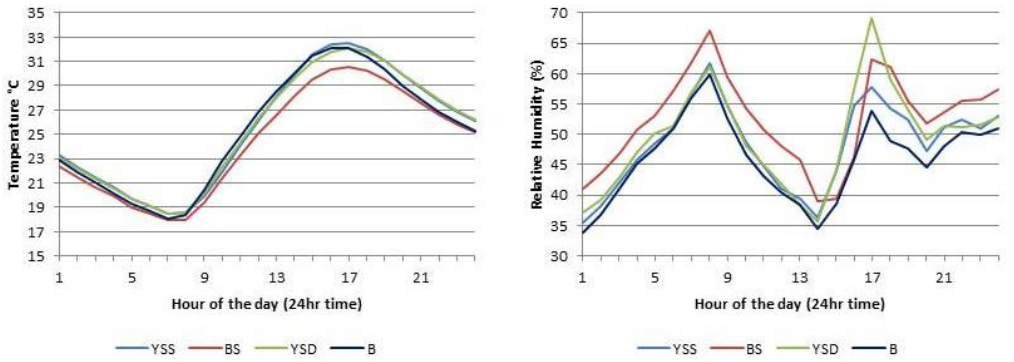

Figure 8: Average hourly temperature and relative humidity for the four different bagging treatments for the hottest day of the trial, 8/10/16.

Discussion and recommendations

Bag colour can significantly affect the colour, degreening and ripening behaviour of banana fruit grown through the winter months in NNSW. The black bags treatments degreened more uniformly and were approximately two days quicker to reach ripeness stage 4 for delivery as per supermarket specifications (Figure 9). This has potential benefits as fruit may not need re-sorting prior to despatch and ripening times and costs may be lower. This fruit will show less physical defects as all fruit handling results in physical damage, which results in a shorter shelf life.

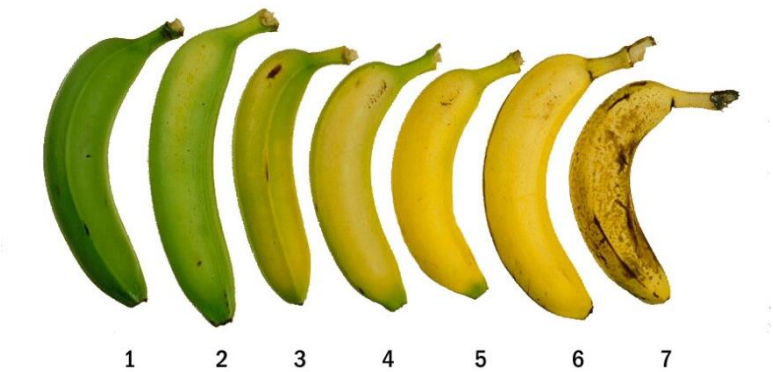

Figure 9. Banana ripeness stages.

The black bag treatments did not reduce underpeel chilling as temperatures inside the bags still dropped below 13°C. As fruit in the black bags were lighter, possibly because chlorophyll development was less in these fruit, as they were not exposed to sunlight, and the underpeel chilling was more obvious.

This research does however suggest that bag colour may be able to improve ripening uniformity and shelf life. A short report from Columbia has suggested that red and green bags can improve fruit quality and shelf life and further trials comparing these bag colours to the grower standard treatments would be worthwhile as dull fruit, caused by underpeel chilling, remains a significant production constraint Cavendish bananas grown subtropical and cooler tropical production areas.

Acknowledgments

The following are thanked for their help in completing this trial. All the staff at Uralba Valley bananas, especially Ian and Melinda Simpson, during the trial establishment and harvesting, John Golding, Shasi Satyan and Mark Bullot from the NSW DPI Ourimbah laboratory for their help with trial rating, Stephen Morris, DPI Wollongbar, for trial data analysis and Mark Hickey and David Peasley for comments on this report.

Appendix 6: Banana BMP Environmental guidelines

Appendix 6.1: Review of the Banana Best Management Practices: Environmental Guidelines

Summary

The banana best management practices (BMP): Environmental guidelines were developed in 2013 by the Queensland Department of Agriculture and Fisheries in partnership with the Australian banana industry with funding support from the Queensland government's Reefocus extension project and the Horticulture Australia Ltd project BA11006 Developing a best management practices guideline for the Australian banana industry. This resource had been designed with the guidance of banana growers for growers to assess their environmental performance. The guidelines follow the structure of the Freshcare Environmental Code which is used by many growers in the industry. The resource consists of two complimentary components: The information resource and the on-line tool. The on-line tool allows growers to systematically review their production processes, identify priority action items for improvement, develop a management action plan and benchmark their environmental practices against the industry.

The review of the BMP will consist of identification and inclusion of developing and emerging best practices, removal of out of date practices and technologies and verification that the web links are active.

Method

The review of the BMP has been divided into two components: Content review and an on-line functionality review. Although these two components are complimentary, different approaches have been taken to review them.

Content Review

The content in the first version of the BMP was thoroughly compiled with consultation with growers in all the growing regions, technical experts, key industry personnel and stakeholders, as well as communication with Freshcare. The author of the first version went through several reviews to achieve the high standard of the current version of the BMP. Since such a thorough process was taken to develop the current content only an assessment of practice changes and research over the past 3 years was undertaken. The growers in the initial reference group were consulted both individually and as part of group to determine and confirm any changes to the content and self-assessment criteria. Engagement with key stakeholders including Freshcare, and researchers involved in recent R & D was a key part of determining alterations and improvements to the content. Contact was made with the major retailers, Coles, Woolworths and Aldi to understand their environmental requirements, gauge whether there were any anticipated changes to these requirements and also remind them about the Environmental BMP Resource.

The results from the self-assessment checklist were analysed to determine overall those areas in growers were not performing well. These areas were then re-evaluated to determine the potential causal factors, taking into the consideration the achievability of the criteria. In addition to these records, feedback received during previous workshops was compiled and evaluated. Once the changes were reviewed by the reference group they were incorporated into version two of the BMP and hosted on the ABGC website

On-line functionality review

The on-line functionality review was conducted by simulating a farm login and observing the functionality of the on-line system. All the hyperlinks were checked to ensure they were still active and alternative links were found if they were not. Comprehensive discussions were held with two growers who were identified as more frequently using the system to determine what system improvements were needed. The NSW industry development officer was also engaged in this process to determine functionality aspects which could improve

the adoption of the BMP in NSW. The list of potential improvements was then provided to the company which developed the on-line system (The Code Company) to understand the complexity involved with the suggested improvements and obtain an estimated budget for the anticipated upgrades. The suggested improvements were confirmed by the reference group of growers before appointing the company to make the changes.

Review

Content Review

The full list of changes, improvements, additions and updates are detailed in Appendix 1. However the key changes and background for the changes are as follows:

Practice changes

The major event that has occurred since the development of the resource was the detection of Panama Disease Tropical Race 4 in March 2015. Although this is not directly an environmental related issue it is does have some implications for the practices that are described in the BMP. For example for properties that are infected, spreading of waste bananas and stalks is not a best practice for managing movement of the disease and in which case storing them in piles away from waterways would be an acceptable practice. Biosecurity Queensland has set and published standards that properties which have confirmed cases of Panama Disease tropical race 4 are required to adhere to. This document was cross referenced against the BMP environmental guidelines to ensure that practices did not conflict with these requirements. The Panama disease section (pg76-77) in the BMP has been updated to reflect current best practice. Upon the completion of the initial BMP it was identified that there would be a need for more emphasis on on-farm biosecurity. A new project which has commenced since the detection of Panama disease Tropical Race 4 will facilitate the development of a biosecurity module for the BMP. This on-farm biosecurity resource will sit alongside the BMP: Environmental guidelines and will follow the same self-assessment checklist with some modifications.

Freshcare Environmental

At the time of this review the Freshcare Code of Practice: Environmental was in the final draft stages for the 3rd Edition. Overall the BMP still reflected the compliance criteria set by Freshcare. The notable new edition to the 3rd edition of the Freshcare Code of Practice: Environmental was the inclusion of a biosecurity section which has been slotted in after the Land and Soil section. The three aspects broadly covered under the code include: Managing access to the property, managing planting material and monitoring and reporting unusual findings. Although there is an additional module being developed as part of another project (BA14013) which comprehensively covers on-farm biosecurity, several questions have been included in the self-assessment checklist to meet the criteria for the Freshcare environmental code. Consequently the on-farm biosecurity questions specific to Panama disease in the checklist have been removed. To mirror the checklist and the information resource, information from the BMP about managing disease was modified and moved to its own section on biosecurity.

Chemical & Pesticides

The pesticides section underwent technical review by Jonathan Parsons from ChemCert and minor changes were made to ensure information was up to date. For example the details of accreditation required to use chemicals, and clarification that the DrumMUSTER®program accepts empty chemical drums where as ChemClear® accepts unwanted or out-of-date chemicals. Similarly links to permits which had expired were updated.

Retailer requirements for environmental accreditation

Coles, Woolworths and Aldi were contacted in the process of this review to establish the minimum environmental requirements for their suppliers. Whilst all three had strict requirements for food safety accreditation systems with different preferences for certain systems, Coles was the only retailer actively

pursuing information about environmental practices.

Since the development of the BMP in 2013 Coles has introduced a self-assessment environmental audit system which growers that supply them are required to complete. It is currently not mandatory for their suppliers to complete a third party audited environmental accreditation e.g. Freshcare Environmental, Enviroveg Platinum or Global Gap. However for the growers that do complete a third party audited accreditation they are only required to answer the last two questions in each section which are about providing examples of improvements that a grower has made and defining any requirement for more information or training. The Coles environmental system which is used for all the different fruit and vegetable commodities is divided into 9 sections:

1) Farm Details

2) Water Management

3) Land and Soil Management

4) Waste

5) Chemical and Integrated Pest Management

6) Fertiliser and Soil Additive Management

7) Energy

8) Biodiversity

9) People Management.

The system uses an online software system called muddyboots (http://en.muddyboots.com/) to collect the data.

Discussions were held with the grower reference group about the possibility of improving features of the BMP streamline the use of the Coles environmental system. Although changing the entire format to suit the Coles environmental system was not feasible, providing two boxes at the bottom of each section to align with the additional two questions surrounding providing examples of improvements and defining requirements for more information/training was discussed. However, since data in the Coles environmental system needs to be collected using muddyboots, adding these questions to the BMP would not add any value for either Coles or the grower.

Environmental Reporting and Benchmarking

Australian Banana Growers Council (ABGC) and Terrain NRM were approached and asked to provide comment and suggestions for improvements to the BMP. It was a recommendation from both of these organisations to include a question where growers can nominate how much nitrogen they use. Terrain and ABGC made a recommendation to include an aspect estimated nitrogen use. Adding a question into the checklist regarding nitrogen application rates was discussed with the grower reference group and it was agreed to include a data capture style question. The question would give growers the opportunity to nominate in ranges of 50kg how much nitrogen they apply per hectare per year. The best, okay, improve categories won't be applied to these values as the question is purely for data capture and benchmarking only. Terrain had also made the recommendation for growers to nominate which catchment or sub-catchment they fall into to assist with modelling run-off. If growers nominated which catchment they belong to (e.g. Wet Tropics) the scale was too broad for the modelling. The alternative was to use the 517 sub-catchments in Queensland which are used for modelling run-off. However this was deemed not to be feasible due to the potential ability to identify individual farms and also the practicality of growers being able to determine which sub-catchment they are located in. The other option was to identify growers at the state level. The on-line system already prompts growers to input their postcode when they login for the first time. However it previously wasn't mandatory.

The upgrades mean that it is now mandatory so grower's data can now be easily averaged down to the state level. In this discussion regarding data ownership it was clarified and confirmed ABGC would remain the custodian of the data entered into the on-line BMP checklist and it would continue to remain confidential.

On-line functionality review

The on-line functionality of version 1 is quite good with only a few minor items requiring attention. For example, there were a few issues with entering dates and some of the N/A categories did not register. Therefore it was decided to seek out potential improvement options for the on-line system. Currently the management plan allows users to set a completion date for a nominated activity. The new system will now allow growers to set both a commencement and completion dates to allow for forward planning and prioritisation. The other key improvement to the management plan is that users will now be able to upload evidence (e.g. a photo or document) of progress &/or completion of a task. The content in the reference material has been updated in the new on-line version and similarly all hyperlinks which were no longer active have been updated or removed (Appendix 1 & 2)

The standalone section for Biosecurity has also been included on the on-line version. Unfortunately the way the on-line program was designed and due to issues with merging data from current users the new Biosecurity section sits at the end of the checklist. The does not have any impact on the functionality of this section. If the opportunity arises in a future review to completely re-write the on-line system this is a point for improvement.

Another important improvement is the generation of automatic reminders. The system will now send an automated reminder on the date the user nominated to either commence or complete start a task in their management plan. In addition to that, if users have not logged into their profile in a 12 month period they will also receive an automated reminder e-mail (See Appendix 3).

To make the BMP more relevant for growers in NSW and WA changes have been made to benchmarking ability. Currently the on-line system averages results from all BMP users and produces an industry average pie chart for growers to compare their practices against. The new system now allows growers from each state to compare against their state only or against a national average. For example NSW will now be able to compare against growers in NSW only as well as nationally.

Observing the raw data output from the BMP it was evident that some growers which have multiple farms had only completed the BMP for one of their properties. Although their practices may differ from property to property, the majority of the time there are only minor changes in the different environmental practices that are implemented. The on-line system will now allow auto population for farms managed by the same owner. Users can then go in and alter the few practices that may differ between properties. Easier management and archiving of the raw data sets was also identified as a needed improvement. Currently the data from the BMP needs to be manually saved into spreadsheet files at regular intervals to ensure there is an opportunity to compare changes in practice over time. Therefore another important upgrade to the on-line system is the ability to automatically save data reports on a monthly basis. This will allow historical data to be drawn upon to demonstrate industry practice change in the future.

With more and more technology being integrated into banana farming practices the role of mobile accessibility is becoming increasing important. Therefore the website has been altered to allow it to be easily used on mobile devices. The ability for the website to be mobile friendly is also increasingly important as a mobile application specific for the banana industry is being developed which will allow growers to electronically record and monitor their fertiliser and chemical inputs.

Conclusion

The BMP Environmental Guidelines is an excellent resource for banana growers. Although environmental practices have not significantly changed in the three years since the resource was released this review has provided an update to the information and positioned the on-line system for future requirements. The feedback from the grower reference group was that they felt that the resource was very comprehensive and the content or format of the resource was not the barrier to some growers adopting BMP. The BMP resource is only a tool to assist in documenting and implementing practices that reduce sediment and nutrient run-off from banana farms. It is important that growers are encouraged through extension of current knowledge of environmental systems to progressively implement environmentally sustainable practices. The industry has come a long way in implementing best environmental management practices however it important that R & D coupled with extension continues to drive the uptake of these practices by growers who are yet to implement best environmental practices.

Additional Information: List of changes to the BMP Content

Page Number - in Version 2	Change/comment
Title page	Updated cover page
Throughout	Change to Version 2 – April 2016 in footer, DAFF to DAF, HAL to HIA, update various images, updated links
V	Reviewed foreword and acknowledgements section –formerly employee acknowledgements, added in Jeff Daniels to acknowledgements
14	Add N/A for Soil erosion section 2
18	Biosecurity question added here to align with 3rd edition of Freshcare Environmental Code **On-farm biosecurity** **Property Access** • Access to the property is limited to authorised people only and their footwear is **effectively** managed (e.g. footwear exchange and disinfected). Vehicle access to the property is limited and any necessary vehicle movements undergo decontamination prior to entry and upon exit (Best) • Access to the property is limited to authorised people only and their footwear managed (e.g. footwear exchange and disinfected). Vehicle access to the property is limited however there are no decontamination facilities (Okay) • Access to the property is not limited and there are no decontamination procedures in place. (Improve) **Planting** • Planting material is ALWAYS sourced from a certified clean planting material supplier (Best) • Planting material is sourced from own property(Okay) • Planting material is sourced from other properties (Improve) **Suspect Plants** • Property owners and staff members are able to identify plants with unusual symptoms and are aware of how and who to report them to. Any suspect plants are reported to Biosecurity Queensland 13 25 23. (Best) • ONLY property owners are able to identify plants with unusual symptoms and are aware of how and who to report them to. Any suspect plants are reported to Biosecurity Queensland 13 25 23. (Okay) • Little attention is given to plants with unusual symptoms and they are not reported. (Improve)

20	Wording altered in the following chemical questions: **Storing** • The chemical storage area is locked, bunded and ventilated, and is either located in an area where spills will not affect waterways, or measures are in place to ensure potential spills will not affect waterways. (Best) • The chemical storage area is locked, bunded and ventilated, and is either located in an area where spills will not affect waterways, or measures are in place to ensure potential spills will not affect waterways. (Okay) • The chemical storage area is not bunded and spills could not be contained. (Improve) • N/A **Handling and applying** • Only appropriately-trained staff handle and apply chemicals. Other staff cannot access or use chemicals. (Best) • Measures are not in place that prevent unqualified staff from accessing chemicals. (Improve) • N/A **Disposal** • Empty chemical drums and unwanted or out-of-date chemicals are disposed of through DrumMUSTER® and ChemClear® programs respectively. (Best) • The DrumMUSTER®program for empty drum disposal is not utilised, neither is ChemClear® for the disposal of unwanted or out-of-date chemicals. (Improve) • N/A
P23 Q1	Included Predatory mites are released to manage pest mites species
24	Removed Panama questions as the biosecurity section will replace these.
25	Add in data capture style question about Nitrogen Fertiliser Use. **Nutrient Target** – indicate average nitrogen application rate • 100-150 kg/ha/year • 151-200 kg/ha/year • 201-250 kg/ha/year • 251-300 kg/ha/year • 301-350 kg/ha/year >350 kg/ha/year
P26 Q4	Added - If fertiliser is broadcast be hand and applicator to measure the correct amount is used
30	Remove blank dot point from Biodiversity section 4

31	Add in Okay category – Attempts are made to manage feral animals to minimise their populations and impact on the environment. In best category change 'controlled' to 'managed'
32	Waste bananas question updated due to panama considerations **Waste bananas** • Waste bananas and stalks are mulched and spread back onto the banana paddock OR waste bananas are dumped in a single pile where water does not directly flow into waterways. (Best) • Waste bananas and stalks are dumped in a single pile where surface water flows directly into waterways. (Improve • N/A
33	Removed fertiliser bags and containers question as fertiliser bags are no longer collected by provider. Covered under general waste in Q1 (Waste)
33	Waste bananas – added in OR waste bananas are dumped in a single pile where water does not directly flow into waterways to best category. Removed okay category.
47	Refer to relevant pages of the NSW resource
48	Constructed waterway – added vegetated
49	Drains point 1 – change ballast to rock
49	Drains point 5 – is it worth including an image of a 'drop structure'?
52	Erosion peg – changed OH&S sentence to mark the rod or its position
53	Soil acidity and alkalinity point 1 – added in 'nitrate from ammonium based fertilisers is being lost in deep drainage or leaching'
53	Soil acidity and alkalinity – added in a point 'pH conditions outside the optimum range (too acid or too alkaline) can restrict the availability of micro and macro-nutrients as well as influencing soil microbiology'
55-56	Added biosecurity section
57	Integrated Pest and disease management, 3rd paragraph –Added 'can encourage some pest species'
60	Monitor pests and disease – added 'Over time, monitoring will allow you to build an understanding of the environmental conditions and times when pests and diseases occur and concentrate your monitoring efforts accordingly.'
60	Life cycle and epidemiology – add 'pest' in the italicised sentence
64	Spray drift point 4 – change to 'appropriate droplet size for the target. Coarser droplet size reduces the potential for off target drift.'

68	Nematode table – include Spiral in the Subtropics east.
72	BWB Cultural control Baits added 'Trials are underway to determine the best strategy to use these in Australian production systems https://bugsforbugs.com.au/product/banana-weevil-borer-trap-pheromone/.'
75	Cultural control rust thrips monitoring- added image of rust thrips
76	Spider mites – changed last point to 'using chemicals that increase spider mite egg laying.'
76	*Introducing Predatory insects - Phytoseilus persimilis* in italics
80	Chemical control paragraph 1 - added 'Recent testing has shown that some banana leaf disease pathogens have developed resistance to strobilurins.'
80-83	**Panama disease – updated this section**
82	Physical control – changed to 'Plants experiencing waterlogging, stress and subsequently oxygen deficiency are more susceptible to infection from Panama disease.'
85	Cultural control Sprayed mulch layer – change tree to plant in the last sentence
87-88	Added section on fruit speckle
95	Applying fertiliser and soil additives dot point 7 – added 'If broadcasting by hand it is important to use an application technique that accurately measures the amount of fertiliser you apply e.g. a small cup or container.'
103	Added breakout box 'increasing soil organic matter will increase soil water holding capacity. A 1% increase in organic matter to a depth of 30cm per hectare, will hold an additional 60 000L of water.'
104	Water quality paragraph suitability for intended use - updated
108	Biodiversity section - the CMAs have now been replaced by the Local Land Services (LLS) - changes from CMA to LLS have been made throughout.
112	Paragraph 3 add LLS to first sentence
116	Managing disease section has been moved to the new biosecurity section (pg. 55-56)
137	Irrigating bananas – removed section, as factsheet is no longer active
139	Managing flying foxes – removed section, as factsheet is no longer active
98 & 102	Reference to additional information replaced with new url

Additional Information: List of hyperlinks which have been updated or deleted

Broken Link	New Link
http://permits.apvma.gov.au/PER11733.PDF	http://permits.apvma.gov.au/PER14850.PDF
http://www.daff.qld.gov.au/4789_18453.htm	http://era.daf.qld.gov.au/3498/
www.dpi.nsw.gov.au/_data/assets/pdf_file/0007/242359/soil-and-water-best-management-practices-for-nsw-banana-growers.pdf	http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/242359/soil-and-water-best-management-practices-for-nsw-banana-growers.pdf
http://www.nrm.qld.gov.au/factsheets/pdf/river/r31.pdf	http://www.qld.gov.au/dsiti/assets/soil/stream-bank-planting-guidelines.pdf
http://www.nrm.qld.gov.au/land/management/erosion/index.html	http://www.qld.gov.au/environment/land/soil/erosion/management/
https://www.daf.qld.gov.au/_data/assets/pdf_file/0009/54738/AgChem-UsersManual.pdf	https://www.daf.qld.gov.au/__data/assets/pdf_file/0009/54738/AgChem-UsersManual.pdf
www.dpi.vic.gov.au/agriculture/farming-management/chemical-use/agricultural-chemical-use/spraying-spray-drift-and-off-target-damage/ag0860-using-buffer-zones-and-vegetative-barriers-to-reduce-spray-drift	http://agriculture.vic.gov.au/agriculture/farm-management/chemical-use/agricultural-chemical-use/spraying-spray-drift-and-off-target-damage/using-buffer-zones-and-vegetative-barriers-to-reduce-spray-drift
http://abgc.org.au/projects-resources/industry-projects/best-management-practice-project	http://abgc.org.au/wp-content/uploads/2013/04/Managing-banana-nematodes_edited-version.pdf
http://abgc.org.au/projects-resources/industry-projects/best-management-practice-project	http://abgc.org.au/projects-resources/industry-projects/best-management-practice-project/
http://www.chemtica.com/site/?p=2764	http://www.chemtica.com/site/?p=2764
www.planthealthaustralia.com.au/industries/banana	http://www.planthealthaustralia.com.au/wp-content/uploads/2015/03/Farm-Biosecurity-Manual-for-the-Banana-Industry.pdf
www.growcom.com.au/home/inner.asp?pageID=57	http://www.growcom.com.au/land-water/water-for-profit/resources-water-for-profit/
www.growcom.com.au/_uploads/54745WFP_Packingshed_water_use_treatment_options.pdf	http://www.growcom.com.au/wp-content/uploads/2013/12/Packing-shed-water-treatment-options.pdf

www.regionalnrm.qld.gov.au	http://www.nrm.gov.au/regional/regional-nrm-organisations
www.environment.gov.au/cgi-bin/sprat/public/conservationadvice.pl	http://www.environment.gov.au/cgi-bin/sprat/public/conservationadvice.pl
www.environment.gov.au/biodiversity//index.html	http://www.environment.gov.au/biodiversity
http://wetlandinfo.ehp.qld.gov.au/wetlands/management/wetland-management/	http://wetlandinfo.ehp.qld.gov.au/wetlands/management/wetland-management/ **Banana case study** http://wetlandinfo.ehp.qld.gov.au/resources/static/pdf/resources/reports/farming-case-studies/cs-bananas-12-04-2013.pdf
www.cleanenergyregulator.gov.au/Carbon-Farming-Initiative/Pages/default.aspx	http://www.environment.gov.au/climate-change/emissions-reduction-fund/cfi/about
www.growcom.com.au/_uploads/114345Climate_Change_Factsheet_No_3_LR.pdf	http://www.growcom.com.au/_uploads/114251_Climate_change_and_horticulture.pdf
www.bp.com/business/iframe.do?categoryId=9038671&contentId=7070696	http://www.msds.bp.com.au/
www.shell.com.au/home/content/aus/products_services/on_the_road/fuels/msds_tds/	http://www.shell.com.au/products-services/on-the-road/fuels/msds-tds.html
www.dpi.nsw.gov.au/_data/assets/pdf_file/0007/242359/soil-and-water-best-management-practices-for-nsw-banana-growers.pdf	http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/242359/soil-and-water-best-management-practices-for-nsw-banana-growers.pdf
www.safeworkaustralia.gov.au/sites/SWA/AboutSafAboutSafeWorkA/WhatWeDo/Publications/Pages/CP2001StorageAndHandling.aspx	http://www.safeworkaustralia.gov.au/sites/swa/about/publications/pages/ns200103storageandhandling
www.safeworkaustralia.gov.au/sites/SWA/AboutSafeWorkAustralia/WhatWeDo/Publications/Pages/NS200103StorageAndHandling.aspx	http://www.safeworkaustralia.gov.au/sites/SWA/about/Publications/Documents/249/CodeOfPracticeStorageAndHandingDangerousGoodsNOHSC2017-2001_PDF.pdf
www.croplifeaustralia.org.au.	http://www.croplife.org.au/
www.goodbugs.org.au.	http://www.goodbugs.org.au./
www.chemcert.org.au	http://www.chemcert.com.au/
www.smarttrain.com.au.	http://www.smarttrain.com.au./

www.legislation.qld.gov.au/OQPChome.htm. www.legislation.nsw.gov.au www.legislation.wa.gov.au www.legislation.nt.gov.au	http://www.legislation.qld.gov.au/OQPChome.htm http://www.legislation.nsw.gov.au http://www.legislation.wa.gov.au http://www.legislation.nt.gov.au
www.ehp.qld.gov.au	http://www.ehp.qld.gov.au/
www.ehp.qld.gov.au/wildlife/livingwith/flyingfoxes	http://www.ehp.qld.gov.au/wildlife/livingwith/flyingfoxes/
www.environment.nsw.gov.au/animals/flyingfoxes.htm	http://www.environment.nsw.gov.au/animals/flyingfoxes.htm.
www.parksandwildlife.nt.gov.au	https://parksandwildlife.nt.gov.au/
www.environment.wa.gov.au/management-and-protection/animals/living-with-wildlife	Deleted – link no longer exists
http://abgc.org.au/projects-resources/industry-info/subtropical-fact-sheets/.	http://abgc.org.au/projects-resources/industry-info/fact-sheets-info/.
www.dnrm.qld.gov.au.	https://www.dnrm.qld.gov.au/
www.terrain.org.au	http://www.terrain.org.au
www.northerngulf.com.au	http://www.northerngulf.com.au
www.capeyorknrm.com.au	http://www.capeyorknrm.com.au
http://www.bmrg.org.au	www.bmrg.org.au
www.seqcatchments.com.au	http://www.seqcatchments.com.au/
www.comlaw.gov.au	https://www.legislation.gov.au/
www.territorynrm.org.au	http://www.territorynrm.org.au/
www.nrm.gov.au/regional/regional-nrm-organisations	http://www.nrm.gov.au/regional/regional-nrm-organisations
www.rangelandswa.com.au	http://www.rangelandswa.com.au/
www.austlii.edu.au	http://www.austlii.edu.au/

www.edo.org.au	http://www.edo.org.au/
www.greeningaustralia.org.au	https://www.greeningaustralia.org.au/
www.landcareonline.com.au	http://www.landcareonline.com.au/
www.weeds.org.au/WoNS.	http://www.weeds.org.au/WoNS/
www.weeds.org.au/noxious.htm.	http://www.weeds.org.au/noxious.htm.
www.weeds.gov.au.	http://www.weeds.gov.au
www.greenpower.gov.au.	http://www.greenpower.gov.au
www.climatechange.gov.au/government/initiatives/carbon-farming-initiative/methodology-development.aspx.	http://www.climatechange.gov.au/government/initiatives/carbon-farming-initiative/methodology-development.aspx.
www.safeworkaustralia.gov.au/AboutSafeWorkAustralia/WhatWeDo/Publications/Pages/NS200103StorageAndHandling.aspx.	http://www.safeworkaustralia.gov.au/AboutSafeWorkAustralia/WhatWeDo/Publications/Pages/NS200103StorageAndHandling.aspx
www.safeworkaustralia.gov.au/sites/SWA/AboutSafeWorkAustralia/WhatWeDo/Publications/Pages/CP2001StorageAndHanding.aspx.	http://www.safeworkaustralia.gov.au/sites/SWA/AboutSafeWorkAustralia/WhatWeDo/Publications/Pages/CP2001StorageAndHanding.aspx
www.saiglobal.com.au/store.	http://www.saiglobal.com.au/store.
www.msds.exxonmobil.com/psims/psims.aspx	http://www.msds.exxonmobil.com/psims/psims.aspx
www.daff.qld.gov.au	http://www.daf.qld.gov.au
www.daff.qld.gov.au/plants/fruit-and-vegetables/fruit-and-nuts/bananas	http://www.daf.qld.gov.au/plants/fruit-and-vegetables/fruit-and-nuts/bananas
www.dpi.nsw.gov.au/agriculture/horticulture/tropical	http://www.dpi.nsw.gov.au/agriculture/horticulture/tropical
www.dpi.nsw.gov.au	http://www.dpi.nsw.gov.au
www.nrm.qld.gov.au	http://www.nrm.qld.gov.au
www.apvma.gov.au	http://www.apvma.gov.au
www.dpi.nsw.gov.au	http://www.dpi.nsw.gov.au

www.dpi.nsw.gov.au/agriculture/resources/soils/structure/cultivation	http://www.dpi.nsw.gov.au/agriculture/resources/soils/structure/cultivation
www.aerialag.com.au	http://www.aerialag.com.au
www.chemcert.org.au	http://www.chemcert.org.au
www.smarttrain.com.au	http://www.smarttrain.com.au
www.chemclear.com.au	http://www.chemclear.com.au
www.dpi.vic.gov.au	http://www.dpi.vic.gov.au
www.dpi.nsw.gov.au/agriculture/horticulture/tropical	http://www.dpi.nsw.gov.au/agriculture/horticulture/tropical
www.croplifeaustralia.org.au/default.asp?V_DOC_ID=1952	http://www.croplifeaustralia.org.au/default.asp?V_DOC_ID=1952
www.growcom.com.au	http://www.growcom.com.au
www.environment.gov.au	http://www.environment.gov.au
www.drummuster.com.au	http://www.drummuster.com.au
www.climatechange.gov.au	http://www.climatechange.gov.au
www.cleanenergyregulator.gov.au/Carbon-Farming-Initiative/Pages/default.aspx	http://www.cleanenergyregulator.gov.au/Carbon-Farming-Initiative/Pages/default.aspx
www.cleanenergyregulator.gov.au	http://www.cleanenergyregulator.gov.au
http://abgc.org.au/projects-resources/industry-info/subtropical-fact-sheets/	http://abgc.org.au/projects-resources/industry-info/fact-sheets-info/
www.environment.wa.gov.au/management-and-protection/animals/living-with-wildlife	No link
www.aspac-australasia.com	http://www.aspac-australasia.com/
www.nrm.qld.gov.au/land/management/land_degradation.html	http://www.qld.gov.au/environment/land/vegetation/
www.daff.gov.au/natural-resources/soils/ems/biodiversity	https://www.daf.qld.gov.au/plants/fruit-and-vegetables/farm-management/emss
http://agbiz.daff.qld.gov.au	https://publications.qld.gov.au/dataset/agbiz-tools-business-and-finance-carbon

http://agbiz.daff.qld.gov.au/tools/business-farm-operations/hortCarbonInfo.XLS	https://www.business.qld.gov.au/industry/agriculture/agribusiness/agbiz

Additional Information: Updated automated reply e-mails to BMP users

Automated e-mail for growers that haven't logged in after 12 months:

Well done on completing the Banana BMP: Environmental Guidelines on-line self-assessment. Do you realise that it has been 12 months since you last logged into your account. Logging in and updating your practices is simple and only takes a few minutes. Recording changes that you make will allow you to keep track of the environmental practices that you have implemented. The banana industry is under growing pressure to increase the number of growers who voluntarily implement best management practices. By updating your BMP, you will assist the industry to understand the extent of implementation of best environmental management practices. However, please be assured that your personal data is NEVER disclosed to any third parties. Aggregated data is used from time to time to monitor overall industry progress. Please click on the link below to be taken to the BMP website.

www.betterbananas.org.au

Automated e-mail for growers who have nominated a task to be completed in their management plan:

This e-mail is a quick reminder that you had nominated to complete/commence a task in you management plan on/by the DD/MM/YYYY. If you have completed/commenced this task, please log in and update your management plan. If this task is still in progress please login and update the estimated completion date. Logging in is simple and will only take a few minutes. By updating your BMP, you will assist the industry to understand the extent of implementation of best environmental management practices. However, please be assured that your personal data is NEVER disclosed to any third parties. Aggregated data is used from time to time to monitor overall industry progress. Please click on the link below to be taken to the BMP website.

www.betterbananas.org.au

Appendix 7: Field walks/workshops

Appendix 7.1: Invite and agenda from the 2014 banana workshop

Friday 21 November 2014, South Johnstone DAFF, 9am – 11.30am

Mite Workshop (1.5 hour)

Were spider mites a problem on your farm over the last summer?

Has the long, dry spell we are experiencing at the moment caused spider mite populations to increase on your farm?

Do you want to know how to manage mites so their populations don't flare?

Come along and hear from a range of speakers about:

- the life cycle of the spider mite
- what conditions cause mite flare
- how to monitor for spider mites
- management options
- the new use registration for Paramite
- sprays – the importance of good coverage and product rotation
- Getting the best from your mister

Presentations will be provided by Richard Piper of Scientific Advisory Services, Allan Blair from the Department of Agriculture, Fisheries and Forestry (DAFF) and Patrick Press of Sumitomo Chemicals.

Fungicide Resistance (10 min)

The banana industry regularly tests for yellow Sigatoka fungicide resistance in far north Queensland. This testing is carried out to monitor how effective the registered fungicide products are. Testing over the last few seasons have showed some concerning trends and growers need to be aware of which products are providing better results. This testing is carried out by Kathy Grice (DAFF- Mareeba) and will be presented by Naomi King (DAFF).

Variety Trial – Plant Data Results (3o min)

Williams is the variety produced by over 95% of the Australian banana industry. The plant data from the industry-funded variety trial at South Johnstone will be discussed. Measurements such as yield, cycle times, fruit length and brix as an indicator for sweetness of these new banana varieties, in comparison to Williams as the industry standard, will be provided by Jeff Daniells (DAFF).

Appendix 7.2: Panama disease tropical race 4 On-farm Biosecurity extension

Background

Immediately following the announcement that Panama disease tropical race 4 had been confirmed on a commercial banana farm in Tully a series of industry meetings hosted by the industries peak body, Australian Banana Growers Council (ABGC) were held to inform growers of the detection, inform them of the steps industry was taking to contain the disease, urge growers to start to implement on-farm biosecurity practices and also give growers the opportunity to ask questions. These meetings periodically held in 3 locations throughout the main growing region (Tully, Innisfail and Mareeba) and were attended by a wide range of industry stakeholders. From these meetings there were a series of questions that growers commonly asked and became evident that a co-ordinated extension program was required to educate growers about the disease and guide them to implement effective on-farm biosecurity practices on their farms. With the disease now being the industry's highest priority Tegan Kukulies and Stewart Lindsay worked in conjunction with the ABGC to develop and deliver the workshops (from March – August) which formed the basis of the ABGC led on-farm biosecurity extension program. Tegan also played an important role in organising and delivering information at the Panama disease tropical race 4 Field Day which was held in November, 2015. Tegan also delivered condensed workshop presentations to growers and industry stakeholders in NSW. The methodology and evaluation of activities are detailed below:

Methods

The ABGC in collaboration with the Queensland Department of Agriculture and Fisheries led the development and roll-out of an extension program aimed to: 1) increase grower's knowledge of the disease and allow them to realise the potential impact the disease can have 2) educate them on how to identify suspect plants and early disease symptoms 3) Guide them to identify the risks to their properties and 4) guide them to implement effective on-farm biosecurity practices.

Workshops

The workshops were based on analysis of the questions raised at the initial industry meetings held following confirmation of the disease. The four key aims of the extension program formed the structure of the 3 hour workshops which were divided into four modules:

1 – Understanding the disease

2 – Identifying and reporting the disease

3 – Risk pathways of the disease

4 – Implementing on-farm biosecurity

The approach taken by the extension program was to begin by running small workshops (10-20 growers) in different locations throughout the growing region. By delivering the workshop to a small group it allowed the workshop to be interactive and individualised to the growers in attendance.

The modules were presented as PowerPoint presentations and accompanied by the use TurningPoint®. The TurningPoint® system produces a live poll graph embedded in the presentation based on the answers that the audience has selected on their individual electronic key pads. The TurningPoint® system was used for both evaluation of the workshop and also reinforcement of information by asking questions based on the information delivered. Each module was formulated on the 'tell them what you going to tell them' 'tell them' and then 'tell them what you told tem' structure. In addition to that the structure also 'tested what you told them' with the use of the TurningPoint® system.

The first two modules were very focused on information delivery. Module one was designed to give growers a background and understanding of the disease. It steps through explaining what the disease is, where it is found in the world and gives some examples of how rapidly it has spread in other countries. It then followed onto explain how the disease spreads and introduces the 'Soil, Water, Plant Material' pathways that are carried throughout the entire workshop. The PowerPoint presentation includes animations that emphasis how the disease infects the plant also why it can take time for plants to show visual symptoms.

Module two focused on identifying and reporting the disease. Emphasis was placed on the early external symptoms of; leaf yellowing, wilting leaves and stem splitting. This was done with the use of clear images and

arrows emphasising each of the potential external symptoms. It was emphasised in this module that Panama disease tropical race 4 has similar external symptoms which can be caused by bacterial wilts, nutritional imbalances, water stress etc. Because of this it was highlighted that because an external symptom may look like something they have frequently seen before that they should not automatically assume it is not Panama disease tropical race 4. The module then moved to stress the importance of reporting suspect plants and the process to report plants. In the later workshops that were conducted this module was largely replaced with a video (produced as part of BA13004) which provided good animations and explanations of the external symptoms This video also doubled as an induction tool that growers could use to train their staff on how to identify and report suspect plants.

Modules three and four were very interactive and PowerPoint is only used to guide the group and give examples. In order for growers to systematically approach the implementation of effective on-farm biosecurity practices it was realised that they needed to prioritise the risks to their farm. The 'Soil, Water, Plant Material' pathway theme was re-introduced in module three and growers were asked to identify the specific ways in which each of these pathways could spread the disease. For example the list of ways in which soil can spread the disease is quite exhaustive but includes, visitors, earth moving equipment, fuel trucks and animals. Once growers had created their lists the participants were asked to share one of the pathways they had listed with the group and an overall lists for each of the three themed pathways for the group was collated. Any potential pathways that the group had not thought off were discussed and included in the lists.

No two farms are identical in their risks and consequently the extension program took the approach of providing individual aerial property maps to each grower. When growers attended the workshop they were provided with two A3 sized maps; one of their entire property and another a close up of their packing facilities. In module three growers used the aerial map of their entire property and three A3 transparent sheets labelled 'Soil, Water and Plant Material' to commence identifying the risks to their own properties. Using permanent marker pens growers identified areas on their farm corresponding to the risks that they had recognised in module three. One transparent sheet was used for each of the themed pathways. For example the 'Soil' sheet had public roads and utility lines sketched on it whereas the 'Water' sheet had areas prone to flooding identified on it. From this exercise growers were able to systematically identify all the risks. In many cases growers had overlooked some pathways and this process helped ensure they didn't overlook anything.

Once growers had identified the risks to their individual properties module four guided them through the most effective on-farm biosecurity practices that they can implement. The heart of on-farm biosecurity practices is the ability to exclude non-essential movements, onto and within a property. Therefore the first focus of this module was introducing and explaining the concept of zoning. A three zone system was explained which included an Exclusion zone (for vehicles that don't need to come onto the farm), Separation zone (designated area of essential vehicles to drive in) and the Farming zone (paddocks and areas where farming activities occur). Photo examples of properties that had already zoned their farms were used to explain the aspects of these three zones. Using the close up aerial map of the packing facilities growers implemented the three zone system to their farms by again drawing on a transparent sheet placed over their map.

Zoning forms the basis of on-farm biosecurity. Excluding vehicles and machinery to zoned areas is ideal however during the course of daily operation people and vehicles may need to cross between these zones. Module four gave growers examples of the specific practices that they can implement to move between zones. For example the features that constitute an effective footbath or wash-down facility.

Panama disease tropical race 4 Field Day

Property access by large numbers of people was complex following strict on-farm biosecurity systems and therefore a surrogate Panama disease tropical race 4 field day was held for all industry stakeholders on the 13th of November 2015 at a local community hall facility. The field day agenda included presentations about the preliminary research surrounding the use of disinfectants, systems to prevent the movement of soil in the high rainfall environment, information surrounding the tissue culture process and the disease, program updates, grower practice video's followed by a grower panel discussion and a trade display of biosecurity based products and services. The grower practice videos and discussion session was organised and facilitated by the National Development and Extension Project (BA13004). The invite which summarises the agenda of the day which was distributed to growers and industry stakeholders is presented in figure 1. A written survey was conducted on the day to evaluate the effectiveness of the event.

NSW On-farm Biosecurity presentations

The project leader (Tegan Kukulies) delivered a presentation on on-farm biosecurity at a field day held on the 17th February 2016 in Burringbar which was hosted by the NSW Department of Primary Industry in conjunction with the Tween Brunswick Banana Growers Association. The presentation summarised the principals of the on-farm biosecurity workshops which were run in north Queensland and also displayed video examples of on-farm biosecurity practices growers have implemented. The project leader travelled to Coffs Harbour to deliver a condensed on-farm biosecurity workshop to growers and industry stakeholders prior to the Coffs Harbour Banana Growers Association Meeting on the 4th of May 2016

Figure 1: Invite to the Panama TR4 field day

Results

Workshops (March – August 2015)

Following the development of the workshops Tegan Kukulies and Stewart Lindsay were involved in organising and delivering workshops until the end of March 2015. During this time 17 workshops were conducted in Innisfail, Tully and Mareeba. These workshops were attended by 157 growers and farm managers. This set the program in good stead for newly appointed ABGC extension staff to continue to deliver the workshops and the rest of the program. Throughout the entire program 37 workshops were conducted, involving 246 growers, partners and farm managers who represented 228 farms. This equates to 77% of total banana farms and 82% of the production area in north Queensland. Figure 1 summarises the evaluation data collated from all the workshops conducted in north Queensland. 91% of participants improved their knowledge of Panama disease tropical race 4 'quite a lot' or better, 81% understood the risk pathways of the disease 'quite a lot' or better and 84% understood suitable on-farm biosecurity practices for their farms 'quite a lot' or better as a result of attending the workshops (figure 2).

Panama disease tropical race 4 field day

The Panama TR4 Field Day was attended by over 140 people. 50% of the attendees were growers. Resellers, agronomists, tissue-culture providers, engineering firms, local councilors and government staff constituted the other 50% of attendees. Evaluation on the day showed that most growers heard about the field day from a flyer in the mail, followed by a phone call/text message and via radio (Figure 3). Most non-growers found out about the field day by word of mouth (Figure 3). There was excellent overall feedback about the day with all participants rating the day as good to excellent for meeting their needs and expectations (Figure 4). The stand out session in the agenda was the grower video and sharing session. This session received the most 'very good' and excellent' responses (Figure 5).

NSW On-farm Biosecurity presentations

The condensed workshop at Coffs Harbour was attended by 17 growers and 13 other industry representatives on the 4th of May 2016. The hour and a half workshop received excellent feedback with 88% of participants indicating that the workshop increased their knowledge of Panama disease Tropical Race 4 quite a lot (4-5/5) and 87% of the growers indicating that the workshop helped them identify the risk pathways and helped them develop a plan for their farms (4-5/5). Although both of these events were focused on Panama Disease Tropical Race 4 the same on-farm biosecurity practices are vital to managing Subtropical Race 4 and Race 1, both of which pose a risk for growers in these regions.

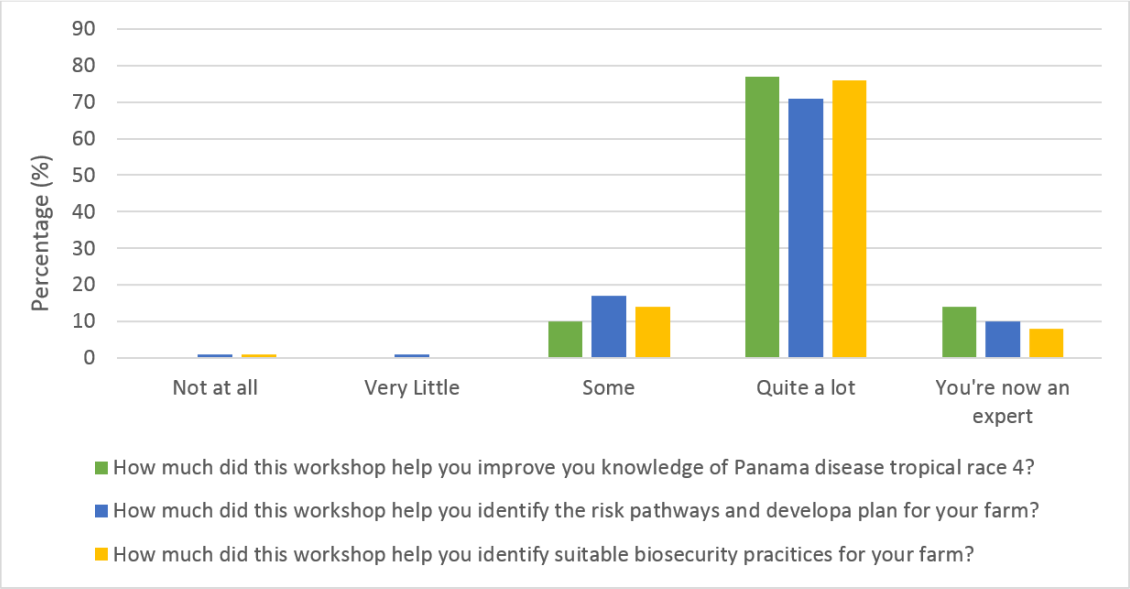

Figure 2: Overall evaluation of the 37 Panama disease tropical race 4 on-farm biosecurity workshops conducted in North Queensland.

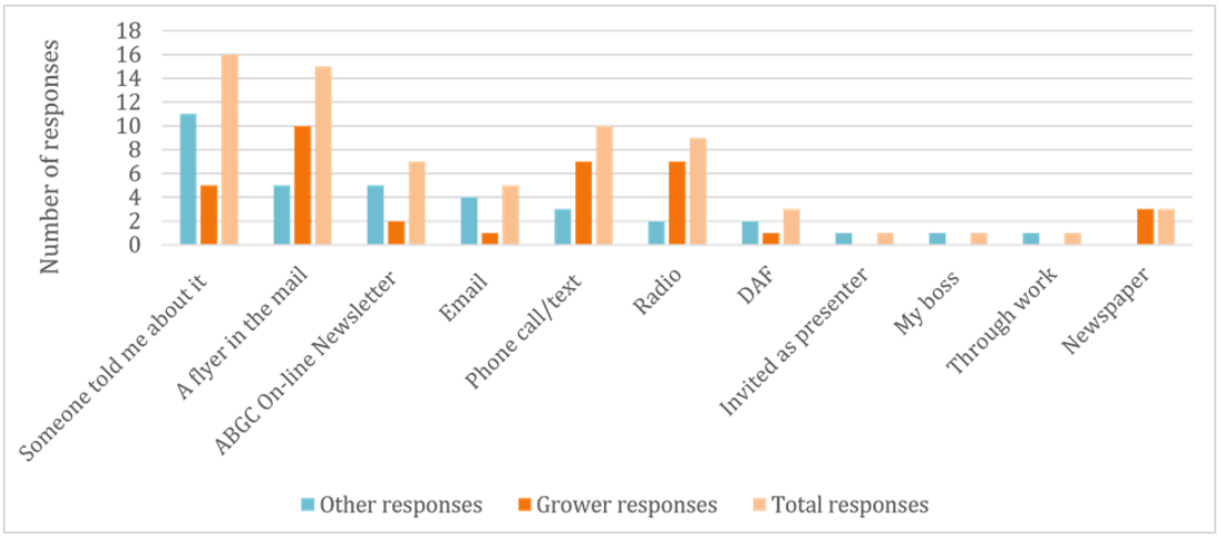

Figure 3: Summary of how growers, industry stakeholders who aren't growers (other responses) found out about the Panama disease tropical race 4 field day.

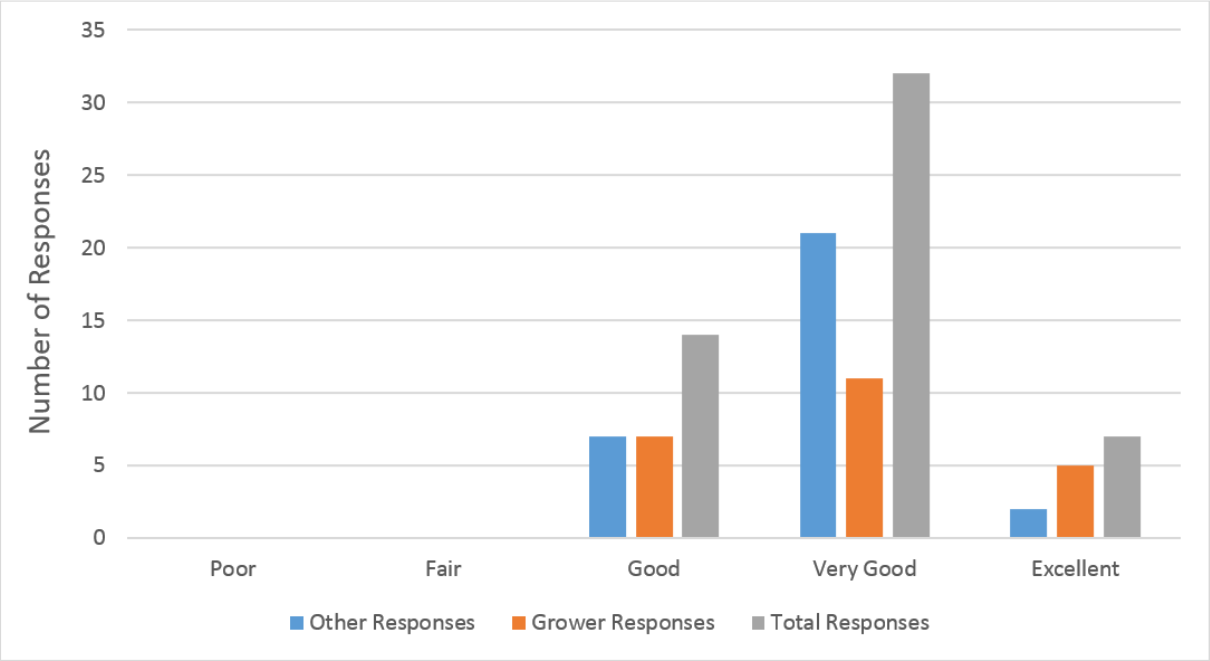

Figure 4: Summary of how growers, industry stakeholders who aren't growers (other responses) rated the Panama disease tropical race 4 field day for meeting their needs and expectations.

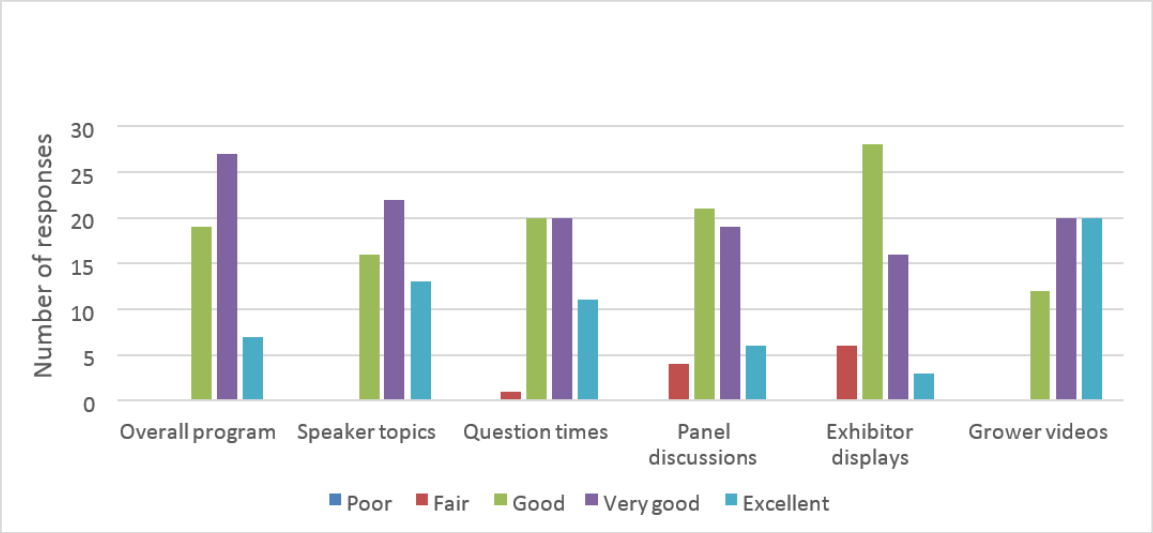

Figure 5: Rating of individual agenda aspects of the Panama disease tropical race 4 field day (total attendees)

Appendix 7.3: Panama R & D Open Day Agenda

Panama R & D Open Day

South Johnstone DAF Research Station, Friday 12th May 2017

8:30 am – 12:30pm

Topic/Activity		
Welcome and overview of the day		
Launch of the Best Management Practices for On-farm Biosecurity		
Disinfectant facts: reminder of effective products, results from testing of products in the Northern Territory, corrosion and longevity results, demonstration on how to use test strips to test concentrations.	*Kathy Grice Peter Trevorrow & Shanara Veivers*	*Activities in the Paddock*
Soil health: groundcover and nitrogen trial results, nematode microscope demonstration, soil biology measurement demonstration.	*Tony Pattison & Anna McBeath*	
Rapid Destruction: explanation about the validation of the use of urea in the destruction process, demonstration of a plant injected with fungus to increase rate of plant degradation.	*David East*	
Proximal and Remote Sensing: showcase remote and proximal sensing tools, demonstration of equipment for detecting 'unhealthy' plants before visible symptoms appear	*Trevor Parker & Katelyn Ferro*	
Tolerant Varieties: tour of varieties which have 'tolerance' to Panama disease tropical race 4, description of the mutagenesis process which is being taken in an attempt to develop a resistant cultivar.	Jeff Daniells	
Grower insights on Panama disease tropical race 4 in the Philippines		
TurningPoint evaluation and Wrap Up		
Lunch + Exhibition of other Panama R & D		

Appendix 7.4: Printed media associated with Panama R & D Open Day

Rural insight

South Johnstone Open Day to highlight latest developments

Panama research hot topic

BANANA growers will soon have access to a new tool to help tackle on-farm biosecurity risks, such as Panama disease tropical race 4 (TR4), which is currently posing a risk to the $600 million banana industry.

The Australian Banana Growers' Council is encouraging local banana growers to attend a unique Panama disease open day at South Johnstone next week.

Hosted by the Department of Agriculture and Fisheries (DAF), the day is designed to highlight the latest research and development focussed on Panama disease Tropical Race 4 (TR4).

The interactive event will include a field tour and exhibits at the DAF research station.

ABGC Chair Stephen Lowe said the half-day event would provide a unique opportunity for growers to learn about some of the current applied research and development focussing on the short-to long-term management of TR4.

"All growers know of the constant threat TR4 poses and most are aware of the extensive history of research and development that has been, and continues to be, carried out by researchers Australia wide," Mr Lowe said.

OPEN DAY EXHIBITS

- Tolerant varieties and the strategies being used to develop them
- Soil health practices
- Disinfectant demonstrations
- Options for remote and proximal sensing
- Understanding the effect of urea in the TR4 destruction process

"The open day is designed to show growers first-hand some of the latest Panama advances and increase their confidence in the future containment and management of this disease."

A key component will be the launch of the new Banana Best Management Practices, On-farm Biosecurity manual — the latest tool designed for growers to help tackle on-farm biosecurity risks.

Queensland DAF's Team Leader of Banana Production Systems Stewart Lindsay said the manual was a valuable resource for all banana farming businesses.

"This manual is designed to help growers implement effective on-farm biosecurity practices," Mr Lindsay said.

The open day will be held on Friday, May 12, at the South Johnstone DAF Research Station (8.30-12.30pm).

Australian Banana Growers' Council chairman Stephen Lowe and deputy chairman Ben Franklin will be present at next Friday's Panama disease open day at South Johnstone.

In brief

ORGANIC IS GROWING

THE Australian Organic Annual Report reveals Australia holds the world's largest amount of organic managed farmland (53%) but it's still not enough to meet local demand. The report supports evidence of a growing consumer consciousness at check-out, and increased education of the benefits of organic food. Australia's organic industry is now valued at more than $1.4 billion and by 2018, the total value is anticipated to exceed $2 billion, given the current growth trajectory. A third of organic operations are in New South Wales, a quarter in Victoria and a fifth in Queensland.

MAREEBA FIELD DAYS

THE future of agriculture in the Mareeba and Tablelands region will go on display at this year's Rotary FNQ Field Days. Mareeba District Fruit and Vegetable Growers Association president Joe Moro said the Field Days provided the perfect platform to promote agriculture across North Queensland and farmers could look forward to seeing the latest and greatest developments in the industry. "I'm hoping Field Days will reveal some of the new technology now being used, such as robotics and drones," he said. Rotary FNQ Field Days will be held between Wednesday, May 24, and Friday, May 26, at Mareeba's Kerribee Park.

PSYCHOLOGY REBATE

The Australian Psychological Society has welcomed the Government's recognition of the needs of people in rural and remote Australia with the announcement that people living in these areas will be able to claim a Medicare rebate for online videoconferencing consultations with psychologists. APS President Anthony Cichello, says the move will provide greater equity of access to evidence-based psychological care for Australians living in small country towns, remote and very remote Australia.

Innisfail Advocate, Saturday May 6th 2017

Rural insight

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New weapons swing into action to fight against threat of Panama disease

No rest in war on pest

TOM VOLLING

HI-TECH detection technology and disinfectants are some of the new weapons wielded in the fight against Panama TR4 disease.

The Department of Agriculture and Fisheries are hosting the open day on Friday at their South Johnstone research station, where they will unveil the first update on research and development since November 2015.

DAF Banana Production Systems head Stewart Lindsay has worked with the Far North's banana industry for the past 23 years.

He has witnessed the disease's devastating impact in countries such as Indonesia and the Philippines, where the disease is unchecked and potentially causing a "major global impact."

Mr Lindsay said growers couldn't risk becoming complacent.

"Banana growers are just like everyone else in society. You've got some people who are very proactive and others who aren't at all. I would say most have done what they can afford to do," he said.

"Maybe they are just a bit complacent because we have done such a good job – they don't know how quickly it can spread."

Satellite imagery, soil biology measurements and management practices are among the topics that will be discussed.

Research horticulturalist Katelyn Ferro will showcase a proximal sensing method that she has been trialling to evaluate the health of banana plants before they show physical signs of Panama TR4 disease.

The disease was first detected at a property in the Tully Valley region two years ago.

It is a soil-borne fungus that can be spread by animals or humans moving between properties.

"The key thing with this disease is if you can get plants early and destroy the disease then it really slows down the spread dramatically," Mr Lindsay said.

"The property is still infected, the only thing is there are no bananas on there anymore. That is what makes this disease so hard to manage is that it never goes away. It reproduces at its fastest and biggest numbers on bananas, but it can tick over on other plants and weeds forever."

The disease is considered a "constant threat" to the country's $600 million banana industry. Attending growers will also be given a free dip test to see if their property is infected.

Australian Banana Growers Council chairman Stephen Lowe, who has a 141ha banana plantation along the Tully River, said there were many "nervous farmers" out there.

"The positive you can get out of that is people still have biosecurity on their minds," he said. "What we don't want as an industry is complacency, where people think we have got it beaten and start having lapsed standards."

EARLY WARNING: Research horticulturalist Katelyn Ferro shows South Johnstone banana grower Doug Phillips a proximal sensing method she has been trialling to evaluate the health of banana plants before they show any physical signs of Panama disease.

STAYING UP-TO-DATE ON LATEST IN TECHNOLOGY

Held at the South Johnstone DAF Research Station from 8.30-12.30pm this Friday.
A key component of the day will be the launch of the new *Banana Best Management Practices, On-farm Biosecurity* manual, which is the latest tool designed for growers to help tackle biosecurity risks.
A field tour will include:
- Options for remote and proximal sensing

- Tolerant varieties and the strategies being used to develop them
- Soil health practices
- Disinfectant demonstrations
- Understanding the effect of urea in the TR4 destruction process

For catering purposes and since strict on-farm biosecurity practices will be required to enter the paddock, please RSVP to the open day, with your shoe size.
Contact Tegan Kukulies on 0459 846 053 or email tegan.kukulies@daf.qld.gov.au

Demand tipped to heat up as weather cools

HOPEFUL: Stephen Lowe.

TULLY banana grower Stephen Lowe is hoping consumers will put chocolate down and start filling up on the Far North's iconic yellow fruit again.

Demand for bananas has lowered in the past two months, especially during Easter, but the Australian Banana Growers Council chairman is anticipating a return to normal buying behaviour in coming weeks.

"The industry has been operating with very low margins and below cost of production, which is never good for any agricultural industry," he said.

"Easter is traditionally a fairly poor demand time of the year. Short weeks don't help and the public seems to get out of their normal buying routine.

"Any school holidays you don't sell many bananas."

Woolworths and Coles are selling the cavendish variety at $3/kg and lady fingers for $7/kg.

Mr Lowe has a 141ha banana plantation along the Tully River. He shifts up to 7000 bananas every week to markets in Brisbane, Sydney and Melbourne.

Winter traditionally sees higher demand for bananas due to less competition from tropical and citrus fruits.

Mr Lowe said the low prices would have hurt some farmers.

"Fortunately in the past two weeks supply has decreased and prices have actually gone up," he said.

"We will see a positive trend for the next two to three weeks and then it will depend what sort of winter we get after that."

Queensland DAF banana scientist Stewart Lindsay said most growers hoped for a cooler and drier winter to help ease supply.

"In warm winters, the fruit grows very quickly and we end up with an oversupply situation," he said.

CCPB012031MA - V1

Cairns Post, Saturday 6th May 2017

DIRE THREAT: Shanara Veivers, Research Horticulturalist with the Department of Agriculture and Fisheries, and Wangan banana farm supervisor Stephen Wells look at test strips used to test concentration levels of disinfectants used as part of on-farm biosecurity practices.

Wild dog baiting

NOTICE is hereby given that Hinchinbrook Shire Council is conducting a shire wide Wild Dog Baiting Program utilising 1080 poison. The baiting program will commence today, Thursday 4 May 2017.

The Wild Dog Baiting Program is required due to high populations of wild dogs in certain areas that are impacting on livestock production.

This notice is to advise that the program is taking place and landholders participating in the campaign must comply with set procedures for baiting. This includes notification to all adjoining landholders at least seventy-two (72) hours prior to the baiting.

For further information, please contact Hinchinbrook Shire Council's Environment and Community Services Department on 4776 4607.

Rainfall Tully

Statistics 2017 - **MAY**

S	M	T	W	T	F	S
	1	2	3	4 4.5 mm	5 2.5 mm	6 0.4 mm
7 7 mm	8 42.5 mm	9 0.8 mm	10 -	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

Month to Date - 56.9 mm Days - 5
Year to Date - 2523.2 mm Days - 87

Fighting the Panama threat

THE Australian Banana Growers' Council is encouraging local banana growers to attend a unique Panama disease open day at South Johnstone tomorrow from 8.30am-12.30pm.

Hosted by the Department of Agriculture and Fisheries (DAF), the day is designed to highlight the latest research and development focussed on Panama disease Tropical Race 4 (TR4), which remains a constant threat to the country's $600 million banana industry.

The interactive event will include a field tour and exhibits at the DAF research station, to see and hear about tolerant varieties and the strategies being used to develop them, soil health practices, disinfectant demonstrations, options for remote and proximal sensing and understanding the effect of urea in the TR4 destruction process

ABGC Chair Stephen Lowe said the half-day event would provide a unique opportunity for growers to learn about some of the current applied research and development focussing on the short-to long-term management of TR4.

"All growers know of the constant threat TR4 poses to our industry and most are aware of the extensive history of research and development that has been, and continues to be, carried out by researchers Australia wide," he said.

"The open day is designed to show growers first-hand some of the latest Panama advances and increase their confidence in the future containment and management of this disease."

A key component of the day will be the launch of the new Banana Best Management Practices, On-farm Biosecurity manual, which is the latest tool designed for growers to help tackle on-farm biosecurity risks.

Queensland DAF's Team Leader of Banana Production Systems Stewart Lindsay said the manual was a valuable resource for all banana farming businesses, whether they already have on-farm biosecurity systems in place or are planning to implement them.

"The Australian banana industry is vulnerable to pests and diseases," he said. "This manual is designed to help growers implement effective on-farm biosecurity practice.

"It consists of a self-assessment checklist and reference materials divided into four major sections: zoning, general farm operations, crop production and fruit movement."

The manual was jointly funded by Horticulture Innovation Australia using banana research and development levies and funds from the Australian Government with co-investment from DAF.

For catering purposes and since strict on-farm biosecurity practices will be required to enter the paddock, please RSVP to the open day, with your shoe size, to Tegan Kukulies on 0459 846 053 or email tegan.kukulies@daf.qld.gov.au

Cassowary Coast Independent News, Thursday 11th May 2017

Rural insight

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Growers learn how to fight back against TR4

A BUNCH of banana growers has dived into the latest research into the Panama disease Tropical Race 4.

About 100 banana growers, researchers and industry leaders learned about disease management at South Johnstone Research Station last Friday.

ABGC chair Stephen Lowe said the half-day event was a unique opportunity to build further industry confidence.

"Panama TR4 is a constant threat to our industry," he said.

"But it was a chance to gain insight into the groundbreaking research and development that is giving growers greater reassurance that TR4 can be managed into the future.

"Australia is recognised globally as a world leader in the fight against TR4 and this was not only an informative exercise, but was also a celebration of the scientific efforts carried out by researchers Australia-wide, that is helping to protect our growers and industry."

A new *Banana Best Management Practices, On-Farm Biosecurity* manual, which is designed for growers to help tackle on-farm biosecurity risks, was also launched.

HANDY WISDOM: Department of Agriculture and Fisheries principal horticulturist Jeff Daniells presenting an information session.

Industry's website upgraded

SUGAR Research Australia has unveiled a fresh website to improve growers' access to the latest industry information.

It follows investor feedback that criticised the old site for being difficult to access and navigate.

SRA chief executive Neil Fisher said the new site provided extensive information on the organisation's research.

"The new site includes information and fact sheets for growing and milling the crop, details about SRA's research investments, information for research collaborators, as well as our corporate information and publications," he said.

"The new-look website presents information in a clear and modern way for our investors and other industry stakeholders."

The SRA e-library is the home of the vast catalogue of research and other publications authored by SRA and others. The site is available at www.sugarresearch.com.au

Cairns Post Wednesday 17th May 2017

Appendix 7.5: Evaluation of the Panama R & D Open Day

Attendance

In total 109 people attended and participated in the Panama R & D Open Day which was held on the 12th of May 2017 and showcased the latest research and development advances. The graph below shows the distribution of those that attended growers and industry stakeholders (e.g. private consultants, agronomists, resellers etc.) who were the main target audience made up 64% of attendees.

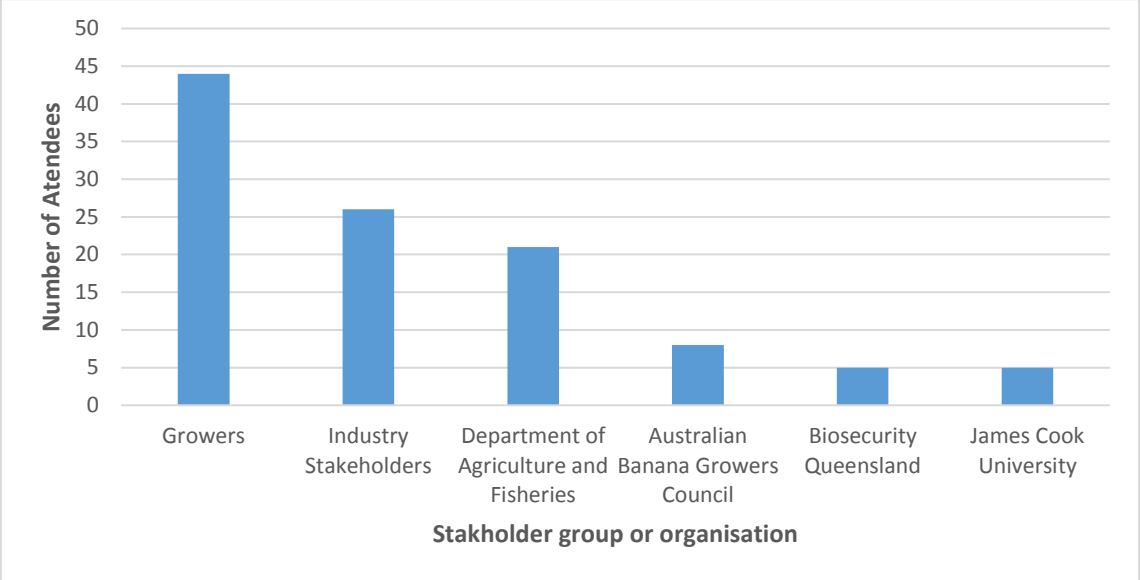

Figure 1: Distribution of industry stakeholders and representatives from organisations which attended the Panama R & D Open Day (12th May 2017)

Evaluation

Turningpoint™ which is an electronic polling system was used to evaluate the Panama R & D Open Day. This survey was conducted at the completion of the day. Polling was conducted with growers and industry stakeholders and excluded researchers involved in Panama & D projects. The table below summaries the questions which were asked of the attendees and the respective percentages for replies.

Table 1: Summary of responses to the evaluation question asked at the Panama R & D Open Day	
How much to you now know about Panama disease R & D?	
1 - Nothing at all	0%
2 - Very little	0%
3 - Some idea	17%
4 - Good understand	65%
5 - I'm across it all	19%
Will you change anything after attending today?	
Yes	46%
Maybe	50%
No	4%
Would you attend an event like this again?	
Yes	59%
Yes & I would recommend it to others	39%
No	2%

How would you rate today?	
1 – Being the lowest	0%
2	0%
3	0%
4	0%
5	4%
6	4%
7	22%
8	29%
9	22%
10 – Being the highest	18%

Appendix 8: Written material

Appendix 8.1: Factsheets

On-farm research helps inform management decisions

How do you know that a product you are using is having a positive impact on your crop?

Figure 1. Comparing a product to your normal farming practice will help you identify whether the product is improving your production

There can be a large range of products being promoted in the banana industry at any time, especially 'biostimulant' or 'biological' products which aim to promote plant growth. The effects of these products are often tested in experiments in controlled conditions in laboratory and glasshouse studies. While there is some science to support the efficacy of some products, extrapolating these results is a long way from the commercial situation where they are being promoted. Small on-farm trials can be useful to test for any effects in a commercial situation if they are done properly.

The key points to consider when planning any on-farm trials are:

1. What to measure

The first question to ask is: **what do you hope to achieve by using the product?** The answer to this question will help you determine what it is you should monitor and measure. For example, you may want the product to increase bunch size, reduce crop cycling time, reduce the required fertiliser inputs or reduce nematodes and other soil borne disease. Therefore some of the things you may measure might include leaf emergence rates, the plant height, the time to bunching, the bunch weight or the root rating relating to nematode damage. The more detailed measurements you take the more information will be obtained, allowing better management decisions.

2. How to set up a trial

Treating an entire block with a product and monitoring its performance over time will not give you a fair comparison of the performance of a product against your normal farming practice. Your normal farming practice is often referred to as an **untreated area** or the **control**. In setting up the trial it is recommended you keep it as simple as possible. For example, compare an area treated with a product to an adjacent untreated area with your normal farming practice (Figure 2). This might mean not applying the product to a couple of rows or even half a paddock. If there is some variation across the block (e.g. soil type, drainage) it is suggested to replicate the treated and untreated areas a number of times. This will enable you to be more certain about the effects (Figure 2). In some cases it may be worth comparing different rates or different products, which should be randomised so each treatment has an equal chance of being applied to different parts of the block. You can do this by drawing product names out of a hat to correspond with different locations in the block.

This factsheet has been produced as part of the National Banana Development and Extension Program which is funded by Horticulture Innovation Australian Limited using the banana levy and funds from the Australian Government

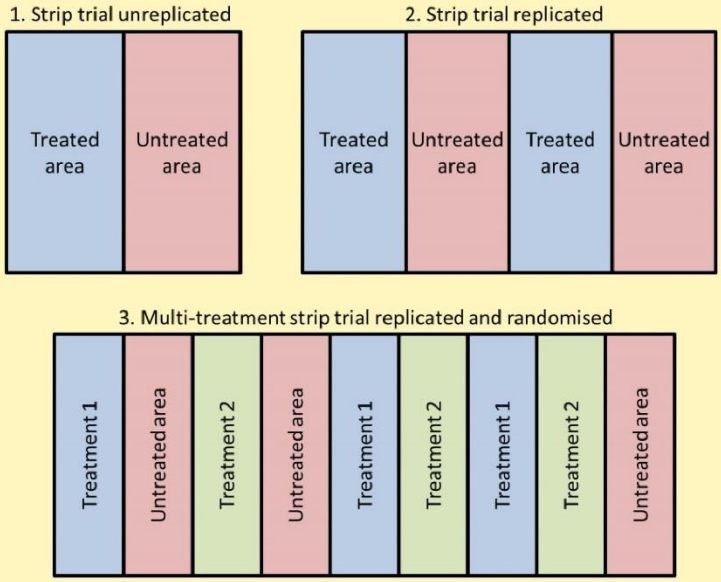

Figure 2. Some designs for on-farm field trials, which can be simple unreplicated designs to more complex multi-treatment, randomised designs

3. How long should a trial run for and how frequently should I take measurements?

How long a trial should run for and how frequently you should take measurements will depend on **a)** the type of product you are using, **b)** what you hope to achieve by using the product, and **c)** the type of measurements or observations you are making. One thing to consider when deciding the duration of the trial is that environmental conditions can have a big impact on growth rates and how products work. It is important to take measurements or observations at several different times of the year at different stages of plant development. It is a good idea to take measurements before application and at selected time intervals after application. It is very important that whenever you take measurements that you do it the same way and at the same time for both the treated and untreated areas. This will ensure that you make a fair comparison.

4. Analysing your results

When analysing the results of your trial it is important to not only look at the average for the treated and untreated areas, but also the variation. A simple measure of the variation is the difference between the maximum and minimum values (known as the range) and a small range suggests small variation. Big differences between the treated and untreated averages with a small variation may suggest there is an effect of the treatment. If your treatment areas are replicated then you can perform statistical tests such as *t*-tests to statistically compare the averages for the treated and untreated areas.

If you have taken measurements over different times of the year it is also interesting to look at the values at each of these time points as well as the total average values. A simple graph of the values over time can provide good insight into any differences between the treated and untreated areas. Although it can be difficult, relating results from a trial to an economic assessment will in most cases help determine the level of effectiveness of a practice. The more information that you can generate from trials directly related to your farm then the more informed you will be to make management decisions about different products.

For more information:

Queensland Department of Agriculture and Fisheries, South Johnstone 07 4064 1130

Banana scab moth

Figure 1. Banana scab moth Larvae feeding on plant material

What damage does it cause?

Banana scab moth (*Nacoleia octasema*) is one of the most economically damaging pests in banana and can cause up to 100% bunch damage if left uncontrolled.

Significant economic damage from banana scab moth is primarily confined to the fruit. Feeding by young larvae starts as soon as the first bracts lift and usually increases in severity as the larvae grow and move progressively down the bunch as subsequent bracts open.

Damage is usually confined to the outer curve of the fingers (the area nearest to the bunch stalk) but, in more severe cases, damage can extend to areas between touching fingers, or even extend to cover the whole fruit surface. The surface feeding by larvae results in scars which quickly turn black. While damage is usually only superficial, affected fruit is downgraded or unsuitable for market.

When does it occur?

Banana scab moth favours moist and warm conditions, therefore the period of greatest potential damage is during the wet season. Bunches which emerge from December through to the end of May are most at risk of attack. The cooler and drier winter months are relatively free of banana scab moth damage. However damage can occur if unseasonal rain occurs at this time. Research has shown adults do not mate and lay eggs under low humidity and dry conditions.

Understanding the lifecycle

Figure 3. Adult banana scab moth

The tiny (1.2-1.5mm) flattened eggs are laid in clusters which resemble miniature overlapping fish scales. These egg clusters are very difficult to locate because of their small size and the fact that they are laid near the throat of the plant. The eggs are usually laid on the emerging bunch and the surrounding leaves and bracts, but eggs have occasionally been found on the pseudostem below the new bunch. The larvae are pink to brown in colour and range in length from 1.5mm when first hatched to about 25mm when fully developed. If disturbed the larvae wiggle violently and drop on silken threads. When the larvae are fully mature they pupate in the trash at the base of plants or sometimes on the bunch or beneath dry leaf sheaths. The brown pupae range in length from 9-13mm.

The adult moths which are quite small (22mm wingspan) are rarely seen due to their size, the fact they hide during the day and their dull brown/grey colouration makes them difficult to spot. Adults are most active at dusk when mating and egg laying occurs. The adults do not appear to be attracted to lights. The total lifecycle takes around 25-32 days. Populations tend to be highest and most consistent during the wet season.

This factsheet has been produced as part of the National Banana Development and Extension Program which is funded by Horticulture Innovation Australian Limited using the banana levy and funds from the Australian Government

How to monitor for banana scab moth

The only practical method for monitoring for banana scab moth is to inspect freshly emerged bunches (bract fall) for the presence of damage and/or larvae. Pay special attention to the underside of the fingers in each hand (closest to the bunch stalk) and also the cushion area. In very young bunches it may be necessary to lift the developing hand away from the bunch stalk to reveal any larvae and/or fresh damage.

Figure 2. Banana scab moth larvae

Also pay attention to the base of the bunch stalk where the larvae enter the throat of the plant. Larvae can be detected by separating the base of the flag leave and removing the bract that is attached to the stalk. Often a clear jelly-like substance, which appears to be associated only with banana scab moth feeding, is present at these sites.

It is a good idea to monitor known 'hot spots' such as rows adjacent to scrub or creek lines.

Managing banana scab moth

Treatment of banana scab moth should be commenced as soon as damage is detected because the damage results in immediate downgrading or rejection of fruit. Management of banana scab moth is particularly important if heavy bunching is anticipated and/or the conditions are favourable or forecast (hot and wet).

Biological control: Although there has been no major specific parasite or predator that has been identified, there are a number of wasp parasites, spiders and other general predators that provide a low level of natural control. The ant, *Tetramorium bicarinatum* which is commonly found on plants and bunches provides some level of suppression of banana scab moth.

Cultural control: Selecting followers of equal size which equates into synchronised bunch emergence over a block will ensures that chemical control methods are more efficient.

Chemical control: Bell injection has significantly reduced the amount of insecticide used by the banana industry. The accurate targeting of insecticide using injection does not harm beneficial insects on other parts of the plant. The correct site for injection is approximately one third of the way down from the top of the upright bunch or 'spear'. Beneficial insects may be providing some control of other pests, therefore this method is preferred to the less-precise application methods of dusting, bunch spraying and broadcast applications from the ground or air. Chlorpyrifos and bifenthrin are registered and commonly used for bell injection. Dusting with chlorpyrifos (PER14240) can also be used but is not as effective as injection. Dust residues can detract from fruit appearance and excess dust residues can cause fruit to be rejected from market. To be effective dust must be applied just prior to bunch emergence to prevent entry of young larvae into the bunch. Once the larvae move beneath the bracts they will not be controlled by dusting unless the bracts are lifted by hand to expose the larvae. Registered and permitted chemicals can change so check the website of the Australian Pesticides and Veterinary Medicines Authority (APVMA) to access the most up to date information. (http://apvma.gov.au/)

For more information contact:

Queensland Department of Agriculture and Fisheries
South Johnstone 07 4064 1130 or Mareeba 07 4048 4600

Top ways to manage banana fungicide resistance

Fungicides help manage yellow Sigatoka (leaf spot) in the tropics. Now we need to better manage their use, or risk losing them forever.

Figure 1. Remove leaves with visible leaf spot to reduce the disease load and to ensure the longevity of the fungicides used in the banana industry for management of yellow Sigatoka

Regular testing of leaf spot infected banana material in far north Queensland shows fungicide resistance is present in the banana industry. Resistance to the strobilurins (e.g. Cabrio® and Flint®) is known to occur in most banana production areas. Now a second fungicide group is at risk with serious shifts in sensitivity being detected in the triazoles (e.g. Folicur®, Opus® & Tilt® are trade names).

With very few new banana fungicides on the horizon, we need to value what we have today so they are effective tomorrow and further into the future. Do your bit to protect the tropical banana industry. Outlined below are the top 6 ways to avoid or manage fungicide resistance.

1. Deleaf that spotted leaf, don't spray it

The most critical part of the Sigatoka disease management program in banana is deleafing. This is also the best way to avoid or manage a resistance issue on your farm and neighbouring farms. Fungicides are not effective on visible spots and the application of these products to infected leaf material encourages fungicide resistance. Therefore, leaf spot infected leaves should be removed before fungicides are applied.

Deleafing is important all year round however spring is a key period. Ensure all spotted leaves are removed to reduce the level of disease prior to summer. Warm and wet summer conditions favour the development of yellow Sigatoka, making it more difficult to manage.

2. Know the fungicide groups

Both protectant and systemic fungicides are available for the management of yellow Sigatoka. Each chemical group has a different mode of action and has an important role to play in a spray program; this in turn influences when these products should be used. Table 1 provides a complete list of fungicide groups registered for the management of yellow Sigatoka in the banana industry.

Protectant fungicides help to prevent the development of yellow Sigatoka and should form the bulk of your applications throughout the year. Mancozeb should **always** be applied with oil, while chlorothalonil should **never** be applied with oil. Therefore growers cannot interchange between mancozeb and chlorothalonil.

'Systemic' fungicides used in bananas are more accurately described as being 'translaminar' which is where the pesticide passes through the leaf tissue from one surface of a leaf to the other'. This means the fungicide moves below the surface of the leaf but is not truly systemic because its movement is limited. The common misconception is that systemic fungicides used in bananas can 'kill' existing disease. While they are often referred to as 'curatives' their activity is limited to the early stages of the disease (stage 1 to 2b).

This factsheet has been produced as part of the National Banana Development and Extension Program which is funded by Horticulture Innovation Australian Limited using the banana levy and funds from the Australian Government

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These products have no effect on lesions beyond stage 2b (see figure 2) and the application of these products to lesion stages 3, 4 and 5 simply encourages the development of fungicide resistance. Therefore, apply systemics when conditions are conducive to disease development (warm and wet weather conditions) and not when you can see symptoms.

Table 1. Fungicide groups and examples of trade names registered for the management of yellow Sigatoka in the Australian banana industry (accurate as of 10 September 2015)

	Activity Group	Active Constituent	Example trade name
Protectants	M1	Copper in various formulations	Liquicop
	M3	Mancozeb & zineb	Dithane, Penncozeb Zineb
	M5	Chlorothalonil	Bravo, Whack, Unite
Systemics	Group 3 (Dimethylation Inhibitors commonly called DMIs or Triazole)	Difenoconazole	Score, Digger, Ace
		Epoxiconazole	Opus, Soprano
		Fenbuconazole	Indar
		Propiconazole	Tilt, Bumper, Throttle
		Tebuconazole	Folicur, Hornet
	Group 9 (Anilinopyrimidine)	Pyrimethanil	Siganex, Predict
	Group 11 (Strobilurin)	Trifloxystrobin	Flint
		Pyraclostrobin	Cabrio
	Group 7 (Pyridinylethylbenzamide)	Fluopyram	Luna Privilege

Figure 2. Stage 2b lesions on a banana leaf.
For all of the lesion stages refer to the "Controlling banana-leaf diseases" poster produced by ABGC.

3. Rotate fungicide groups

There are nearly 200 trade names of fungicides registered for the management of yellow Sigatoka in banana. Know which groups the products belong to and ensure that the systemic chemical groups are rotated.

It is important to rotate between the groups, not simply between products in these groups to avoid resistance. For example, switching between propiconazole and difenoconazole is not considered 'rotating' as both actives belong to Group 3.

4. Follow the product use recommendations

There are restrictions that apply, especially to the systemic fungicides, in relation to:

- maximum number of applications per year
- maximum number of consecutive sprays of the same fungicide group
- restricted 'no spray' periods when some fungicide groups are not permitted for use

Table 2 below is based on CropLife Australia's Fungicide Resistance Management Strategy for the far north Queensland banana industry. This resistance strategy came into effect on 25 June 2015 and as product labels are renewed they will refer to this strategy.

Table 2. CropLife's fungicide resistance strategy for the far north Queensland banana industry
(valid as at 25 June 2015)

Chemical group	Max. no. of applications/year	Max. no. of consecutive sprays	Restrictions (no spray) periods
Group 3 (DMI)	6	2	June to September inclusive
Group 9 (Anilinopyrimidine)	6	2	No restrictions
Group 11 (QoI)**	2	Not allowed	May to September inclusive

****IMPORTANT** – Resistance to yellow Sigatoka in banana amongst products in Group 11 (strobilurin fungicides) has been recognised and documented by CropLife Australia. Group 11 products must only be applied in a mixture with another fungicide from a different activity group, registered for the control of yellow Sigatoka, at the full registered rate. Each fungicide included in the mixture counts towards the maximum number of spray applications allowed for Group 3 or Group 9 fungicides. Also note that Group 11 fungicides are no longer to be applied with oil alone.

5. Use the recommended label rate

The application rates listed on the product label have been proven through field efficacy trials. Therefore, halving the rate to save money puts the fungicides under adverse pressure and increases the risk of a build-up of a resistant population of spores.

Always check the label for the correct application rate, as different trade names may have varying amounts of an active ingredient. For example, the active ingredient propiconazole (Group 3) appears in over 50 products registered for yellow Sigatoka management in bananas, and amongst this list are 4 different concentrations of the active ingredient.

6. Thorough spray coverage

For the fungicide to have the best chance at protecting the leaf from further infections, thorough spray coverage is required. This is especially important for the protectants which only work on the leaf area they come into direct contact with, and as already mentioned, the systemics have limited ability to move within the leaf.

More information about the fungicide resistance strategy for the far north Queensland banana industry is available at CropLife Australia's website www.croplife.org.au

To download or print a copy of the strategy, go to: www.croplife.org.au > crop protection > resistance management > 2014 Banana- Yellow Sigatoka

For more information contact:

Queensland Department of Agriculture and Fisheries
South Johnstone 07 4064 1130 or Mareeba 07 4048 4600.

Managing fruit speckle

Recent studies have revealed more information about this potentially costly disease and how to manage it.

Figure 1. Close-up of fruit speckle spots showing the water-soaked halo (arrowed)

While fruit speckle is not a new disease, recent studies have provided more information on its causes. It has previously been known as 'swamp spot', 'salt and pepper spot' and 'Deightoniella spot'. The last name relates to the mistaken belief it was caused by the fungus *Deightoniella torulosa.* However, studies now show fruit speckle is actually caused by three different pathogens, *Colletotrichum musae, Fusarium oxysporum* and *Fusarium semitectum.* These pathogens are found on banana flowers, bracts and old leaves.

All banana cultivars appear susceptible; however, anecdotal evidence suggests Lady Finger may be more susceptible than Cavendish. Losses can be substantial; growers have reported levels of more than 20 per cent. Fruit speckle is worse in subtropical production areas and during warm, humid months. Speckle spots are caused when fungal spores land on the fruit. Spots caused by *C. musae* are brown to black in colour, 0.5–1 mm in diameter, often with a water-soaked margin. Spots caused by the two *Fusarium* species are brown in colour and reach a maximum diameter of 0.5 mm. As fruit ripens, the spots caused by *C. musae* can enlarge to 3–4 mm in diameter and become dark, sunken and circular. Spots caused by *Fusarium* almost disappear as fruit ripens.

Sap coming into contact with fruit skin, along with flower thrip infestations, can increase the number of speckle spots on fruit, particularly those caused by *Fusarium.* Early removal of bracts and bagging bunches to prevent bird and bat damage can result in sap contacting fruit, increasing fruit speckle damage. There is no link between bunch cover type and the incidence of speckle. Chemicals used to control yellow Sigatoka leaf spot, when used in conjunction with oil, can be phytotoxic to young fruit. This damage can be confused with speckle.

How to manage speckle

As with many diseases in banana plantations, hygiene is the key to successful management. Growers should deleaf and desucker, particularly prior to the wet season, to help reduce the amount of fungal spores in a plantation. As fruit matures, it becomes less susceptible. Dust bunches with Mancozeb (Tatodust®) before bracts are fully open and again when bunch covering. Spray applications of Mancozeb to all leaves in the canopy, including suckers, to reduce the number of spores. Growers should ensure they have good control of bunch pests and minimise bunch damage, particularly when bagging fruit early.

Oil sprays used with some fungicides to control yellow Sigatoka leaf spot can damage fruit skin, particularly in hot dry conditions. This damage can be confused with speckle. The inclusion of oils is still recommended in spray programs as it is important in yellow Sigatoka management. Bagging bunches prior to spraying is the only way to stop this damage.

This factsheet has been produced as part of the National Banana Development and Extension Program which is funded by Horticulture Innovation Australian Limited using the banana levy and funds from the Australian Government

Figure 2. Severe fruit speckle symptoms on Cavendish

Figure 3. Damage on banana fruit caused by spraying Tilt® + oil

Figure 4. Damage on banana fruit caused by spraying Folicur® + oil

Quick Facts

1. Symptoms

- Reddish-brown to black spots 0.5–1 mm in diameter
- A water-soaked halo may surround the spots
- Spots more common on the neck and flower end of the fruit but can affect the whole fruit
- Speckle may be present on fruit at all bunch stages
- Circular or run-like disease patterns on the fruit indicate sap contacting the fruit, increasing infection

2. Source and spread

- The fungi *Colletotrichum musae, Fusarium oxysporum* and *Fusarium semitectum* cause banana fruit speckle
- These fungi are found on banana flowers, fruit bracts and dead leaves
- Fungal spores are discharged into the air and land on fruit causing the spots, which develop in a few days
- Fruit is less susceptible as it matures
- Thrips may increase the incidence of speckle caused by *Fusarium* spp.

3. Speckle management

- Deleafing and desuckering will reduce spores in the plantation
- Ensure full canopy coverage, including suckers, with fungicides
- Dust with Mancozeb at bunch emergence and bagging
- Reduce sap contact with young fruit.

For more information contact:

Queensland Department of Agriculture and Fisheries
South Johnstone 07 4064 1130 or

New South Wales Department of Primary Industries
Wollongbar 02 6626 1200

Managing soil erosion

Managing soil erosion is important to maintain productivity and reduce sediment and nutrient run-off

It can take millions of years to produce 30 cm of topsoil. So basically, the topsoil that you have is all you have got for the life of the farm. A million years of nature's work can be removed in a bad erosion event. Good soil health is an essential element of productive banana farming. Conserving this valuable asset not only helps to maintain productivity but also minimises the amount of sediment and nutrients entering the water systems in the Great Barrier Reef catchment.

Figure 1. Slashing inter-row spaces maintains ground cover, which limits the potential for soil erosion

There are two main principles for managing soil erosion: **Maintaining ground cover** and **controlling run-off water**.

1. Maintaining ground cover

Ground cover intercepts rainfall, reduces the surface impact of raindrops, slows the velocity of surface water, increases water infiltration and stabilises the soil. Good ground cover is essential for managing soil erosion and is critical on any gradients greater than 3%. Ground cover should be maintained on at least 60% of the inter-row. Living ground covers are ideal as the root system binds soil particles making it more resistant to erosion, builds up soil biodiversity and increases organic matter. Suitable ground covers are shade tolerant, non-invasive, perennial, traffic tolerant, short growing and have a spreading habit. The native vegetation which grows in the inter-row is usually the best suited because of its shade tolerance and response to machinery traffic. However it may be possible to introduce ground cover species that will grow successfully. Maintain vegetation by slashing rather that spraying out. Side throw slashers are best as the clippings are deposited on the mounds. If inter-rows do require spraying out, opt to use a knockdown herbicide to ensure rapid re-establishment.

When it isn't possible to maintain slashed inter-rows and headlands, across the farm all year round, ground cover should be a priority: in plant blocks, during the wet season, on slopes greater than 3% and on lighter soils that are prone to erosion. Specific fallow species (e.g. Canola, Rhodes grass) should be planted in fallow blocks to manage nematode populations, which also avoids leaving a bare block prone to erosion. Maintaining soil cover will reduce the amount of sediment and nutrients entering waterways. Other benefits associated with maintaining soil cover include limiting the spread of pest and diseases such as plant parasitic nematodes and Panama Disease.

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2. Controlling runoff water

Controlling the speed and direction of runoff water is critical for minimising erosion. Measures and structures should be introduced to slow water where slopes are likely to produce high velocity water flows. Using topographical maps and GPS enabled tractors will assist to design and improve farm layout to provide permanent, all weather access and good drainage. Avoid growing bananas in low-lying flood prone areas.

Contouring: As a general rule any land with a gradient greater than 3% (3 m fall in 100 meters) should be contoured. Contouring stops water running off slopes too fast and subsequently eroding soil. GPS controlled tractors can help simplify the contour design process. Unless major modifications are required, maintain these rows as permanent beds. Seek professional advice before developing and establishing contours.

Figure 2. Contouring paddocks stops water running off slopes too fast and therefore reduces the risk of soil erosion

Diversion banks: These are often used to intercept surface water from above a paddock and divert it away from a block into a suitable waterway.

Figure 3. Silt traps are the last line of defence and prevent sediment leaving the farm

Constructed waterway: These are wide, flat-bottomed structures designed to collect run-off and slow the water before conveying it at a safe velocity to a drainage line. They differ from constructed wetlands, which are planted with vegetation to capture and hold runoff water (min two days), allowing time for tine sediments and nutrients to be removed from the water.

Silt traps: These are the last line of defence against sediment leaving your farm. Silt traps are to be used in conjunction with other practices which minimise soil movement.

Laser levelling: On farms with little gradient, blocks should be laser levelled to ensure a constant fall and prevent water from collecting in the paddock and creating wet areas.

An annual maintenance program will ensure the structures and block arrangements that you have invested in will continue to reduce soil losses and prevent sediment and nutrients from entering the waterways that run out to the Great Barrier Reef.

Monitoring soil erosion

There are simple and effective ways to monitor soil erosion. By monitoring soil erosion you can demonstrate that the implemented practices are effectively reducing soil erosion. Three possible methods for monitoring soil erosion include:

Turbidity tube: Make a dark mark (e.g. an 'X') on the bottom of a clear plastic tube that has millimeters marked on the outside. Fill the tube with run-off water until the mark can no longer be seen. The less sediment in the water, the more water the tube will hold. This is a relative measure, since different soil types will have different dispersion properties. Essentially this means that this technique can only be used to compare different practices on the same soil type or at the position at different times of the year.

Erosion peg: Hammer a piece of threaded rod into the ground, away from traffic areas. Put a washer at ground level and a nut above this. If there is any erosion, the washer will fall to the new ground level but the nut will remain. The distance between the washer and the nut is a measure of the amount of soil that has been lost. Note - for workplace health and safety reasons make sure the rod is easily visible to staff by painting it or attaching some coloured tape to it.

Photographs: This is an easy way to demonstrate a change in practice over time. It is a good idea to include land features for size comparison and to determine the exact location of the photo. Many smart phones and cameras also have GPS functions that allow the exact co-ordinates to be linked to photos.

Figure 4: Simple ways to monitor soil erosion include: a) Turbidity tube, b) Erosion peg, c) Taking photographs of practice change over time

For more information contact:
Queensland Department of Agriculture and Fisheries
South Johnstone 07 4064 1130

Banana spider mites

Banana spider mites (*Tetranychus lambi)* are a common pest of banana, especially over the warmer summer months. Mites mainly feed on the plant leaves, consuming the contents of plant cells and damaging them so the leaf becomes less functional. Under high levels of mite damage, fruit development is delayed and occasionally fruit can be marked with a reddish discolouration towards the cushion end. Early detection and the adoption of practices to help minimize spider mite populations will greatly assist in managing this pest.

Causes of mite flare

While specific trials have not been carried out in bananas to monitor the impact of the following variables, field trials in other crops and extensive field observations in bananas, have provided the following list of factors likely to increase the potential for a mite problem:

- General plant stress
- Water stress
- High nitrogen rates (e.g. 500kg/ha plus)
- Dusty conditions
- Use of some insecticides and fungicides
- Warm/hot and dry weather conditions
- Weed spraying during hot weather, as it removes an alternative host encouraging the mites move onto the banana plants to feed.

Management options

Avoiding the above mentioned situations will greatly assist in managing spider mite populations. Other activities that will assist include:

1. Encouraging predators and beneficial insects
2. Monitoring mite populations
3. Restricting the use of chemicals that cause mite flare, or confining their use to low mite risk periods such as winter
4. Correct application of miticides.

Figure 1. Adult mite and its spherical eggs. Note the dark leaf tissue, an indication of dead leaf cells caused by mite feeding.

Encouraging predators and beneficial insects

Predatory insects can be encouraged by limiting the use of chemicals that are harmful to them. This includes broad spectrum insecticides and miticides in the case of the predatory mites. *Stethorus* (figure 2) and the large metallic blue lady beetles, *Halmus ovalis* are naturally occurring. Their populations will lag behind the spider mites as they will need the spider mites present as a food source to sustain them. Predatory mites such as *Neoseilus californicus* and *Phytoseilus persimilis* can also be purchased for release in your paddocks. Due to the climatic conditions in far north Queensland and the nature of the mites, *N. californicus* is possibly the more appropriate beneficial mite to source.

Figure 2. The larva (left), pupa (bottom right) and adult ladybird beetle (top right), of *Stethorus*

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Monitoring mite populations

Mites have a short life cycle which can be as short as 7-10 days during hot-dry conditions and as long as 4 weeks. Over the summer months, weekly monitoring would be preferable however fortnightly is sufficient during cooler, wet conditions. To monitor for the presence of mites inspect the underside of the leaf. It is important to take note of the youngest leaf the mites are present on, the relative numbers of the various mite life stages and the presence of predators. In general, the greater the number of mites and the younger the leaf they attack, will result in more severe damage. However, treatment may not always be required if predators are present.

Figure 3. To monitor for the presence of mites and their predators, inspect the underside of the leaf

Restricting the use of chemicals that cause mite flare

Some chemicals are associated with mite flare. This can be due to a number of reasons but primarily because they either encourage the mites to become more fecund (= laying more eggs) (the neonicotinoids, e.g. imidacloprid) or they eliminate predators (the synthetic pyrethroids, e.g. bifenthrin). Where possible avoid using these chemicals or if they must be used, time their use to the low-risk periods for mite flare e.g. winter.

Apply miticides correctly

With only a limited number of miticides available to the banana industry, it is important for treatment efficacy and the long term availability of these products that they are applied correctly.

- Miticides will not provide instant results and monitoring after spray applications is required as it may take 2-3 days before the mites begin to die.
- Apply miticides in the cooler parts of the day as the leaves will close up during the middle of the day and make coverage difficult. Mites are generally found on the undersides of the leaves therefore it is important the leaves are open at the time of application.
- Apply miticides with at least 400L/ha and up to 600 L/ha of water to ensure good coverage. Poor coverage will result in limited mite deaths and may create resistance problems.
- Rotate between the available chemicals and abide by the restricted number of annual uses for each product to minimise the chance of chemical resistance issues.
- **Avoid** using the broad spectrum pyrethroid (e.g. bifenthrin) as this product will remove the predator population and mites are known to have resistance.
- **Avoid** using neonicotinoids (e.g. imidacloprid), particularly if hot dry conditions are expected.
- Knockdown miticides will only control nymphs and adults and therefore may require a follow up application 10-14 days later to control mites that have hatched from the eggs.
- It is recommended to apply miticides when mite populations are low in order to obtain the best control. It is too late once high populations are present as the damage has already occurred.

For more information contact:

Queensland Department of Agriculture and Fisheries South Johnstone 07 4064 1130 or Mareeba 07 4048 4600.

PLEASE NOTE: Product registrations listed in this table are current for Queensland as of 10 September 2015. Registrations and product labels should always be consulted prior to application. Trade names provided below have only been included to help identify the active constituent and do not reflect a preference for a particular product.

Activity Group/ Active Constituent	Example trade name	Max. no. of applications/ year	Comments
3A (pyrethroids)/ Bifenthrin	Talstar		**AVOID:** Quickly develops resistance and removes predator population.
10A / Clofentezine	Apollo	1	Ovicide meaning it controls the eggs and prevents eggs from hatching. Must be applied with a knockdown miticide to control the adult population.
10B / Etoxazole	Paramite	1	Mite growth regulator. Causes adults to lay sterile eggs and stops existing nymphs and eggs developing. It does not control adult mites. Can be ground or aerially applied.
12B / Fenbutatin oxide	Torque		Knockdown miticide that kills adults and nymphs. Acts more rapidly in hot weather.
12C / Propargite	Omite, Betamite		Knock down miticide meaning it controls adults not eggs. May cause phytotoxicity (fruit burn) to bunches. Recommended that use be restricted to unbunched blocks or at very least ensure all bunches are bagged. Avoid spraying under hot-humid conditions as phytotoxicity will be worse. **CAUTION:** re-entry periods are specified on the label and staff should wear overalls if entering within these periods.
21A/ Pyridaben	Sanmite		May not be available on the market place any longer.
Unknown / Dicofol	Miti-Fol, Kelthane		Knock down miticide meaning it controls adults not eggs. May have phytotoxicity issues.
Sulfur PER9409			Queensland and New South Wales for bunch treatment only. Advise that application to leaves may interfere with beneficial insects.

What to consider when preparing for tropical cyclones

Bananas are very prone to wind damage and losses can be severe, even with low-category cyclones or severe thunderstorms. The likelihood of banana crop damage relates directly to wind strength, the wind resistance presented by a plant and the presence or absence of a bunch.

Pre-and-post-cyclone management options were investigated in 2011/12 in an industry project, particularly the effects of canopy removal of unbunched plants before the cyclone hits, and the impact of staggering the return to cropping on the subsequent fruit supply.

Figure 1. Canopy removal reduces wind resistance and significantly reduces plant losses from 'roll outs'

Step 1 - looking at your blocks

The first step is to develop a clear idea of the stage of development of the blocks on the farm. How many blocks are plant crops, early ratoons or nurse-suckered, all of which will be more uniform than older ratoons. Of the more uniform blocks, identify those which are heavily bunched, those where the bulk of plants are close to bunching (within 4-6 weeks) and those which are about 2-3 months from bunching.

The uniform unbunched blocks offer the best opportunity to efficiently apply techniques like canopy removal rather than older ratoon blocks.

Step 2 - deciding whether to remove canopy

The next step is to decide which blocks are most appropriate for treatments like canopy removal, which depends not only on the plant development stage but also the likely wind strength. With any cyclone the bunched and large unbunched banana plants are most at risk, so strategies to reduce the wind resistance of these plants can help reduce the damage.

Canopy removal of unbunched plants prior to the cyclone helps to reduce the incidence of plants rolling out and can provide early bunch production. However, removing the canopy has major impacts on yield and fruit length, with 35-50% reductions in bunch weight and 20-35% reductions in proportion of fruit in the extra large (220-260mm) fruit category. Reductions in fruit length were most pronounced in the plants closest to bunching (4-6 weeks) while the biggest reductions in bunch weight occurred for plants that were 6-8 weeks from bunching.

Therefore a fair degree of certainty of damage is needed before embarking on canopy removal on a large scale. For a low-category or physically small cyclone, often the decision to remove the canopy is best left to the latest practical time possible.

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Step 3 - how to cut if removing canopy

The manner in which the canopy is removed is also important. 'Full deleafing' where the stem was generally not cut, resulted in a stronger stem that was better able to support a subsequent bunch compared to plants that had been cut through well below the 'throat' of the plant. See figures 2 and 3.

Figure 2. Full deleafing to remove the leaf canopy provided a stronger stem to support the bunch

Figure 3. Removing the leaf canopy reduces wind resistance and fruit length and bunch weight

Canopy removal results

Table 1. Bunch and plant characteristics for the canopy removal treatments

Treatment	Bunch characteristics					Plant characteristics		
	Bunch mass (kg)	% fruit 220-260mm length	% fruit 200-220mm length	% fruit <200mm length	No. of hands	Total no. leaves	No. leaves @ bunching	Days from bunch emergence to harvest
Canopy removal at 14-15 leaves	20	61.5	27.2	6.6	7	28.3	13.5	117.2
Canopy removal at 19-20 leaves	21.1	40.8	39.1	20.7	8.6	27.2	10.7	112.9
Canopy removal at 24-25 leaves	25.3	13.6	38.3	48.1	9.2	29.7	5.1	115.7
No canopy removal	**38.9**	**64.8**	**22.9**	**10.2**	**10.3**	**28.5**	**14.7**	**104.2**

For more information contact:
Queensland Department of Agriculture and Fisheries, South Johnstone 07 4064 1130

Appendix 8.2: Examples of e-bulletin content which has been distributed to banana growers and industry stakeholders

LAKELAND TRIP FOR NEXT GEN GROWERS - MARCH 27 & 28

The Next Gen group of north Queensland banana growers is planning a trip to the Lakeland growing region on March 27 and 28.

Queensland Department of Agriculture, Fisheries and Forestry Development Horticulturist Naomi King is organising the trip as part of the National Banana Development and Extension Project. Young growers interested in attending should email her by this Friday March 7 at naomi.king@daff.qld.gov.au

It's planned to visit Swiss Farms, Kureen Farming and Mackay Estates. Growers will see the packing systems used at Lakeland farms, which are similar to Central American systems, and the in-field bunch lines used at Swiss Farms to bring fruit back to the shed.

Peter Inderbitzin from Swiss Farms will talk about the compost they produce for use on their bananas. Paul Inderbitzin from Kureen Farming will show photos and videos from his trips to banana farms in China, Taiwan and Central America as part of the Nuffield Scholarship.

At Mackay Estates, growers will see the recently established farm where harvesting began late last year. The trip may also take in a visit to a Tablelands farm.

Growers are to cover the costs for dinner, breakfast and one night's accommodation in Cooktown. Lunches and coach transport are provided by the project.

GROWERS GET READY - RESEARCH HITS THE ROAD IN JULY AND AUGUST

The latest results from industry-funded research will be discussed at a six-stop national roadshow of banana growing regions in July and August.

The research looks at on-farm issues as well as the latest from the supply chain. The roadshow is part of the industry's National Banana Development and Extension Program, a new project ensuring industry research reaches growers. It also provides growers with a chance to talk about what they need from research.

Project leader Naomi King, from the Queensland Department of Agriculture, Fisheries and Forestry (DAFF) (pictured) said research to be discussed related to three major themes.

"The roadshow sessions will be looking at the latest information on farm production and best management practices, farm business and marketing and the supply chain," Naomi said.

"It will be a great opportunity for growers to hear about the latest research and how it applies to their farms and growing regions."

"The days will also be designed to give growers the opportunity to provide feedback to industry project leaders and to discuss how they can have input into industry projects."

For further information on the Queensland and West Australian events contact Naomi on 07 4064 1152 or email naomi.king@daff.qld.gov.au and, for the New South Wales events, contact Mark Hickey on 02 6626 1277 or mark.hickey@nsw.dpi.gov.au

Dates are:
July 15, Tuesday: Murwillumbah Golf Club, 9am - 5pm, includes visit to the Duranbah trial block
July 17, Thursday: Coffs Harbour Showgrounds, 9am - 3.30pm
July 23, Wednesday: Carnarvon Yacht Club, 9am -3.30pm
July 31, Thursday:Tully Showgrounds, 9am -3.30pm
August 1, Friday: Innisfail Brothers Leagues Club 9am -3.30pm, followed by Annual Banana Levy Payers' Meeting
August 7, Thursday: Walkamin Sports Club 9am - 3.30pm.

Workshops reach 70% of NQ production area

The TR4 extension workshops have achieved an important milestone thanks to the support of North Queensland growers.

TR4 extension project members (from left) Tim Liebelt, John Bagshaw, Shane Dullahide, Stewart Lindsay, Robert Mayers and Tegan Kukulies

Strong participation rates mean growers from farms covering 70 per cent of North Queensland's banana production region have now attended.

TR4 Extension project leader Shane Dullahide said the workshops continued to receive excellent feedback from participants with word-of-mouth recommendations helping the project to reach its participation milestone.

"Many of those who have attended have been recruiting other family members and staff to attend a second workshop so that everyone from their farm is up to speed on containing TR4," Shane said.

The extension project is continuing with the workshops as well as farm visits to assist growers with implementing on-farm biosecurity.

Shane said growers who were yet to attend a workshop could book by calling to speak to a TR4 project member on 4064 1182.

BANANA EXTENSION PROJECT ON NATIONAL TOUR FROM JULY

Growers will be able to find out how the latest industry research can benefit their farms when the banana industry's National Banana Development and Extension Project visits banana growing regions throughout Australia.

Naomi King

A nationwide roadshow visiting six locations in three States will be held in July and August to make growers aware of the latest research. Information about plans for the roadshow have been discussed at Banana Grower Association meetings held in NSW and Queensland in February.

The project's leader, Queensland Department of Agriculture, Fisheries and Forestry Development Horticulturist Naomi King (pictured), said the roadshow would give growers access to current information and provide a forum for sharing ideas and discussing issues.

"The banana industry is investing in a broad range of projects and the roadshow will provide a great opportunity for industry members to stay informed," Naomi said.

"Updates and outcomes of both existing and recently completed industry projects will be discussed. We aim to make these days as interactive as possible and encourage all banana industry members to attend."
Planned venues and dates for the roadshow are:

- Tweed/Lismore - Tuesday 15 July
- Coffs Harbour/Woolgoolga - Thursday 17 July
- Carnarvon - Wednesday 23 July
- Tully - Thursday 31 July
- Innisfail - Friday 1 August
- Tablelands - Thursday 7 August.

More information will be available in upcoming industry publications and on the ABGC website, www.abgc.org.au

ROADSHOW PROGRAM OUT NOW - RESERVE YOUR SPOT

Up to 15 banana industry scientists and other experts will all be on the road in July and August in a major initative to take the industry's latest research findings directly to growers and industry partners.

The extension roadshow's program has just been released and outlines information days covering both national and regional growing issues. Growers are asked to check the program and reserve their spot at the events.

To see the program, please click this link.

The scientists, along with other industry experts, are making a three-State, six-stop tour covering north Queensland, the far north and mid north coast of New South Wales and Carnarvon in Western Australia.

Each will give an overview of the latest developments in their specialty areas and be available to answer questions. The programs are tailored for each growing region with some topics being covered at all roadshows and others giving insight into regional issues.

Roadshow dates

July 15, Tuesday – Murwillumbah Golf Club, 9am – 5pm, includes visit to the Duranbah trial block
July 17, Thursday – Coffs Harbour Showgrounds, 9am – 3.30 pm
July 23, Wednesday – Carnarvon Yacht Club 9am – 3.30 pm
July 31, Thursday – Tully Showgrounds 9am – 3.30 pm
August 1, Friday – Innisfail Brothers Leagues Club 9am – 3.30 pm followed by annual levy payers' meeting
August 7, Thursday – Walkamin Sports Club 9am – 3.30 pm.

Roadshow topics and presenters
Topics include Panama disease management and biosecurity risks, resistant and new varieties, the plant diseases Bunchy Top and yellow Sigatoka, fungicide resistance, chemical use, soil health, nutrients and sediment, industry benchmarking, marketing, standardised carton and packaging, international insights, subtropical fruit, plantation mapping and the banana Best Management Practices environmental guideline.

Up to 15 presenters will be at each sesson, including Queensland Department of Agriculture Fisheries and Forestry scientists Jeff Daniells, Tony Pattison, Mike Smith, Sharon Hamill, Suren Samuelian, Stewart Lindsay, Naomi King, Rebecca Sapuppo and Kathy Grice.

Other industry participants include Australian Banana Growers' Council Research and Development manager Jay Anderson and Howard Hall from CDI Pinnacle Management.
Presenting at some sessions are Tully grower Patrick Leahy, Joe Stacey from Joe's Cartons, Robert Crossley from AgTrix, Coffs Harbour wholesalers Paul Gibbins and David Norberry, the Bunchy Top project's David Peasley, NSW Department of Primary Industries' Mark Hickey and Justine Cox and, Valerie Shrubb from the Western Australian Department of Agriculture and Food and Christina Mortimore from the Queensland Department of Natural Resources and Mines.

The roadshow is part of the industry's National Banana Development and Extension Program. The program's leader, Naomi King, said: "It will be a great opportunity for growers to hear about the latest research and how it applies to their farms and growing regions."

LOOK OUT FOR BEETLE IN POST-CYCLONE PADDOCKS

Growers who lost trees during Tropical Cyclone Ita have been reminded to be vigilant for a potential increase in Banana weevil borer numbers .

Queensland Department of Agriculture, Fisheries and Forestry (QDAFF) Development Horticulturist Naomi King said growers should be mindful of the potential for borer numbers to lift.

"Growers who have trees down following the cyclone should be aware over the coming weeks that the extra decaying plant material could encourage an increase in beetle borer activity," Naomi said.

She said growers should consider how much decaying material may be on their farms and what increase in beetle borer treatment might be appropriate. Beetle damage, pictured above.

New Panama video has info on protecting your farm

The banana industry's National Banana Development and Extension Program has produced a video on identifying Panama TR4 and ways to protect your farm.

It's an excellent video put together with the assistance of the Queensland Department of Agriculture, including South Johnstone Research Station Principal Development Horticulturist Stewart Lindsay and Development Horticulturist Tegan Kukulies and Northern Information Development Officer Ingrid Jenkins, and features some North Queensland growers.

To see the video, please go to

https://www.youtube.com/watch?v=enPpPvTGESE

National roadshows prepare to launch

Banana growers around Australia have the opportunity to hear the latest research in a biennial roadshow.

On it's second tour around the country after the successful 2014 event, the Banana Roadshow will profile the latest industry research, bringing growers up to date with information on biosecurity, disease research, farm production, environmental practices and supply chain management.

Dates/locations include:

June 9 – QLD - Mareeba, Department of Natural Resources and Mines John Charles room, 9am – 2:30pm

June 10 – QLD - Innisfail Brothers Leagues Club, 9am – 2:30pm

June 16 – QLD –Tully Senior Citizens Hall, 9am – 2:30pm

June 23 – WA - Carnarvon Yacht Club, 9am – 1:30pm

July 5 - NSW - Coffs Harbour Showgrounds, 9am - 2pm

July 7–NSW – Murwillumbah Golf Club, 9am – 2pm

DAF pilot trials take flight

Three small, 'out of the box' innovative banana trials have commenced at South Johnstone.

One is trialling chemical options to remove flower remnants, another is looking at the effect on suckers by injecting harvested mother plants with a urea solution and a third is looking at different desuckering methods.

Department of Agriculture and Fisheries' senior development officer Tegan Kukulies, who is co-ordinating the trials, said "These trials are high-risk in nature."

"For example we have already damaged bunches attempting to remove flower remnants. I would like to know if growers are interested in receiving regular updates (including the failures) of these trials".

If you are interested in receiving more regular updates contact Tegan at tegan.kukulies@daf.qld.gov.au or 07 4220 4152.

Panama Open Day

All growers are invited to attend a Panama R & D Open Day at the DAF South Johnstone Research station on Friday, May 12.

This interactive event will include a tour of the banana paddock at the research station to see; tolerant varieties and grasp the strategies being taken to develop them, disinfectant demonstrations, soil health practices, options for remote and proximal sensing and understanding the effect of urea in the destruction process.

The half-day event will be held from 8:30am to 12:30pm, followed by lunch. For catering purposes and since strict on-farm biosecurity practices will be implemented to enter the paddock, please RSVP with your shoe size to Tegan Kukulies on 0459 846 053 or email tegan.kukulies@daf.qld.gov.au

Panama Open Day success

Big congratulations to the Queensland Department of Agriculture and Fisheries' (DAF) staff who organised a hugely successful Panama open day at the South Johnstone Research Station last Friday.

About 100 banana growers, researchers and other industry leaders took part in the interactive event, hearing the latest research and development focussed on Panama disease Tropical Race 4 (TR4).

One of the issues discussed was the importance of using disinfectant products in the most effective manner. Growers were shown high range test strips (0-1500ppm) that test the concentration of DDAC based disinfectants.

These strips can be sourced from reputable laboratory suppliers however for more information please don't hesitate to contact Shanara Veivers – Shanara.veivers@daf.qld.gov.au or 07 4220 4149 - who will be able to assist with providing further information.

Appendix 8.3: Examples of Australian Banana Newsletter articles

industry news

Seasonal change brings bacterial rot risks

Dry weather in recent months leading into expected higher than average rainfall during the wet season will create ideal conditions for the organism Erwinia.

Erwinia can cause bacterial corm rot or bacterial heart rot. Symptoms generally appear when prolonged dry periods are followed by the first storms of the season. Water stress and compacted soil tend to exacerbate the problem, with plant and first ratoon crops most susceptible.

Queensland Department of Agriculture, Fisheries and Forestry (QDAFF) Development Horticulturist Naomi King said growers should be aware of the symptoms, which include yellowing of the leaves. The disease occurs mainly in tropical regions but also in the subtropics.

Corm rot is identified by the dark border around the infection zone in the corm, and in most cases also has an unpleasant odour. Heart rot is identifiable by the death of the cigar leaf, and when the stem is cut in half lengthways this infection will continue down the very centre of the stem some distance.

Infected trees should be cut down allowing the sucker to come away, generally unaffected. Sterilise cane knives after cutting down an infected plant to prevent further spread.

Even if you suspect the problem to be caused by bacterial corm rot or bacterial heart rot, it is recommended to have a sample examined as symptoms resemble other serious quarantine diseases such as Panama disease and Moko disease.

Bacterial corm rot (top left) is identified by the dark border around the infection zone and, usually, an unpleasant odour. Leaves showing signs of infection (left) and (above) bacterial heart rot kills the cigar leaf and continues down the plant's centre. Photos: Stewart Lindsay, Richard Piper and Naomi King.

farm management

New guide gives quick tips for cyclones

industry news

Northern exposure for next gens

Far north Queensland's young coastal and Tablelands growers have toured the Lakeland district to see the latest in harvesting and packing systems.

The tour in late March was the first major event for the new Next Gen banana growers' group.

Twenty-five young growers from Tully, Innisfail and the Tablelands travelled to Lakeland, 400 kilometres north of Tully, where they were hosted by Swiss Farms, Kureen Farming and Mackay Estates.

The tour took place just weeks before Lakeland was hit by Tropical Cyclone Ita which caused some damage to bunched trees but left infrastructure intact.

Department of Agriculture, Fisheries and Forestry development horticulturist Naomi King organised the tour. She said it provided growers with an opportunity to see some new systems not in use elsewhere in far north Queensland.

The tour visited Red Valley, Swiss Farms' newest banana farm, designed with a harvesting and packing system similar to those found in Central America. It also visited Kureen Farm, which uses a similar packing system, and Mackay Estates' Golden Tyne.

Naomi thanked Lakeland farm owners and managers for taking the time to show their farm operations to the Next Gen group.

"The trip was a fantastic opportunity for growers to see working examples of some innovations in harvesting and packing and to compare them with systems in place on the coast and the Tablelands," she said.

"A big thank you to everyone who welcomed us onto their farms and took the time to show us around. When growers get together in this way and share information it has benefits for the whole industry."

The Next Gen group is targeting far north Queensland banana growers 40 years and under, encouraging them to become more involved in the banana industry. Growers wanting to join the group's contact list for notification of future events should phone Naomi on 4064 1152.

More information on the Lakeland tour will feature in the next edition of Australian Bananas magazine.

The Next gen tour visits a Lakeland packing shed.

Growers wanted

Two farms in soil-health trials

Banana farms at Woolgoolga and Palmwoods will host soil-health trials to see how the use of compost and groundcovers can improve yield and plant health.

Banana growers will be able to follow the progress of the trials with the two sites to be used for field days and extension activities.

NSW DPI Leader Northern Horticulture Mark Hickey said: "We will be implementing a range of soil health best practices, including applying compost in a two-metre wide strip under plants at a rate of 30 tonnes/hectare, and sowing annual rye and clover as a groundcover in the inter-row.

"We are expecting to reduce plant stress via improved soil health and increased soil micro organism diversity. Recently completed research in Queensland found that planting cover crops in bananas also reduced the impact of Panama Disease in Ladyfinger bananas."

He said the practices were also expected to help control nematodes which were a major problem for NSW growers. Soil nutrients, banana plant health and yield would be sampled throughout the seasons at appropriate times. The trial would be monitored for at least two years.

The national project is also running trials in Queensland.

Bananas' extension project on the road

Growers will be able to find out how the latest industry research can benefit their farms when the banana industry's National Banana Development and Extension Project visits banana growing regions throughout Australia.

A nationwide roadshow visiting six locations in three States will be held in July and August to make growers aware of the latest research.

The project's leader, Queensland Department of Agriculture, Fisheries and Forestry Development Horticulturist Naomi King, said the roadshow would give growers access to current information and provide a forum for sharing ideas and discussing issues.

"The banana industry is investing in a broad range of projects and the roadshow will provide a great opportunity for industry members to stay informed," Naomi said.

"Updates and outcomes of both existing and recently completed industry projects will be discussed. We aim to make these days as interactive as possible and encourage all banana industry members to attend."

Planned venues and dates for the roadshow are:

- Tweed/Lismore - Tuesday 15 July
- Coffs Harbour/Woolgoolga - Thursday 17 July
- Carnarvon - Wednesday 23 July
- Tully - Thursday 31 July
- Innisfail - Friday 1 August
- Tablelands - Thursday 7 August.

More information will be available in upcoming industry publications and on the ABGC website, www.abgc.org.au

On the road: Naomi King will be visiting growing regions in three States to tell growers about the latest banana research.

Extension Roadshow

Tuesday, July 15, Murwillumbah Golf Club, 9am -5pm including Duranbah trial block visit.

Thursday, July 17, Coffs Harbour Showgrounds. 9am - 3.30pm.
Contact Mark Hickey, NSW DPI, 6626 1277 or mark.hickey@dpi.nsw.gov.au

Wednesday, July 23, Carnarvon Yacht Club 9am – 3.30 pm.
Contact Naomi King, Qld DAFF, 07 4064 1152 or naomi.king@daff.qld.gov.au

Roadshow success

The banana industry's biggest initiative yet to take research direct to growers has been an outstanding success.

The National Banana Development and Extension Program held six information sessions during a national roadshow. Presentations will be posted at www.abgc.org.au

The events are set to be held every two years.

Appendix 8.4: Examples of articles printed in the Australian Bananas magazine

Nursing a headache

CUTTING PLANTS TO SMOOTH PRODUCTION

Following Cyclone Yasi in 2011, many growers have taken another look at nurse suckering. Queensland Department of Agriculture, Fisheries and Forestry (QDAFF) Principal Horticulturist Jeff Daniells and Senior Development Horticulturist Stewart Lindsay report.

Above: Stewart Lindsay at a South Johnstone nurse-suckered block.

The banana industry's recent cyclone recovery project recommended the development of a database of crop cycle information for nurse suckering done at different times of the year.

This article starts this process by looking at records generated by past research trials at DAFF's South Johnstone Research Station.

When nurse suckering was first developed in the 1950s it was widely used in north Queensland to help confine fruit production to the Winter-Spring period when prices were highest on the southern markets. This remained the norm during the 1950s and 1960s.

Since then, nurse suckering has experienced revivals following cyclones because it can delay production of fruit and so avoid production gluts and associated low market prices. Nurse suckering has also been used to arrange farm production to provide more constant fruit supplies through the year, to make the time of harvest more uniform within a block and to rejuvenate older ratoons.

Present opportunities

These days, because north Queensland supplies nearly 90 per cent of the Australian market, fruit is required year round in relatively even quantities. Nurse suckering is very effective for adjusting the time of production to achieve this continuous supply across the farm.

If you want bunching and harvest in particular months of the year when should you be nurse suckering?

Our studies at DAFF South Johnstone prior to a few years ago were limited to using nurse suckering to schedule bunching and harvest to particular times of the year better suited for rating for leaf spot disease and for the maturity bronzing fruit disorder.

More recently in our cyclone recovery work we investigated some additional

Table 1. Bunching and production times at South Johnstone resulting from different nurse suckering times.

Nurse cut down	Sucker set on nurse	Bunching	Harvest
Jun 1987*	Jul 1987	Dec/Feb 1988	Apr/Jun 1988
Jun 1988*	Jul 1988	Jan/Feb 1989	May/Jul 1989
Early May 2011**	Jun 2011	50% Jan 2012	50% Mar 2012
Early Aug 2011**	Sept 2011	50% Feb 2012	50% May 2012
Late Oct 2011**	Nov 2011	50% May 2012	50% Nov/Dec 2012
Mid Dec 2012**	Feb 2013	50% Aug 2013	N/A
Jan 2013**	Mar 2013	50% Sept 2013	N/A
Feb 2013**	Apr 2013	50% Nov 2013	N/A

Table 2. Cropping patterns resulting from nurse suckering conducted at South Johnstone.

Cut down	Bunch emergence	Bunch harvest	Months (cut down to harvest)
January	September*	N/A [~ Dec/Jan]	11-12
February	November	N/A [~ Feb]	12
May	January	April	11
June	January	April**	10
August	February	May	9
October	May	September	11
December	August	Nov/Dec	11-12

1. * Nurse suckering involved physically cutting down nurse and gouging out growing point as per Daniells et al. Nov 1997 Good Fruit and Vegetables p 58. ** 2011 dates – chemical treatment of non-bunched plants and remove canopy or cut down bunch and canopy on bunched plants. All 2012/13 dates were chemically treated followed by canopy removal.
2. * Average month shown – actual spread usually 2-4 months. ** Harvest date adjusted to today's thinner caliper grade.

Bedtime stories for banana growers

They're a quicker, cheaper and more flexible way to plant, so why don't more growers use pre-formed and permanent beds? Queensland Department of Agriculture Fisheries and Forestry (QDAFF) Horticulturist Naomi King reports.

The concepts of pre-formed and permanent beds are not new to the banana industry. However, despite the many benefits they provide, they continue to be a rarely used practice.

The two types of beds can be used together to support each other or individually, depending on a farm's management practices.

Here is an explanation of the terms "pre-formed" and "permanent" and some of their advantages.

Pre-formed beds

Pre-forming beds refers to the practice of getting a banana plant block ready well in advance of the planting date.

This means all of the ground preparation and the forming of banana-row beds is carried out and the block is then left to sit fallow, generally over the wet season.

When the block is ready to plant, the row is simply sprayed out and any cultivation is restricted to the row. This leaves the inter-row space intact, maintaining ground cover and also providing a hard, trafficable inter-row surface for the plant crop.

Advantages include:

- opportunity to take advantage of short windows of fine weather for planting
- quicker planting after rain as the raised beds dry out faster than flat ground
- allows wet season planting and generally more flexibility in the planting schedule
- improved inter-row access and trafficability.

Permanent beds

The term 'permanent beds' refers to the practice of leaving the row in the same place crop after crop – often with no, or very limited, ground preparation to the inter-row space.

Growers find there are advantages in only cultivating the banana-row bed, including:

- reduced cultivation as only half of the block is cultivated, therefore it is cheaper, faster and means less of the block is susceptible to erosion
- plants do not come into contact with the compacted inter-row soil which may restrict root growth
- subsoil and topsoil are less likely to be mixed, especially in blocks with mounded rows that require the whole block to be flattened before reforming rows
- Plant block inter-row spaces are already compacted and trafficable as they have not been disturbed, therefore machinery and vehicles are less likely to cause ruts
- Ground cover can be maintained in the inter-row spaces of fallow and plant crops
- Lime, magnesium and mill by-products can be applied just to the row, reducing costs.

Gavin MacKay: wet season planting

Gavin MacKay of Mackay Estates' Bolinda farm has found there are a number of advantages using pre-formed beds.

"We see a number of benefits from pre-forming our plant blocks," Gavin said. "The main one is the planting window. By having the block ready, it gives us the opportunity to plant in the wet season if we choose to.

"Also we find we can get our plant in earlier after rain as the formed rows dry out faster than flat ground."

Gavin said other benefits were the prevention of soil movement during the wet season and the improved trafficability of the plant block's inter-row space.

"Currently we prepare the block as per usual and leave it with a grass fallow. If we have a nematode problem we would look at using a non-host fallow crop but most of the time it's just a grass fallow. Down the track we may also look at using a wick wiper in the inter-row before planting to get a good ground cover established early.

"We also find we get a chance to get rid of some of the problem weeds as they are easier to control before the bananas are planted."

Gavin didn't believe there were any problems associated with this practice as they prepared the block exactly as they normally would. The MacKay family have been pre-forming their plant blocks for a number of years and each year they try to prepare some of their plant blocks this way. All of the MacKays' ground preparation activities are performed with the aid of GPS-guided machinery. First they survey the farm by driving over it with a GPS-guided tractor that allows them to produce a map showing the gradient across the block.

Then they prepare the block as usual and, with the aid of GPS guidance, ensure the row and even inter-row spaces are positioned correctly. Where possible, the row spaces will be kept in the same location over successive banana crop cycles.

"If, at the end of the crop cycle, the block doesn't require any major renovations, we will leave the rows in the same place and just reshape the inter-row space," Gavin said.

"This is much quicker as we don't have to work up the whole block. We also aren't mixing up topsoil and subsoil and mixing compacted inter-row soil into the row when we get the block ready."

A pre-formed bed at LMB where both pre-formed and permanent beds have helped prevent ruts.

Stephen Lowe has tried permanent beds at the family's Tully farm.

Banana extension project hits the road

Growers will find out how the latest industry research can improve their farms when a three-State roadshow visits banana growing regions in July and August.

Day-long information sessions will be held at six locations in Australia's banana-growing regions.

The roadshow is part of the banana industry's new National Banana Development and Extension Project.

Plans for the roadshow have been discussed at Banana Growers' Association meetings held this year in NSW and Queensland. The roadshow also plans to visit the West Australian growing region of Carnarvon.Banana Development and Extension Project leader, Queensland Department of Agriculture, Fisheries and Forestry Development Horticulturist Naomi King, said the roadshow would give growers access to current information and provide a forum for sharing ideas and discussing issues.

"The banana industry is investing in a broad range of projects and the roadshow will provide a great opportunity for industry members to stay informed," Naomi said

"Updates and outcomes of both existing and recently completed industry projects will be discussed. We aim to make these days as interactive as possible and encourage all banana industry members to attend."

Planned venues and dates for the roadshow are:

- Tweed/Lismore - Tuesday 15 July
- Coffs Harbour/Woolgoolga - Thursday 17 July
- Carnarvon - Wednesday 23 July
- Tully - Thursday 31 July
- Innisfail - Friday 1 August
- Tablelands - Thursday 7 August.

More information on venues will be provided as soon as it is available. For details, watch upcoming industry publications and the ABGC website www.abgc.org.au

On the road: Growers will get updates on the latest research.

Northern exposure for young growers

Twenty-five young growers from Tully, Innisfail and the Tablelands made the journey north to the Lakeland production region to see the latest on their composting, harvesting and packing systems.

The tour was the first for the Next-gen banana group, a group of young north Queensland growers. It gave them the opportunity to visit the Lakeland production region and see the farming systems first hand.

Yvette Eaden, Kairoo Farming and Mackay Estates hosted the visit.

The March tour took place three weeks before the region was hit by Tropical Cyclone Ita. The cyclone caused some damage to bunched trays but fortunately left production and infrastructure intact.

Visiting Red Valley

First stop on the tour was Red Valley, Swiss Farms' newest banana farm. This farm has been designed with a fast-setting and packing system similar to those in Central America.

Features include:

- Bunches are brought into the shed on a cable system, rather than tractor and trailer
- Fruit is dehanded into large concrete troughs using water to cushion the fruit rather than conveyors
- Clusters are placed on trays, post-harvest treatments are applied and the trays are stacked for weight
- When the trays reach the packer, they pack exactly what is on the tray removing the need for the packer to select fruit and check box weight.

Swiss Farms' Indelicato family redesigned their main farm shed after Peter Indelicato saw the system overseas. The establishment of the newer Red Valley farm allowed them to design the farm and shed from scratch using this new system.

The Red Valley shed also has a hydro-cooling system installed to their trough which rapidly reduces the pulp temperature of the bananas prior to them being processed through the packing shed. The visit to Red Valley also included a look at their extensive composting facilities.

Above: First visit for the Next-gens – the group at Lakeland. Below: Young growers inspect the concrete trough system at Swiss Farms.

Kairoo Farming

At Kairoo Farming, the Next-gen group was able to see a similar packing system, with stainless steel troughs rather than concrete, providing some dual-technology options.

Farm manager Paul Indelicato is the current Nuffield Scholar for the banana industry. He shared photos from his scholarship study trips to Australian banana production regions in Taiwan, China, Martinique and Central America.

Mackay Estates

The final visit was to Mackay Estates' newest farm, Goldfynch, which the Tully-based Silacoya established in 2013.

While Mackay Estates uses the trash-blend through and conveyor system at their coastal farms in Tully, they have installed the concrete trough system at Lakeland.

This visit provided the opportunity for the group to discuss the merits of the different packing systems in use in Lakeland and in their own growing regions.

A big thank you must go to the farm owners and managers who welcomed the next group into their farms and took the time to show us around.

The trip was a great opportunity for young growers to see working examples of some of the innovations in harvesting and packing and to compare them with the systems in place on the coast and the Tablelands.

The Next-gen group is targeted at for north Queensland banana growers 40 years and under, and encourages them to become more involved in the future of the banana industry. Growers wanting to become involved in the group, which meets regularly to discuss industry issues, should contact us on 4064 1132.

TR4 trio tops Tully tryout

In a first for on-farm trials into the performance of Tropical Race 4 (TR4)-tolerant banana varieties in north Queensland growing conditions, four varieties have been assessed in Tully. Three of the four Cavendish varieties have shown promise in the year-long study of plants grown on a trial block at Leahy's Bananas. The fourth variety has been flagged as potentially having slower production cycles. The plant crop assessments are the first completed on-farm in north Queensland where growers are keenly interested in varieties tolerant to TR4, a devastating soil-borne fungus.

Story by Naomi King

Above: A bunched Formosana row on the left, a harvested DPM25 row in the middle with the GCTCV-119 plants on the right yet to bell.

Field trials are also being conducted for the agronomic performance of varieties in north Queensland at the South Johnstone Research Station and for agronomic performance and Race 1 susceptibility, in the subtropics, at Duranbah.

The global spread of TR4, found in parts of Asia, in the Northern Territory in Australia, and recently found in parts of the Middle East and Africa, has been of major concern to the Australian banana industry.

As TR4 is not present in north Queensland, the bananas trialled at Tully were assessed for production traits only. At Leahy's Bananas, the varieties were planted on a block not previously planted with bananas or any other crop.

The varieties assessed were two Taiwanese Giant Cavendish selections, Formosana and GCTCV-119, Queensland's DPM25 and Sumatran variety CJ-19. Williams plants were also grown on the trial block to provide a comparison with the industry's standard variety.

Based on the observations of the plant crop, Formosana, DPM25 and CJ-19 show promise. GCTCV-119 does not appear to be a favourable alternative variety based on undesirable production traits. However assessments will continue on this variety.

The mean (average) for each variety is shown in the following information and table. The information cannot be considered as statistically valid but rather as observational data.

Queensland Department of Agriculture, Fisheries and Forestry Senior Development Horticulturist Stewart Lindsay and Development Horticulturist Naomi King, collected the data over six months and will continue to follow these plants through subsequent ratoon cycles.

Ms King said the findings were useful for providing an indication of how the varieties performed on-farm.

"Obviously we can only assess these plants for their agronomic performance in the absence of TR4 but it's really important for the industry to have an idea of how these plants perform, just in case we ever need a Plan B."

The Leahys were among the first growers to obtain the TR4-tolerant varieties by applying for the plants supplied through the quarantine program conducted at the Maroochy Research Facility on the Sunshine Coast.

Cycle time

There was little difference in the average time from planting to bell emergence between the Williams, DPM25 and CJ-19. Formosana and GCTCV-119 were 10 and 20 weeks slower respectively. By the time the last of the GCTCV-119 bunches was harvested, the Williams, DPM25 and CJ-19 had all commenced bolling in their first ratoon crop, therefore GCTCV-119 had a much longer cycle time.

GCTCV-119 hands fingers and variable fruit size throughout the bunch was a common problem.

GCTCV-119 bunches were, on average, the lightest with smaller fruit.

CJ-19: an average bunch weight of 18.7kgs and some interesting off-types that may also have potential.

Plant height

CJ-19 were the shortest plants, bolling at two metres while there was no difference between Williams and DPM25 at 2.2 metres. Formosana averaged 2.4 metres while the GCTCV-119 were very tall with an average plant height of 3.1 metres in the plant crop.

Bunch weight

The longer cropping cycle of the GCTCV-119 was not compensated for by a heavier bunch. There was little variation in bunch weight between the varieties with average bunch weights ranging from 17.3kg to 19.5kg.

Ripening

Observations of ripened fruit from a single week of harvest indicated that the varieties ripen at different rates and therefore could not be packed in the same carton. Sample boxes of CJ-19, DPM25 and Formosana were ripened at the South Johnstone research facility and showed there were up to two days difference between ripening times.

On day eight from harvest, the CJ-19 were advanced colour Stage 6 (fully ripe but no spots), DPM25 were colour Stage 5 (mainly yellow with green tips and necks) and the Formosana were colour Stages 4 to 5. Table 1 provides a summary of the production data for the plant crop.

Formosana: Averaging both the heaviest bunch weight, at 19.5kgs and longest fruit length.

DPM25: The quickest cycle of the TR4-tolerant varieties with an average 34 weeks to bell emergence.

Table 1. TR4 tolerant Cavendish variety plant crop assessments

	Planting to bell emergence	Plant height at bell emergence	Hands per bunch	Bunch weight	Hand 1 fruit length	Hand 2 fruit length	Hand 3 fruit length
Williams	33 weeks	2.2m	8.0	18.1kg	238mm	239mm	238mm
DPM25	34 weeks	2.2m	8.4	17.6kg	245mm	250mm	241mm
CJ-19	37 weeks	2.0m	8.9	18.7kg	244mm	247mm	232mm
Formosana	43 weeks	2.4m	8.3	19.5kg	258mm	258mm	249mm
GCTCV-119	53 weeks	3.1m	7.1	17.3kg	218mm	220mm	216mm

Growers show the love for 'speed-dating' scientists

It's been called banana science's version of "speed dating" and it's a concept that banana growers seem to have fallen in love with.

The National Banana Roadshow was an industry first – a road trip taking some of Australia's top banana scientists and industry experts on a six-stop, three-state tour to visit banana growers on their home patch.

Discussing the presentations at the Tully roadshow, are growers Stephen Lowe (left) and Jonny Wells

Tully grower Aiden MacKay (centre) discusses industry issues with ABGC CEO Jim Pekin and Lakeland grower Paul Inderbitzin (backs to camera) and Tully grower Keith Rixon.

Banana growers at the roadshow held for Tablelands growers at Walkamin in north Queensland.

Presenters with years of research and technical experience were given only a strictly-policed, ten-minute timeslot to tell banana growers and industry partners the key points about their projects.

The days had three major themes – farm production and best environmental practice; farm business and marketing and supply chain management.

Topics included soil health and Panama Disease, disease-resistant and new banana varieties, leaf disease, best management practices, plant nutrients and sediment, chemical registrations, banana marketing and supply chain, carton design, benchmarking farming profitability and international production insights.

The snappy 10-minute presentation format allowed up to 15 presentations at each session as well as group discussions, questions and feedback from attendees. While some of the presentations were made at each roadshow stop there were also some especially tailored for specific regional issues. Video presentations were also included and showed footage of carton design, tissue culture science and international growing practices.

The roadshow was part of the levy-funded National Banana Development and Extension Program led by banana scientist Naomi King.

Naomi said the roadshows had been a valuable way to find out how science could help growers and the industry achieve their production goals.

The ten-minute presentation format had been a hit with growers.

"We told them it was banana science's version of speed dating – a chance for scientists to talk about the most interesting aspects of their work. The growers loved the idea and the scientists have also been very pleased with the response.

"The event not only gave banana scientists the chance to tell growers about their work, just as importantly it gave growers the chance to talk directly with scientists about how they can use that research and what other research they would find useful.

"We now have some great information on the issues that are of most interest to growers, both nationally and on a regional basis."

Attendees from across Australia, at sessions in north Queensland, northern and mid-north coast New South Wales and Carnarvon in Western Australia, all provided enthusiastic feedback on the roadshow.

They rated the roadshows using electronic polling keypads and the results have been impressive.

The event achieved a major upgrade in knowledge about the research projects that are a key to improving banana farming practices.

At the start of the roadshows, 84 per cent of participants had rated their knowledge of research projects at the lower end of a five-point scale – in the range of one to three. Only 16 per cent rated themselves in the top two levels. By the end of the event, that result had flipped with 71 per cent of participants rating their knowledge about the projects in the top two levels, an increase of 55 percentage points.

Other impressive results were that 90 per cent of participants said they either would change or were thinking of changing a farming practice based on the information they heard about on the day.

The roadshows seem assured of strong continuing interest from growers with 98 per cent saying they'd attend another event.

The roadshows are now planned to be held every second year with the next ones to be held in 2016. This slots them into the years between the Banana Industry's major event, the biennial Banana Industry Congress.

Ms King said the two events would work well together to provide information to growers in a variety of formats.

Handover

Banana Roadshow leader Naomi King will be handing over the role to another researcher following her move to a new industry position in 2015.

National Banana Development and Extension Program leader Naomi King at the Tully roadshow with, from left, Aiden MacKay, Paul Inderbitzin, Caleb Matthews, Keith Rixon, Stephen Lowe and Paul Johnston.

Naomi is leaving the Queensland Department of Agriculture, Fisheries and Forestry, which delivers the National Banana Development and Extension Program.

Roadshow co-ordinators, Queensland Department of Agriculture, Fisheries and Forestry horticulturists Stewart Lindsay and program leader Naomi King at the final roadshow at Walkamin.

What the growers said

As reported in the last edition of Australian Bananas, growers who attended the first roadshows at Murwillumbah in northern NSW and Coffs Harbour on the mid-north coast, were enthusiastic about the event.

Comments from the north Queensland roadshows were equally appreciative:

Stephen Lowe: "The ten-minute format is a winner, the presenters have to put all the main points in to that timeframe and you can't fall asleep in ten minutes! It's great to have the researchers presenting directly to us."

Craig Buchanan: "It was just a good day all round. There was a little bit of everything. I like all the soil health stuff."

Adrian Cirema: "There was a great variety of information. I really enjoyed Paul Inderbitzin's video presentation on his Nuffield Scholarship studies. He hit every nail on the head. It's all about hands-on, and I loved the comment 'the shed's not a hospital'."

Roadshow snapshot

- More than 150 attendees
- Banana grower and industry partners participated
- Achieved a major upgrade in knowledge about research projects
- 90% of participants to consider or make changes to farming practices based on roadshow information
- 98% would attend a future roadshow and 62% said they would also recommend the roadshow to others
- 94% of participants rated the day 7 or higher, out of 10

Roadshow unites growers and researchers

The Australian banana industry has taken its biggest initiative to bring research findings directly to banana growers around the nation.

In an industry first, a National Banana Roadshow made a six-stop, three State tour of banana growing regions in July and August.

The roadshows brought together banana industry scientists and other industry researchers to tell how their work benefits growers and also answered growers' questions.

The first Banana Roadshow event was on July 15 at Murwillumbah, in the Tweed Valley on the far north coast of New South Wales, followed by a July 17 visit to Coffs Harbour on the mid-north coast.

At the time this edition of Australian Bananas magazine was being published, other events were scheduled for Carnarvon in Western Australia and, in north Queensland, at Tully and Innisfail on the coast and Walkamin on the Tablelands.

Tweed District growers, industry partners and banana scientists at the Duranbah trial block during the first Banana Roadshow event.

The Roadshow is an initiative of the National Banana Extension and Development Program led by banana scientist Naomi King. It is planned to be held every two years adding another outlet for research information in between the biennial Banana Industry Congress.

Naomi launched the first roadshow telling growers: "This is a new initiative of the banana industry. It's your levies which fund the projects so we're putting you in contact with the people who do the work."

Eleven growers attended the Murwillumbah event and were particularly interested in soil health and solutions for the soil disease Panama Race 1, found on many farms in the far north region.

The roadshow included a visit to the Duranbah trial block, also in the Tweed district, where 15 new banana plant varieties are being trialled for Panama resistance.

In Coffs Harbour, 28 growers attended and engaged in discussions on research and provided feedback on presentations. Twelve Coffs and district growers also attended a Best Management Practices (BMP) Guideline training course following the roadshow.

Growers were asked to focus on the information that could help their businesses and were asked to think about to consider what changes they could make on their farms as a result of roadshow information and the additional information they needed. Growers were also asked to provide feedback to presenters on the research.

Up to 15 presenters gave summaries of their research during the roadshows and there were also information videos on the Australian Bananas marketing campaign, carton design and from banana industry Nuffield scholar Paul Inderbitzin on his international study tour.

Banana scientists spoke on topics including the soil borne Panama Disease. Those speakers included Tony Pattison (Panama Race 1 and soil health), Mike Smith (disease-resistant varieties), Stewart Lindsay (Panama TR4 variety testing), Sharon Thorrell (accessing new varieties) and Jay Anderson (addressing disease risks).

Other speakers on plant disease issues including National Banana Bunchy Top Program Manager David Peasley (Bunchy

Continued opposite »

Growers road test the first stage

As the Banana Roadshow began its way around Australia – some initial thoughts from growers attending the first presentations at Murwillumbah and Coffs Harbour.

Tim Johnson - Murwillumbah

"It's good to see the banana industry taking the time out to inform growers, particularly the smaller growers in all regions – including the smaller growing regions. We're all part of the one industry. It was good to be updated on packaging – it's a very important issue that a lot of people have problems with. I know New South Wales growers sometimes have problems with packaging, such as instances of packaging collapsing at the markets."

Rob Johnson - Murwillumbah

"It's good to be kept up to date with all the new plant varieties and what's going on in that world – what may be coming up and the possibilities we've got. It was very interesting to see all the varieties at the trial block."

Stephen Edwards – Murwillumbah

"Some really interesting ideas were presented today. I think growers need to be willing to try some new ideas and give them a go, including finding ways to help with soil improvements which is critical if the industry is going to flourish in the long term. We have to find ways to look after our soil better."

Wally Gately – Coffs Harbour

"As far as the day and the presenters were concerned – you couldn't have done any better.

The 10-minute presentations with question time was an excellent format. Everyone listened very attentively and got a lot out of the day. It was a pity we didn't have a few more growers here."

Michael Hendrick – Murwillumbah

"We heard lots of good stuff today. I'm particularly interested in the BMP project for my farm. I'd like to see what improvements we can put into the hills in Northern NSW and what we can do to improve our farming practices."

Joshua Tate – Coffs Harbour

"There was a lot of information provided. Overall it was a valuable day. The packaging presentation video was good – it was interesting to see how supermarkets like to see the fruit packaged. I'd like to find out more on soil health – how to look after soils and the different things to look out for."

Duane Pierce - Murwillumbah

"I found the day to be very educational. I'm interested to learn more about the finer points of chemical usage and also about the new ground cover concepts that might benefit the farm."

Top), Tony Pattison (soil health), Jay Anderson (chemical registrations and permits) and Suren Samsudin (leaf disease).

There were also presentations on marketing and supply chain, including benchmarking information on farm profitability from Howard Hall of Pinnacle Research and information on new varieties from scientist Jeff Daniells.

The roadshows addressed both industry-wide and local issues and in New South Wales there was information about the appointment of a new Industry Development Officer who will assist growers in the far north and mid-north coast regions.

Coffs wholesalers Paul Gibbins of Golden Dawn and David Norbury of D&D Ripeners took part in an "on the couch" discussion led by NSW DPI Leader, Northern Horticulture, Mark Hickey to talk about initiatives to market NSW bananas.

BREWING UP A SHOT OF SCIENCE

In a new format for the Banana Industry Congress R&D sessions, delegates were asked to grab a coffee and chat with researchers in the event's Science Café. Some of our scientists provided these updates on their research.

National Banana Development and Extension Project

by project leader Tegan Kukulies, Queensland Department of Agriculture and Fisheries, Senior Development Horticulturist

What's the project about?
Co-ordinating extension to growers of information from past, current and future research projects.

The project delivered the national technical information updates (banana roadshows) in 2014 and will co-ordinate them again in 2016.

We develop and maintain links with Next Gen growers, industry service providers, grower associations and supply chain members. We also create You Tube-style videos on priority topics and conduct small-scale research and demonstration trials to fill information gaps and exhibit best management practices.

Why's it important?
To achieve successful uptake and adoption of project outputs by growers around Australia.

What's next?
The main activities will be co-ordinating the technical series roadshow events in 2016 around Australia and reviewing and updating the Banana Best Management Practice Environmental Guidelines.

We would love to see as many growers as possible at next year's roadshow technical update series. Ninety per cent of people that attended last year say they would recommend the event to others.

What did growers ask at Science Café?
This project ran a small-scale on-farm research trial assessing the productivity of some varieties that have some tolerance to TR4. There were quite a few questions about the varieties' agronomic characteristics.

Using tissue culture and rapid growth of FOC

by Sharon Hamill, Senior Principal Research Scientist, the Department of Agriculture and Fisheries

What were your posters about?
There were two, one was "First step to prevent disease! Use QBAN tissue culture planting material, it is disease free!"

Tissue culture banana plants produced under the guidelines of the Quality Banana Approved Nursery Scheme (QBAN) are a quality source of pest and disease free plants but growers need to know the plants are safe.

The poster described how QBAN prevents entry of disease both in the tissue culture and nursery stages.

The other poster was "Rapid growth of Fusarium oxysporum f. sp. cubense (FOC) Race 1 and Subtropical Race 4 in tissue culture." It looked at whether Fusarium is obvious in tissue culture and described the progress of the disease development on tissue culture cultivars.

What work are you doing now?
My research and support work relates closely to banana plant protection in a strategic and applied way.

I maintain the quarantine tissue culture laboratory at the Maroochy Research Facility to enable new banana cultivars to be safely introduced into Australia. I also manage a high health QBAN research laboratory where the Australian banana collection is maintained in tissue culture.

What's coming up?
Industry needs to maintain the ability to access new banana cultivars.

We will continue to need the quarantine facilities specific to banana to be able to import cultivars and maintain the Australian banana collection in a high health QBAN research lab so be able to send them across domestic quarantine zones.

Further research is investigating transmission of Fusarium in tissue culture plants and investigating if they are more susceptible to Fusarium wilt than plants from bits or suckers.

Additional research will include working with the Australian Banana Growers' Council and Biosecurity Queensland to develop an improved QBAN scheme.

What are other industries doing?
Other industries such as ginger suffer from Fusarium but are building towards an improved way of obtaining disease-free planting material.

What did growers ask you?
About the information that tissue culture plants started to show Fusarium symptoms similar to those seen in infected plants in the field but onset of disease and symptom development was much more rapid.

Growers were interested to see what Fusarium looked like in culture and the fact it grew on the banana tissue culture so rapidly.

There was also interest in the range of cultivars available, especially those that show tolerance or resistance to TR4. Growers can contact me anytime to discuss banana cultivars, QBAN or how quarantine works.

Minimising off-farm movement of nitrogen

by Jeff Daniells

Jeff Daniells had samples of some of new varieties available for delegates to try.

Franz Wiskemarker of Agroamerica with Sharon Hamill at her research posters on tissue culture and Fusarium.

What's the project about?
Loss of nitrogen fertiliser off-farm is considered to be a serious threat to water quality. We investigated if controlled release nitrogen (N) fertilisers would reduce nitrogen leaching in a banana crop. (See story Page 44.)

What did it find?
Cultivation prior to planting led to significant release of N from the large soil N pool and associated high leaching losses in the first few months after planting. Strategies such as permanent bed systems, which cultivate only a fraction of the paddock area, should lead to less losses of N (this requires quantification).

Are other industries interested?
This research will have application to other crops on the wet tropical coast.

What did growers ask you?
One overseas visitor was surprised that good quality crops could be grown with such low N application rates.

For many years, very high rates of N were applied in the North Queensland industry but growers have shown that good quality crops can be grown with much less when applied optimally.

Suchet Bargoti (left) speaks with marketer Mike Evans about the research by the Australian Centre for Field Robotics.

Towards Autonomous Banana Information Systems

by Suchet Bargoti, Australian Centre for Field Robotics, PhD Student

What's your project about?
Precision agriculture – advances in field robotics and sensing technology are driving research and the development of new technologies.

Why's it important for bananas?
The high density information provided allows farmers to optimise their growth management strategies.

Distinct from seasonal fruit, the asynchronous growth and harvest cycle of banana plantations presents additional challenges for crop management.

What's happened so far?
As an extension to our ongoing work on apple and almond information systems, we performed a pilot study to explore the potential for autonomous crop mapping and harvest forecasting at commercial banana plantations.

We considered two potential applications: 1) automatic detection of coloured banana bags for in-field stock taking and 2) leaf axil height measurement for bunching date prediction.

A tele-operated ground vehicle robot was driven along rows of a banana plantation near Mareeba.

What did you find out?
There are potential applications of ground-based robotics and sensing for banana information management systems.

Data were gathered from multiple sensors, including colour video and LiDAR.

Coloured bags were automatically detected from the video stream, for the purpose of mapping the stock. Different coloured bags could be reliably recognised, other than black, which was difficult to distinguish from shadows.

For the second objective, the height of sucker leaf axils was shown to correlate with the future bunching date. LiDAR data was used to build a metrically accurate 3D model of the plantation from which the height of individual axils could be determined with centimetre accuracy.

What's next?
Automating leaf axil detection and accurately geo-registering captured data.

We welcome discussion with growers and industry stakeholders to determine avenues for future research and development.

What are other industries doing?
We have conducted field trials at mangoes, bananas, apples, almonds, avocados and custard apple farms and developed algorithms to automatically detect and map fruits and flowers on the trees.

The goal is to provide a holistic, digital picture of orchard performance to enable the most efficient use of inputs, such as fertigation and chemigation. The information also assists in detecting and diagnosing potential problems as early as possible, to improve orchard performance over time.

Zoning out the bad habits

What used to be normal, everyday farm practices can now put banana production at risk from TR4. Stewart Lindsay* reports on how to make the change to safer farming.

It's one of the most significant disease threats to global banana production and it's now in North Queensland.

Panama disease Tropical Race 4 of bananas, caused by the fungus *Fusarium oxysporum* f. sp. *cubense*, is spread through the movement of contaminated plant material, soil and water.

There are currently no effective chemical, biological or cultural practices that can eliminate the disease and there are no suitable resistant banana varieties that are commercially acceptable.

That means implementing effective biosecurity practices on your farm to prevent Panama disease is currently the only measure to safeguard continued banana production.

Planning how to implement these practices is crucial.

Firstly, it can help you decide if significant capital investment is justified. And planning will also help you to determine where best to place any infrastructure you decide to introduce to your farm.

Moving vehicles, people and equipment between zones must be subject to be thorough wash down and sanitisation.

Developing a plan might initially seem overwhelming because what has been considered normal practice in the banana industry can now pose a significant risk of spreading the disease.

Excluding risks

Excluding the movement of plant material, soil and water onto your property should be the foundation of your biosecurity planning to manage the risk of introducing Panama disease.

Machinery, vehicles, tools and people are high-risk items due to the soil they carry.

An important part of exclusion is to limit access by fencing some, or all, of the property boundary and limiting vehicle access points to the minimum number possible.

These vehicle-access points need to have gates and clear signage to inform visitors of the conditions of entry.

People and vehicles coming to your property should seek prior approval so they are fully aware of your conditions for access.

Upon arrival, all vehicles and footwear should be inspected to confirm freedom from attached soil or plant material.

When planning for implementation of biosecurity practices, you should start with the question: "To conduct my banana farming business and keep my farm free of Panama disease does this person/vehicle/machinery/equipment/planting material absolutely have to come onto my farm?"

The answer should be "no", especially for machinery, equipment and footwear that has been used on other farms.

If the answer must be "yes" then you should implement practices to manage access to the farm.

In the zone

One of the best ways to manage this access is to organise your property into different zones with restricted access between each.

These zones create treatment "layers" that enhance biosecurity.

A practical way to manage a biosecurity policy on your farm is to establish three different zones with no uncontrolled movement between them.

Experience with helping establish these zones shows that defining where they fit on your property is best done on a property map using a different colour for each zone.

You can also mark important risk pathway information on this map such as drainage lines, flood prone areas, public roads, railway lines etc.

Top priority

After considering your farms access points and the people, animals, machinery, and equipment that come onto your farm, the next step is to prioritise your implementation of biosecurity practices.

The high priority is implementing the zones and restricting access between them. It can be implemented quickly with temporary barriers (pipes, logs, rocks etc) until fencing or other permanent barriers are put in place.

Fencing or other types of physical barriers are very important to reinforce the separation of zones.

Movement across zone boundaries must be managed very closely with clear procedures and appropriate facilities to wash down and decontaminate vehicles, footwear, machinery and tools.

Clear procedures must be developed and communicated to any person who needs to cross over a zone boundary. It is especially important for all staff, suppliers and contractors to be trained in complying with the procedures.

The owner or manager is ultimately responsible for the biosecurity of a banana farm and regular checks for compliance with exclusion and wash down and decontamination procedures and facilities is vitally important.

*Stewart Lindsay is Principal Development Horticulturist & Team Leader at the Queensland Department of Agriculture and Fisheries' South Johnstone Research Station.

Banana farm separation zones

Farm zone	Separation zone	Exclusion zone
• includes all your banana blocks • includes all machinery and equipment associated with the field production of bananas • as a general rule, don't let the machinery and equipment leave this zone • no other equipment or machinery is allowed in • movement of staff and contractors into this zone is based on thorough washing and decontamination procedures, including managing staff footwear and entry procedures • the zone boundary must include access to the part of the packing shed where bunches are unloaded • boundary must give access to machinery and workshop areas • a physical barrier, such as a fence, separating this zone from the other two zones will help stop accidental movements across the boundary.	• the area where essential farm inputs are delivered, packed fruit is collected and farm vehicles not directly involved in banana cultivation are parked • generally, encompasses an area adjacent to the output side of the packing facility and close access to other storage and workshop area • access is limited to essential business inputs and vehicles. These must be inspected, washed and decontaminated • no movement between this zone and the farm zone without detailed washing and decontamination to manage the risk of cross-contamination from the separation zone • surface runoff from this area must be intercepted and drained away from the farm zone to avoid contamination.	• for vehicles and people that do not have to enter either of the other zones for the conduct of your banana business • think of it as being like an extension of the public road • segregate this zone from the other two. It is for visitors and staff not directly associated with the production aspect of your business • external vehicles should remain in this zone • staff and visitors can only go into the other zones if they use clean footwear or wash and decontaminate their footwear.

Fencing and other physical barriers are important to restrict movement across the farm zone boundary.

"effective biosecurity is currently the only measure to ensure continued banana production"

Using property maps helps to plan your zones.

Small changes make a hulking difference

Workshops are showing North Queensland banana growers how to defend their properties against Panama disease. ABGC Communications Manager Rhyll Cronin reports.

If you know the comic book story of The Incredible Hulk, you already know a bit about why Panama TR4 can be so bad.

The story of the Hulk's transformation from brilliant scientist to, as Marvel Comics says, "an incredible engine of destruction" features in the banana industry's current series of TR4 workshops.

It's one way the workshop team helps growers appreciate the seriousness of the plant disease – and how important it is to do everything possible to keep it off their farms.

As team member Stewart Lindsay says during one workshop, it's the Hulkish and near-indestructible chlamydospores produced by the fungus Fusarium oxysporum that makes Panama disease so fearsome.

"For whatever important commercial crops you can think of there's a Fusarium that attacks it," Stewart says. "But they're all separate and different – and what makes them a major disease issue is chlamydospores."

In the case of banana plants, when first attacked they're infected by potentially millions of the less damaging conidia spores. It's the plant's own actions to defend itself that ends up shutting down its vascular system leading to plant death and the triggering of chlamydospores. The same thing happens when an infected banana plant is cut down without using proper destruction methods.

"These things are incredibly robust," Stewart says of the spores responsible for strains of Panama disease, including TR4. "They're just about impossible to kill."

The fungal 'spores' survival skills include outlasting "very high temperatures for long periods, 30 years in the soil in the absence of any plants, these things can take up to three months in the bottom of a dam to drown".

The function of the TR4 workshops, which are funded by $600,000 of Australian and Queensland Government funds, is to help banana growers understand the disease and to provide practical information on stopping it reaching their farms.

The workshops are held by TR4 Extension Project, led by Shane Daffahido, and have so far reached growers whose farms represent more than 70 per cent of the North Queensland production area.

The workshops are now reaching out to other growers to make sure as many as possible attend, the message being that efforts to contain TR4 are substantially strengthened when more growers participate.

"For all of us caught up in this, it's such an overwhelming issue you kind of end up like a deer in the headlights," Stewart tells growers.

"The only way to deal with what seems like an overwhelming issue is to deal with it one step at a time."

The steps used at the workshops include include growers being provided with maps of their farms and worksheets to help them identify possible entry points for the fungus and ways to block it.

"At the end of it you'll have a better understanding of how the disease works and spreads, the disease pathways onto your farms, you will have begun thinking about a plan or have one drawn up and have a prioritisation of which things you'll tackle first," Stewart says.

Shane Daffahido speaks at workshops about issues including identifying and reporting suspect plants. At this workshop he advises what will happen if reporting doesn't happen.

"The only way we're going to contain this disease is if we catch it early," Shane says.

"We've had plenty of people tell us at workshops that there's a real issue with reporting a plant.

"If you ignore it, those chlamydospores are going to get in the soil, they're going to be spread eventually to somewhere else. It's going to be a time bomb down the track for your farm, eventually it's going to be in your neighbours' farms and eventually it's going to be everywhere downstream."

The workshops also discuss how TR4 is carried.

"It's important to understand all the pathways for TR4 to come onto your farm," Australian Banana Growers' Council officer Robert Mayers says.

Growers place transponncies over aerial maps of their farms to mark the points where TR4 vectors - plant material, soil and water – could enter.

The project leader of the banana industry's National Banana Development and Extension Project, Tegan Kukulies, tells growers the key is to "exclude, exclude, exclude" any non-essential farm visits.

"Ask yourself this question, 'in order to conduct your farm business and to keep your farm Panama-free does that person or item absolutely have to come onto my property?'

"If the answer's 'yes' then that's what this workshop module is about - how to get that person or equipment onto your farm in the safest possible manner.

"To grow and sell bananas you can't exclude all movements onto and off your property but from the exclusion principle we come to the point where people are 'coming clean and leaving clean' on your property on your terms."

Growers are encouraged to think of their farm as "clean" and everything else as "dirty".

They are provided with information about how to establish zones on their farms to limit the potential of TR4 reaching the paddocks. (See story, Page 14)

The workshops also inform growers about the decontamination and wash down processes and important basics like the proper management of footbaths.

There is information on the use of planting material and tips on fencing, including using feral pig-proof wire and ensuring property boundaries are surveyed before fencing work begins.

Many growers have already come up with their own innovations for decontamination, zones and managing drainage and the workshop is an excellent forum for exchanging ideas.

"It's about changing the habits of a lifetime," Stewart says. "But in the scheme of things, they're only small changes."

And when growers are up against one of the world's worst banana plant diseases – every change helps make a Hulk-sized difference.

Growers wanting information on the TR4 workshops should go to www.panama.org.au or phone 4064 1182.

TR4 Extension project team members (from left) Tim Liebelt, John Bagshaw, Shane Daffahido, Stewart Lindsay, Robert Mayers and Tegan Kukulies (Sarah Elmgreen has also joined the team).

"The workshop was very good. It's good to discuss all the issues. We've already got a lot of the things mentioned in place (tri-farm biosecurity measures) but it's good to discuss them and hear other people's ideas."
Jason Vipiana

"It was a great day. There was a lot of useful information discussed and everything that you learn is a positive."
Mike Gallagher

"There was some useful information on decontamination processes – particularly information on the life of sanitisers and the requirements for the frequency of changing the water and keeping it as clean as humanly possible."
John Dezzi

"It was bloody great. I liked the whole lot. I know that I've got a lot to do to bring things up to speed. For instance, I've put a lot of temporary barriers in place and I'm going to be converting them to permanent ones."
Phil White

Tegan leads extension program

North Queensland soil health scientist Tegan Kukulies has been a as the new leader of the banana industry's Banana Development and Extension Program.

The new role began in March and Tegan is leading initiatives bringing the findings of banana research to growers via activities such as field days, presentations and videos.

She will also be running the national banana extension roadshow which takes scientists to Australia's major banana growing regions and coordinating the NextGen young growers' group.

Tegan is a Senior Development Horticulturist at the Queensland Department of Agriculture and Fisheries' South Johnstone Research Station. Her banana research work has included participation in an international project on Panama TR4 which included work in the Philippines last year on the use of ground covers to suppress the pathogen's spread.

One of her first tasks in her new role was to produce a video showing growers the symptoms of TR4 and providing advice on protecting their farms. Tegan answers our ten questions.

Tell us what got you interested in the banana industry?

At high school I did work experience at the Department of Primary Industries. I had the opportunity to spend the week working with different researchers based at the South Johnstone office. This really sparked my interest in agricultural research and helping find practical solutions for growers.

Where did you do your training, both academic and in the field?

I completed my science degree at James Cook University in Cairns. I was fortunate enough to start working with Dr Tony Pattison after I completed my degree, which then led to Tony co-supervising my honours project about organic matter management in bananas. I have been a part of the successful soil health team at the Queensland Department of Agriculture and Fisheries ever since and have gained a great deal of knowledge on soil health, particularly the biological aspect.

Tell us what happens on a good day? And on a not-so-good day?

On a good day you observe something that has the potential to improve the way we do things in the industry and on a bad day things don't go to plan and you can't explain why.

How does your work help the industry and tell us about a breakthrough moment you've had on a project?

I have worked on a range of banana projects however the most significant ones are the ACIAR (Australian Centre for International Agricultural Research) funded projects which are focused on soil health and Panama Disease.

More specifically, investigating how the management of ground covers coupled with good farm management can potentially create suppressive systems that could allow growers to continue growing bananas in the presence of the disease.

A breakthrough moment was working with Dr Tony Pattison showing that encouraging indigenous organisms by maintaining a groundcover around the base of plants significantly reduced the symptoms of Panama Race 1 in Ducasse. The current ACIAR project is designed to allow us to continue researching these soil management practices as well as provide insight on the most effective on-farm biosecurity practices for Panama.

What's one of your favourite things about working in the banana industry?

As a part of my new role I am really going to enjoy working more closely with the people in the industry. Characteristically, people in the banana industry are down to earth, open minded and very innovative, which I think largely contributes to the success of the industry as a whole.

When you tell people your work includes banana research, what do they usually ask about?

Over the past couple of months the hot topic is Panama Tropical Race 4! However before that detection, and given my previous involvement in soil health, people would ask about cover crops, soil biology and microbial products.

What's one of the things most people don't know about bananas?

Bananas have amazing health benefits. They say an apple a day keeps the doctor away but I think a banana a day will also do the trick!

From a science perspective, what's a current hot topic about banana production?

Well, there's no doubt about it - Panama Tropical Race 4! More specifically, matters relating to on-farm biosecurity practices and the future research into tolerant varieties.

How do you like your bananas – fresh or cooked, what's your favourite banana recipe and how often do you make it?

You can't beat a fresh banana (firm), although it is also hard to go past a fresh banana cake. Just recently I tried a banana and Nutella pizza, and it was delicious.

When you've got time off, what are some of your favourite pastimes?

Growing up at Kurrimine Beach means that, by default, I enjoy all the water sports - fishing, diving, spearfishing, water skiing and wakeboarding. We really are spoilt in this part of the world and I count myself lucky to have the opportunity to enjoy all of these water sports.

Champion effort gets research working

Stewart Lindsay, a banana scientist at South Johnstone in North Queensland, was one of the industry champions who received an Award Of Honour at this year's Australian Banana Industry Congress. Stewart answers our ten questions.

"The banana industry is dynamic and innovative ... it's never boring"

Tell us what got you interested in the banana industry

I grew up on a small family banana farm in the Caboolture/Wamuran district of south-east Queensland and we helped out on the farm, particularly during school holidays. When I started working with DAF (then the Department of Primary Industries) I moved to the Granite Belt and those five years are the only time I have not been around bananas.

Where did you do your training, both academic and in the field?

I studied at the Queensland Agricultural College at Gatton before it became a campus of the University of Queensland. Moving into the role of extension officer meant a lot of on-the-job training in communication and adult education techniques, including some TAFE courses.

Tell us what happens on a good day in banana research? And on a not-so-good day?

On a good day you can help someone find a workable solution to a problem or gain an insight into an issue or problem. For an extension officer it's often about being able to realise the significance of some trial results so you can communicate the key message. There are plenty of good days.

On a not-so-good day you spend a lot of time trying to juggle a lot of different activities without ever getting to do a really thorough job on any of them. The aftermath of natural disasters like cyclones and storms are not good days either.

How does your work help the industry and tell us about a breakthrough moment you've had on a project.

My role is about trying to bridge the gap between the implications of research trial results and the reality of banana growers and others making changes in their production and marketing system so the whole system benefits. A key requirement for this is getting to know the industry and its systems, especially the growers and other people in the industry.

Any breakthrough moments were always as part of a project team. One was getting the minor-use permit approved for ethephon injection for nurse-sucker-ing, because it took a lot of trial work and is so important for cyclone recovery and managing fruit supply.

What's one of your favourite things about working in the banana industry?

The banana industry is dynamic and innovative so there is always something changing or developing. It's never boring, even after 22 years. The people in the industry are another favourite – some of the best people you will ever run into. Living in a beautiful part of the world in FNQ is also on the list of favourites.

When you tell people your work includes banana research, what do they usually ask about?

Lately it's been about Panama disease, but a whole range of things, particularly about different varieties. My partner once asked me if Sugar bananas and Lady Fingers were the same thing, something which she says she really regretted afterwards. She thought it was a yes/no answer.

What's one of the things most people don't know about bananas?

Banana fruit have a bend because of gravity. Their growth is described as being negatively geotropic, which means that they bend in the opposite direction to the gravitational force.

From a science perspective, what's a current hot topic about banana production?

Panama disease is the hot topic in Australia and internationally. A lot of businesses and research agencies across the world in bananas are keenly watching the situation in Australia to see how we manage the recent incursion. They see Australia as the country most likely to put best practice on-farm biosecurity in place.

Stewart Lindsay (right) accepts an Award of Honour from ABGC Chairman Doug Phillips at the Banana Industry Ball.

How do you like your bananas – fresh or cooked, what's your favourite banana recipe and how often do you make it?

I have been lucky enough to travel overseas in this role and that has been a real eye-opener to the range of varieties and uses for bananas. I eat bananas fresh and cooked and rate Gros Michel and Hom Thong Moldso as the best bananas I have eaten fresh.

A favourite combination is a banana, bacon and cheese open grill sandwich. You can use the same combination as a topping on a fish fillet too.

When you've got time off, what are some of your favourite pastimes?

Spending time with my partner and our teenage children at their sports, camping, fishing or on a road trip holiday. Now that I'm older, I can openly admit to enjoying bird-watching. It's not cool but there it is.

Video tips

New TR4 videos produced by the banana industry's National Banana Development and Extension Project are now online.

Go to www.panama.org.au to see the latest video, featuring North Queensland growers, on identifying and reporting suspect plants.

There are also videos on "come clean go clean" decontamination, using ground covers to suppress TR4 and containment measure in use on the world's largest banana farm.

National banana Roadshows launch success

The biennial Banana Roadshows launched with great success in Northern Queensland this month.

In the first two days of presentations in Mareeba and Innisfail around 150 people attended to gain insight into the latest scientific research, biosecurity measures and forward planning.

Pictured at Mareeba on June 9, the first of six roadshows across the country, are ABGC director and Lakeland banana grower, Paul Inderbitzin with Mackay Marketing's Naomi King.

For an image gallery of the events at Mareeba and Innisfail see pages 28-30.

ABGC Board director and Lakeland banana grower, Paul Inderbitzin with McKay Marketing's Naomi King

Our Biennial Banana Roadshows launched

Above: Speaker, Katie Ferro with one of the organisers of the Roadshow Shanara McComiskie

Below from left: Luke and Reinout Posma, Mareeba, with Donna Chambers from DAF

Above: Rob Mayers (left) from ABGC with Dan Hickey from Toowoomba.

Below from left: Michelle McKinlay ABGC, Tegan Kukulies DAF and Tim Liebelt ABGC

Below left: Andrew Franz Swiss Farms, Tim Heath GT Ag Service, Marke Reppel Mareeba, Peter Fomiatti Mareeba and Leon Collins Tully

Above from left: Pam Groundwater, David Ruiz (farm manager), Peter Howe (Rock Ridge owner) Korinne Cockrell, Billy Bezuidenhout, Carlo Cuda and Joshua Hassem.

Below left: Patrick Gorman, Atherton (left) with Trevor Parker, DAF Mareeba Below right: The Rock Ridge boys - Carlo Cuda (left) with Billy Bezuidenhout

Roadshow at Innisfail

From left: Katie Ferro with event organisers Stewart Lindsay, Tegan Kukulies, Shanara McCorniskie

Above Bianca Cairns, Horticulture Innovation Australia, with Louis Lardi, ABGC.

Below: Innisfail Roadshow attendees, Rhett Heffernan and banana grower Shannan Paton

Above: Gathering in Innisfail - left Chris Borsato and Paul Edwards.

Below from left: John Bagshaw (contracting to ABGC as part of the on-farm biosecurity project), Katie Ferro (DAF), Anna McBeath (DAF)

Dealing with TR4 in the short, medium and long term

As the north marks the one and a half year milestone since Panama TR4 was first detected on a property in Tully, we take a look at the collaborative research approach that aims to ensure the future of the Australian banana industry. The research is insightful and aims to provide answers to the growers' questions now and into the future. The research is formulated around the short, medium and long term scenario's producers in the industry may find themselves in:

Short-term research objectives

Disinfectant testing

The effectiveness of common disinfectants used in wash down facilities, dips and footbaths is has been under the spotlight.

In initial research conducted in Mareeba tests showed that products containing 120g/L quaternary ammonium based products made at a 1% solution were effective against Tropical Race 1 spores.

Principal Development Horticulturist and Banana production systems team leader Stewart Lindsay said establishing the effectiveness of common on-farm disinfectants was vital to on-going biosecurity efforts.

"When they were doing the testing, unless the product was 100 per cent effective, it was not considered to be an option," Mr Lindsay said.

"So even if it was 99 per cent effective, it was not good enough" he said.

The research being conducted in Queensland is now being taken a step further with researchers in the Northern Territory retesting the same disinfectants against Tropical Race 4 spores.

Initial results have indicated those disinfectants that have shown 100 per cent effectiveness against TR1 are showing the same rate of effectiveness against TR4.

"I guess it gives us a bit of confidence in the work that we are doing on Panama Race 1 and giving people the peace of mind that they are using the right products," Mr Lindsay said.

"There is no point putting in place practices without having the best products to make them effective."

Biosecurity test kit trials

By now, most banana farms have comprehensive biosecurity measures in place including footbaths, dips and spray shuttles.

But is there a way to determine whether the disinfectants used in these controls measures are continuously effective? Research being conducted by the Department of Agriculture and Fisheries is hoping to provide an answer to this question.

Test kits – similar to a pH test – are being trialled to give growers an effective means of measuring the concentration levels of disinfectants used on-farm biosecurity practices, to give them a better indication of when they need replacing.

Corrosion testing

Since rigorous biosecurity measures have been implemented, there have been many questions arising relating to corrosion resulting from the disinfectants used in on-farm practices.

A study is currently underway testing four commonly used quaternary ammonium based products and their effects on various metals including galvanised, 304 stainless steel, painted steel, unpainted steel and aluminium.

This research is still in its very early stages, but it is hoped the results will give guidance to growers on the best metals to use to minimise corrosion when building footbaths, wash down facilities and other on-farm biosecurity practices.

Treatment of infected plants

To the best of our scientific knowledge, when a banana plant which is highly infected by TR4 is cut down, it produces highly resilient "time-capsules" known as chlamydospores, which allows the disease to exist in soil for up to 30 years.

Researchers are currently trying to establish the best methods of destroying TR4 infected plants to ensure the fungus is broken down as quickly as possible, preventing inoculum from going back into the soil. Research to date is showing that the current destruction protocol used is effective at destroying spores.

Early detection

As with any disease, prevention is better than a cure and scientists are now honing their efforts towards early detection methods to keep Panama disease TR4 at bay.

Responding quickly and effectively to future Panama disease TR4 is vital. Research by Department of Agriculture and Fisheries and the University of New England is looking at options determining if technology including thermal imaging and high resolution satellite imagery can be used to detect stressed plants before any external panama disease symptoms are exhibited.

On-farm Biosecurity BMP

Very similar to the banana industry's Environmental Best Management Practices (BMP) guidelines, growers will soon have an On-farm Biosecurity BMP.

The On-Biosecurity BMP will work in a similar fashion to the Environmental BMP and will assist growers to prioritise which biosecurity practices should be carried out, should their farm become infected. It will also include an information resource to help guide growers on what constitutes the on-farm biosecurity practices.

Medium-term research objectives

Weed hosts

The Department of Agriculture and Fisheries and Biosecurity Queensland are working to establish if weeds are a potential host for TR4.

Weeds have been sampled from known tropical race 1 sites in north Queensland and Subtropical race 4 sites in New South Wales in an initial scoping exercise to determine potential hosts.

Controlled pot trials using 18 different species commonly found in banana plantations in North Queensland is currently being conducted to determine if they are able to host the disease.

New plant material scheme

The QBAN scheme is being phased out and replaced by new guidelines for banana tissue culture producers.

Under the guidelines, tissue culture producers will operate under the Nursery and Gardening Industry Association (NGIA) Scheme.

The scheme incorporates a range of other agricultural crops and bananas will be added under the same banner. Tissue culture producers will be eligible to apply for NGIA accreditation under the scheme, allowing growers to easily identify those who are accredited and those who are not.

Detecting Panama in soil

The Department of Agriculture and Fisheries is working with the South Australian Research and Development Institute to develop a DNA based research tool that can be used to detect and give some indication of the level of Panama TR4 spores in reasonably large quantities of soil. It is anticipated that this test can be used in research trials to help quantify whether practices are impacting on the level of disease in the soil.

Soil management

Different on-farm practices are being put under the microscope to establish methods that may increase the biological activity in soil, which could potentially create a suppressive environment against Panama TR4.

The research has included studies of different ground covers that may inhibit Panamam wilt spores from multiplying. Other more regionally-specific organisms are also being investigated.

Long-term research objectives

Mutagenesis trials

Developing a commercially viable banana variety that could tolerate or potentially be resistant to Panama disease Tropical Race 4 has been researched globally for decades.

This effort has been stepped up in Australia in the wake of the North Queensland TR4 detection with investment into mutation breeding. Although all breeding programs are a numbers game, this technique offers the opportunity to increase the chances of producing a commercially viable resistance variety.

Importation and screening of banana cultivars

The industry's plant protection program continues to negotiate access and support the importation of new banana cultivars from banana improvement programs across the globe to screen against Fusarium wilt. A field trial which is testing 27 different cultivars was established in mid-2016 and offers the opportunity to test the cultivars against TR4 and also make initial agronomic assessments.

Biosecurity on-line technology

Just as the BetterBunch mobile phone app was devised to help growers easily record and retrieve information for their Environmental BMP, similar on-line technology is expected to be developed to assist growers with record keeping in terms of on-farm biosecurity practices. However this is a longer term activity that is not expected to commence until late 2018

To the best of our scientific knowledge, when a banana plant which is highly infected by TR4 is cut down, it produces highly resilient "time-capsules" known as chlamydospores, which allows the disease to exist in soil for up to 30 years.

Extension extended

The National Banana Development and Extension Program, which is known for organising the industry roadshows, has been extended for seven months.

The program was originally due to end in September, but has now been extended to April. During this time the project will be running small, innovative trials mostly based around productivity practices.

Project leader from the Queensland Department of Agriculture and Fisheries (DAF) Tegan Kukulies said, "We are looking for growers' input on 'out of the box' practices that we can trial in field at the South Johnstone research station."

"Some examples of practices that have been suggested so far include GPS-based yield mapping and mechanical / chemical removal of flowers from fruit. We will ask growers to help us prioritise the practices that we will focus on."

The Program is funded by Horticulture Innovation Australia Limited using the banana industry levy with co-investment from DAF and the Australian Government.

If growers have any innovative ideas please contact Tegan at *tegan.kukulies@daf.qld.gov.au* or 07 4220 4152.

Leading banana researchers met recently to discuss latest applied research and technology focusing on the short- to long-term management of TR4.

MEETING OF TR4 MINDS

THE LATEST UPDATE ON TR4 RESEARCH. WHAT'S NEW, IN PROGRESS AND ON THE HORIZON.

Last month marked two years since Panama Tropical Race 4 (TR4) was first detected in Queensland's Far North, on a farm in the Tully Valley. As the anniversary neared, leading banana researchers from across Australia met to discuss the latest applied research and breakthrough technology that continues to focus on the short- to long-term management of the disease. By Tony Pattison and Tegan Kukulies.

Since its initial detection in North Queensland, Panama TR4 has brought many challenges to banana growing, production and the industry at large.

In the two years since detection, banana growers have become much more aware of the disease, and most have implemented effective on-farm biosecurity. Practical banana research is heading toward reducing the impacts of the disease.

There is a long history of research on Panama disease throughout Australia. The use of applied research and cutting-edge technology by banana researchers from the Department of Agriculture and Fisheries (DAF) (agri-science and biosecurity), University of Queensland, James Cook University, Northern Territory Department of Primary Industries and Resources, New South Wales Department of Primary Industries and the University of New England was discussed at a recent workshop in Brisbane.

The latest research and development aimed to improve growers' confidence in disease containment, reduce disease spread and provide farm management options if the disease became widespread.

One of the first questions North Queensland banana growers asked when TR4 become a reality was, "How do I protect my property?"

Implementing effective on-farm biosecurity is paramount. New management strategies are being developed using revolutionary studies on the genetics of the Fusarium fungus, the cause of Panama disease.

Containing the disease on the single, infected property has also been a priority, and improving our knowledge of containment by establishing the most effective destruction of infected plants continues to be a primary goal.

However, in the event that Panama disease did spread, options for managing the disease and its impacts on the banana industry need to be developed. The creation of banana plants with better resistance is underway by manipulating the tissue culture process.

When Australia's leading scientists researching aspects of Panama disease met in Brisbane in February, they discussed a range of exciting research; what is new, in progress and on the horizon. Here, we take a snapshot of their innovative work.

WHAT'S NEW?

Extensive research into the use of disinfectants has shown the quaternary ammonium (QA) group of chemicals to be very effective.

The initial disinfectant testing, which was conducted using Panama disease Race 1, is now being tested using Panama TR4 in the Northern Territory (NT). Testing so far shows that products — for example, products containing 120g/l didecyl dimethyl ammonium chloride, a Quaternary Ammonium (QA), made up at 1% — are also effective on Panama TR4.

Further testing is also showing that detergents (such as Farmcleanse) can actually de-activate disinfectant products, if mixed directly. Therefore, growers should ensure they have thoroughly washed off detergents, before applying disinfectant products.

Dip and compare colour test strips have also shown promise, with testing currently being finalised. Also in this space, there is good news for growers that have a shuttle or spray tank and don't regularly make up QA-disinfectant solutions. Using the test strips as indicators, disinfectant solutions (1% QA products), which have been left in a sealed container exposed to the elements of the weather (full sunlight), have remained at a 1% solution for 12 weeks. Initial testing is also showing that these disinfectants are no more corrosive to a range of metals than water. Together, the use of colour test strips and metal corrosion tests are helping banana growers make sure chemicals are being used effectively.

Current destruction protocols of infected plants involve bagging the plants, gouging growing points and applying high rates of urea to infected plant material, as well as the soil immediately surrounding it. Results from a novel lab bioassay and a field trial in New South Wales (NSW) (using Subtropical Race 4) demonstrated that this was an effective method to quickly kill the Fusarium fungus.

Surveys of weed and groundcover species from Panama Race 1 sites in North Queensland and Subtropical Race 4 sites in NSW, identified that some weed species are alternative hosts to Panama disease. A pot trial with 18 common weed and groundcover species revealed that under controlled conditions, Fusarium could be recovered from all 18 species. Where and how the Fusarium is surviving on the weeds needs to be clarified and how this translates to the field.

WHAT IS IN PROGRESS?

There are some exciting advancements in understanding the Fusarium genetics. Genetics is another language to most of us but, in a nutshell, there are many different Fusarium species, each with their own individual 'barcode'. Researchers are analysing the differences in these 'barcodes' to better understand their relationships with each other, and which segments may be responsible for causing Panama disease.

Under strict quarantine conditions scientists have also manipulated the Fusarium fungus to 'glow' in order to better understand where and how the fungus moves through banana plants. This research is important to help understand how the fungus moves through the banana plants, to cause disease symptoms which lead to plant death.

The first trial looking at the effect of nutrients on Panama Subtropical Race 4 development has commenced. Using a controlled aeroponic system (soilless), disease development is going to be monitored following different application rates of boron. Other nutrients will be evaluated following learnings from this initial trial. In addition to this, an extensive soil type survey is being conducted on North Queensland banana properties' characterising differences in soil characteristics, and understanding how these differences attribute to suppression of Panama disease.

Scientists are continuing to apply mutagenesis techniques to tissue culture banana plantlets in an attempt to develop a commercially viable banana cultivar with improved tolerance to Panama TR4. In a multi-pronged approach, firstly mutagenesis has been applied to GCTVC 119 in an attempt to improve tolerance to the disease and also Gold Finger in an attempt to improve agronomic and eating quality. The first plants produced from this approach are expected to be planted in the NT soon.

WHAT IS ON THE HORIZON?

Genome sequencing and soil community profiling are just two of the methods that will be applied to help understand the role soil biology may play in suppressing Panama disease. An array of methods will be used to monitor the soil biology following varying practice changes, such as the use of different cover crops. Different cover crop options are currently being evaluated in a pot trial and this will help determine which species will be used in a cover crop field trial in the NT.

Clean planting material is a key priority for minimising the risk of spreading TR4. Negotiations are nearing completion to develop a Quality Banana Approved Nursery (QBAN) Scheme 'replacement', which is anticipated to be merged under the Nursery Industry Accreditation Scheme Australia biosecurity system, which will be ultimately certified by the Australian Banana Grower's Council. This improved system will give growers renewed assurance that tissue culture producers, that are certified under the new system, continue to supply clean disease-free planting material.

The hard copy of the On-farm Biosecurity BMP, developed as a 'sister' program to the industry's well adopted Banana BMP Environmental Guideline, is nearing completion. The resource aims to set industry guidelines for on-farm biosecurity practises through the use of a self-assessment checklist, similar to that of the BMP Environmental Guidelines.

These projects have been funded by Horticulture Innovation Australia Limited using the research and development banana levy with co-investment from the Queensland Department of Agriculture and Fisheries and funds from the Australian Government.

Planning has commenced for DAF to host a Panama R&D update event for growers at the South Johnstone Research Station in May. The exact date we'll bring the industry up to date on the latest Panama research. Watch the e-bulletins for updates on this event.

See page 20 for more news from the 'Meetings of TR4 Minds' gathering.

Appendix 9: Information Technology

Appendix 9.1: Details of videos produced as part of the National Banana Development & Extension Project (BA13004)

Title of video	Link	Publication date	Host Channel	Public or private	YouTube views	Facebook views
Banana BMP online training instructions	https://www.youtube.com/watch?v=ZJkOo9bBojo&feature=youtu.be	Nov-13	Australia Banana	Public	139	
Importing banana material and accessing new varieties	https://youtu.be/Qpc4cV1wZjk	Aug-14	HortSmart	Private	128	
Developing a standard industry banana carton	https://youtu.be/ratF0XdbY7s	Aug-14	HortSmart	Private	227	
International insights with banana Nuffield Scholar Paul Inderbitzin	https://youtu.be/sx3srFr4wAk	Aug-14	HortSmart	Private	386	
Observations of on-farm biosecurity practices in the Philippines (Presentation)	https://youtu.be/302ooDVwJ8s	Apr-15	HortSmart	Private	357	
Use of vegetated ground covers can suppress Panama disease in bananas (Presentation)	https://youtu.be/Y-yX_CNR78s	Apr-15	HortSmart	Private	178	
Panama disease Race 4 - Identifying the disease and protecting your farm	https://youtu.be/onPpPeTGESE	Apr-15	Biosecurity Qld	Public	2898	1000
Banana Development and Extension Program Project Update	https://youtu.be/aToTQW6W0fA	Jun-15	HortSmart	Private	93	
Panama disease tropical race 4: identifying and reporting suspect plants	https://youtu.be/DheDd8J1IUE	Jul-15	Biosecurity Qld	Public	1765	
Diagnostic testing: safeguarding the Australian banana industry	https://youtu.be/070qct89VFk	Sep-15	HortSmart	Private	28	
Keeping Australian bananas from virus diseases	https://youtu.be/t-G0K0olJ2E	Sep-15	HortSmart	Private	16	
Testing new banana varieties for resistance to Race 1 Panama	https://youtu.be/oSu37pCLRcg	Sep-15	HortSmart	Private	29	
On-farm biosecurity – managing footwear	https://youtu.be/FlxbM4Zb6es	Feb-16	Biosecurity Qld	Public	925	471
Recommendations for the 15kg 1-piece carton	https://youtu.be/fjssgurhPY4	Aug-16	HortSmart	Private	12	
Introducing Nuffield Scholar Matt Abbott	https://youtu.be/jm9HvDDf7GM	Aug-16	HortSmart	Private	15	
Banana Development and Extension Program Project Update 2016	https://youtu.be/zHP07bI0fcU	May-16	HortSmart	Private	8	
How to control burrowing nematodes in banana production	TBA	To be published				
Total views					**7204**	**1471**

Appendix 9.2: Examples of how the Panama Tropical Race 4: Identifying the disease and protecting your farm video was shared on social media


Australian Agricultural & Environmental Solutions shared Biosecurity Queensland's video.
Monday at 6:42 pm
Biosecurity Queensland uploaded a new video: Panama Tropical Race 4: identifying the disease and protecting your f…
Monday at 11:48 am · Edited
New video launched today for banana growers. Important information to help protect your farm a… Continue Reading
Mareeba District Fruit and Vegetable Growers Association Inc shared Biosecurity Queensland's vi…
Monday at 8:52 pm
Attention all banana growers - important information to help identify disease and protect your farm.
Biosecurity Queensland uploaded a new video: Panama Tropical Race 4: identifying the disease and protecting your f…
Monday at 11:48 am · Edited
New video launched today for banana growers. Important information to help protect your farm a… Continue Reading

Appendix 9.3 Needs Analysis for a Banana Specific Information Database

Introduction & Background

There is currently no banana industry specific digital or central repository of past and current research and development (R & D) results or activities. Typically at the end of research projects final reports are submitted to the funding body (e.g. Horticulture Innovation Australia) who then host these final reports. However, results from a project will often be relayed at meetings or through the Australian Banana Growers Council communications material (e.g. e-bulletins, Australian Banana News or the Australian Bananas magazine). There has been interest in making information more easily and readily available to growers and industry stakeholders through the development of an industry database. This needs analysis defines the industry requirement of an information database resource requested by industry and HIA.

Methods

The needs analysis was executed by conducting a survey of key stakeholder groups within the banana industry to gauge the level of need for an information database resource. A stratified sample was identified using a bias matrix to account for time in the industry, age, farm size and location. The key stakeholders surveyed included growers, consultants, resellers, private researchers and a market agent. Ten growers and seven agribusiness providers were surveyed. The survey was conducted as a semi-structured personal interview mainly in person but also over the phone where that was more appropriate. The survey questions which triggered conversation included whether they had a need to access information about past and current R & D, where they currently search for information, how successful they were in finding the information required, the frequency they would search for information, gauge which banana related websites they visit, whether they would use an electronic database and from what device/s they would access an electronic database if it was to exist.

Key Findings

Quite in-depth conversations with the survey candidates provided a great deal of insight into what, how, and where industry currently sources information to make informed practice management decisions. Since all of the growers that participated in the survey indicated that one of their sources of information was from agribusinesses, whether it is private consultants, resellers or agronomists, it was evident that it was very important to include key people from a selection of agribusiness in this analysis.

What topics: When asked what if there was a need to access information about past and current R & D activities, grower participants indicated that they were interested in anything that was to do with the production of bananas. 80% of growers indicated that they are interested in pest and disease management and Identification. The DAFFQ tropical and subtropical Banana Information Kits include a problem solver section which encompasses descriptions and images of common banana pest, diseases, disorders and deficiencies. Several participants mentioned this during the survey as being a useful resource that they still refer to. Similarly a number of participants voluntarily indicated that they would find an electronic reinvigoration of the identification guide of this problem solver section a very useful tool for their day to day activities. Although the majority of discussion was held about information requirement at the farm level some participants were interested in other aspects of the supply chain including, post-harvest practices and marketing.

Where information is currently sourced: As previously mentioned 100% of grower participants rely on agribusiness providers as a source of information. Similarly 100% of grower participants would also approach DAF staff as at least an initial point of contact if they were searching for specific information. Interestingly, the 7 agribusiness participants also indicated that they would source information from DAF staff and also depend on information distributed to and discussed at the Banana Agribusiness Managers (BAGMan) group meetings. Only 2 out of the 7 agribusiness participants read journal articles, and only 2 out of the 7 have read industry R & D final reports. General feedback from the agribusiness participants was that they were willing to read the summary or abstract of journal articles and final reports however were not willing to purchase such material.

Although not unexpected none of the grower participants use journal articles or final reports as a source of information. Some were aware that such material existed and felt that the practical inferences were buried in the report and did not have the time or inclination to read such material. One of the growers uses social media (Facebook & Twitter) to keep updated, especially on what other organisations and industries are doing. This grower felt that these resources were best used to provide updates and links to new information that is available on websites.

Success in finding information: All of the growers surveyed indicated that they do not always find the information they are looking for and attribute it to two reasons: the research simply hasn't been done or they cannot readily find the information. However a common comment was that by talking to people with experience on the topic at hand, they always got to the bottom of what they were looking for. A similar outcome was noticed when the agribusiness participants were asked the same question. The overall consensus was that they were always successful at troubleshooting a problem (e.g. pest identification) however felt that the time taken to solve the problem could be shortened by having all the information in a central location. In contrast to when they were investigating different management or innovative practices which may not have had much research focus, required them to research several avenues in different formats in order to find a solution.

Frequency of requirement of information: The growers could nearly be divided into two groups based on the frequency at which they search for information. The active information searchers (4/10) searched for information at least once a week. The passive information searchers (5-10) search for information anywhere between 1-6 times per year. All the growers agreed that they search for topic specific information when a situation arose requiring a solution beyond their knowledge. The agribusiness participants were actively looking for information more frequently. Keeping updated with the latest information is important as they pass on the information they have learnt to growers.

Banana related websites: The topical nature of Panama disease Tropical Race 4 since its detection in Tully has meant that growers and agribusinesses are more frequently visiting the ABGC website for updates. The general feedback on the ABGC website from growers and agribusinesses is that they are more likely to visit the site if they are directed there via a link in the e-bulletin. Only one of the growers had visited the HIA website on one occasion for an industry representative role. Similarly the website of the international banana R&D network Promusa was not used by any of the growers. The agribusiness participants were more aware of HIA, and would be more willing to use it if it was more accessible, however were not willing to purchase final reports. Again a similar trend was observed when asked if they had visited the Promusa website with 57% very infrequently visiting the website and 28% unaware that it existed.

Interest in using an electronic database: All of the participants indicated that they would find a dedicated banana website or information database useful. However there were a number of stipulations and recommendations that arose from this. 'Must be easy to use' was a comment consistent among all the participants. Further to that, the inclusion of easy to navigate drop down menus indexed by topic was proposed. A good workable search function was also a suggestion from several of the growers. The growers which less frequently search for information suggested that such a resource would need to be made interactive (e.g. directed to the website via links in e-mails or e-mailed with regular updates on topical information). Growers were interested in having access to past and current R & D however would mainly be interested in a summary of the practical implications of the research rather than the final reports or journal article. In contrast while agribusiness also saw the value in summarising information they were more inclined to want access to the original articles and final reports. Growers and agribusiness representatives both saw value in including an up to date and perhaps more comprehensive pest, disease and nutrition identification function.

Accessing an electronic database: To investigate the most appropriate platform/s to host an electronic database on, participants were asked what devices they currently use to access websites from. 80% of growers prefer to access websites from their computers however also used their mobile phones and tablets to visit websites. The remaining 20% of growers predominantly used their mobiles to visit websites. There was only one grower which had not visited a website on a mobile phone. Similarly 83% of the agribusiness participants

also preferred to access websites via their computers however also used mobiles and tablets especially when in the field to access information on websites. The issue was raised that reception and internet access is not always available on some farms and therefore if a resource was to be developed it would need to have some ability to work offline.

Recommendations

- Growers and key industry stakeholders would utilise a banana specific website which is easy to use but contains relevant, and practical information from past and current R & D which has links to more detailed information (e.g. linked to HIA for final reports)

    - This resource would need to contain a pest, disease and nutrition identification guide, with brief descriptions and good quality images. This ID guide could then be transitioned to hard copy and app based platforms to cater for different demographics in the industry.
    - The website would need to contain direct contact details of people in the different disciplines so that users could easily make contact with them.
    - The website would need to be mobile friendly.
    - The ABGC website would be the preferred location to host or at least link this resource to. The website could not only be a static resource but also provide growers with regular e-mail updates when new resources are added to the website.

- Advice would need to be sought after from HIA to understand how their information resources and access to them will transform with the transition from HAL to HIA. Similarly industry would need to be consulted in the proposal phase.

- Grower engagement during the development phase of such a resource would be essential to establish a layout which they find simple to navigate and easy to find specific information.

- It can be costly to not only develop an interactive website but also update and maintain the information resources. Therefore there should be realistic expectations of what this information resource could comprise of.

Additional Information: How do other industries make information easily accessible?

Below is a quick summary of how three other industries ensure that their users are kept up to date on R & D activities and the general aspects of crop production:

Soil Health in Vegetables

Soil Wealth and Integrated Crop Protection which are two programs funded by Horticulture Innovation Australia have developed a website for hosting information on R & D activities and information on vegetables. This website covers a large range of resource information on specific crops including brassicas, leafy vegetables, asian vegetables cucurbits, solanaceous crops, legumes and herbs right across Australia. Information on the website can be accessed a number of ways. If growers want information specific to their growing area the 'My Area' function allows them to view information specific to their growing region and also gives updates on upcoming events in their area. Similarly you can search via "My Topic", for example search all information about compost and soil amendments. Alternatively the more typical dropdown menu also allows access to resources, videos, links to additional resources, contact details, etc.

The website is quite interactive as it has links through Facebook and Twitter pages. The demonstration sites all have their own Facebook pages which provide continuous real-time updates of sites. This webpage is very user-friendly as an information resource which can be easily updated. (http://www.soilwealth.com.au/)

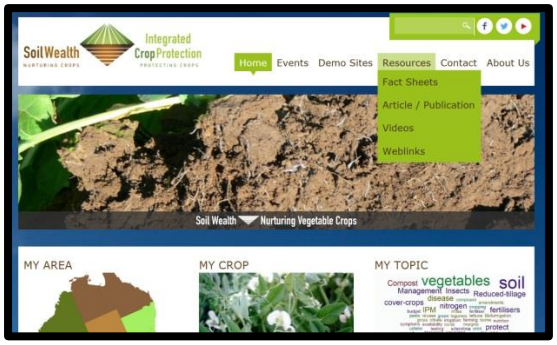

Figure 1: Home page of the website, with resources drop down menu options

Figure 2: 'My Area' options where you can click on states on the map to access area specific information

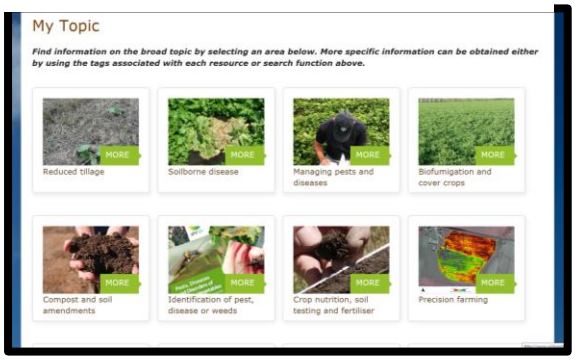

Figure 3: 'My Topic' options to access topic relevant information

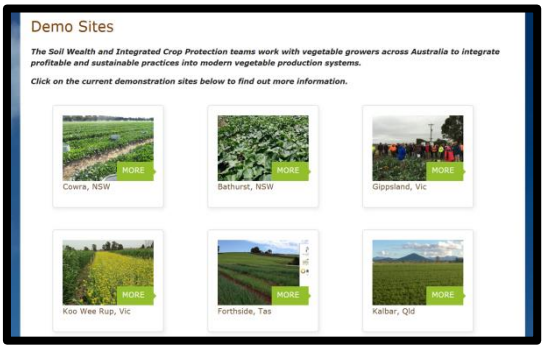

Figure 4: Each demonstration site has its own page which contains trial specific information

The Beef Industry

FutureBeef which is a joint initiative between the Queensland, Northern Territory, and Western Australian Governments and Meat and Livestock Australia also hosts a website which facilitates access to industry R & D information. The website contains knowledge centre and resources drop down menu tabs which facilitate access to: knowledge of beef production which is categorically grouped, multimedia – which includes videos and copies of presentation, demonstration sites, information about research projects, and upcoming workshops and events. This website also has links to the FutureBeef Facebook to allow information to be continually updated. This website hosts a large amount of very useful information, however navigating the website to gain quick access to resources is challenging. – (https://futurebeef.com.au/)

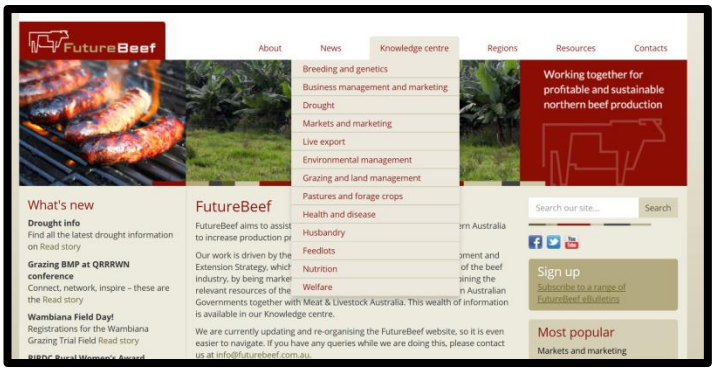

Figure 2: Home page of the website, showing the **resources** drop down menu options

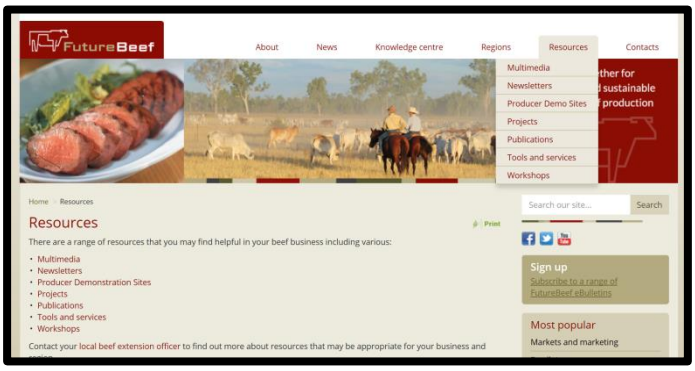

Figure 1: Home page of the website, showing the **knowledge centre** down menu options

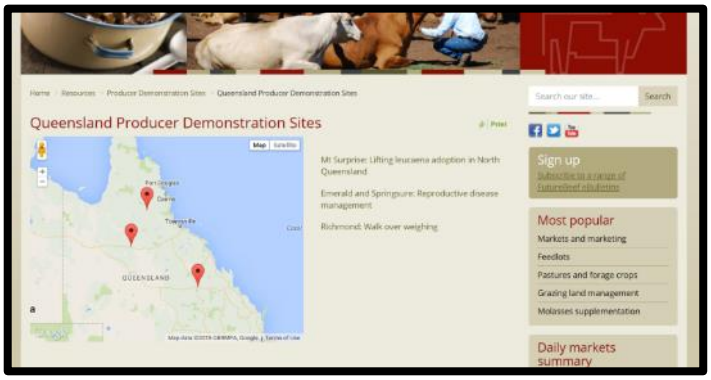

Figure 3: And example of the page which navigates to information about the Queensland **producer demonstration sites**

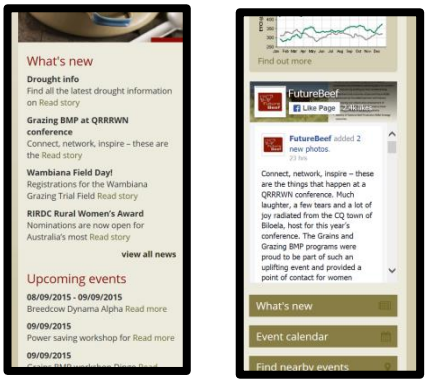

Figure 4: The **what's new, upcoming events** and integration of the **Facebook page** makes the page interactive

The Macadamia Industry

The Macadamia industry has a very innovative approach to making information available to their growers. The web based resource is password protected so that only levy paying growers can access the information. The resource termed MacSmart – Smarter information for Australian macadamia growers, comprises of over 40 YouTube style video resources which are grouped by topic and have icons to easily determine if the video features a grower, researcher or business. The use of short videos to relay information and keep macadamia growers updated with the latest information has proved to be very successful which is evident from the number of views of the videos. The website also has static information resources under the “Manuals” option (Figures 3 & 4). For example the “Pest Facts” option contains information on each of the insects, diseases and pests. The website also has a search function which allows growers to quickly search for specific information without having to navigate the menu options - (http://macsmart.com.au/start)

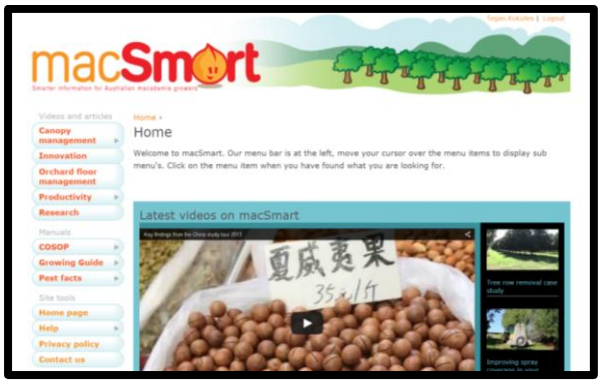

Figure 1: Home page of the website with menu options on the left of the page. Latest videos are linked to the home page

Figure 2: **Growing guide** menu options with information displayed for each category.

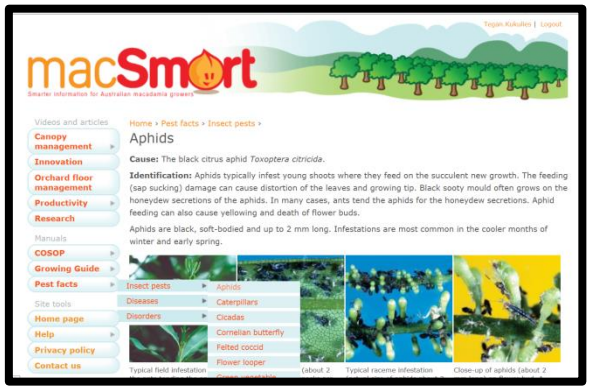

Figure 3: Information on each pest is accessible via the **Pest facts** menu options

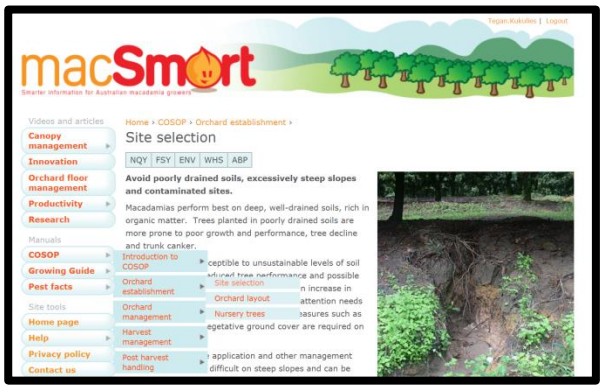

Figure 4: Example of other **Manual** menu options

The Avocado Industry

The Avocado industry has an excellent best practice information resource available online. The web based resource is password protected so that only levy paying growers can access the information. The website has easy to use drop down menu's with the categories logically groups for easy navigation. There is a large amount of information available ranging from pest and disease information through to transport and wholesale information. There is also a tab for upcoming events so that people can easily see upcoming industry events. There is a section on the home page which has links to the latest articles that have been uploaded. In addition to this each of the pages indicates the last time that it was updated, which allows users to quickly know if the information is has recently been added. The website also has a search function which allows growers to quickly search for specific information without having to navigate the menu options. – (http://industry.avocado.org.au/home.aspx)

Figure 1: The home page with the drop down menu options

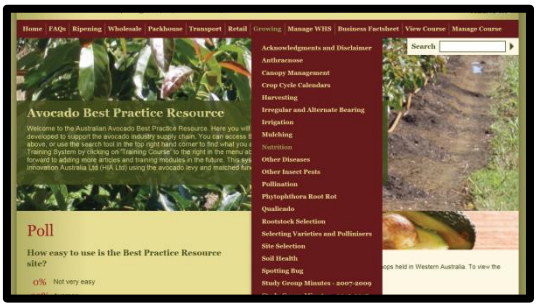

Figure 2: Example of the **Growing** drop down menu options

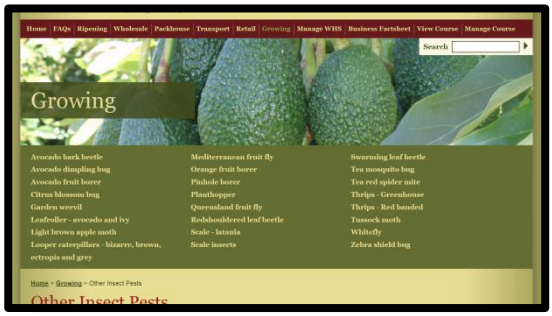

Figure 3: Options from the dropdown menu are easy to see and navigate as a new page opens

Figure 4: Events Page