

Horticulture Innovation Australia

Final Report

Delivering information and technology to the mango industry (DMT stage 2)

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The Department of Agriculture and Fisheries (DAF)

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Summary

The HIA project, “Delivering Mango Information and Technology to the Mango Industry” (DMT2), builds upon the achievements of predecessor HAL projects to improve the adoption and use of new information resources by mango growers and supply chain partners. Communicating information and training resources in a relevant and timely manner to growers and stakeholders across the geographically diverse Australian mango industry, continues to be recognized as a major industry challenge.

“Delivering Mango Information and Technology to the Mango Industry” has investigated and tested a range of technologies to help facilitate improved management and access of information and technology tools for mango growers. Using a range of methods, including training manuals, workshops, events and the use of web based technology including the Australian Mango Industry Association (AMIA) website and the two key state/territory government (Queensland and Northern Territory) websites, DMT2 has piloted the use of electronic mango information delivery techniques and has helped build industry knowledge and resources.

The focus of DMT2 has been the integration of road-shows, workshops and field days with new internet and multimedia technology, to improve access and adoption of information and training resources by mango growers and supply chain partners.

Major outputs from the DMT2 project include:

1. Delivery of 24 presentations, road-shows and training workshops for industry and supply chain partners, to over 500 participants throughout the major mango growing regions in Australia.
2. Development of four information and training packages for growers and supply chain partners for improved technology uptake and staff training in the priority areas of picking, packing and post-harvest management, nutrition management and integrated pest management.
3. Testing and identification of internet and multimedia technologies to improve mango industry access to the latest news, ideas, information and training resources from the mango extension network.

The DMT2 project demonstrated that the delivery of mango information and training resources via the integration of personal information delivery methods and web based systems, is the most efficient and effective use of limited resources and has the greatest potential to improve the adoption and use of new technologies by mango growers and supply chain partners. The AMIA website will be an important foundation for the delivery of these information and training resources to the Australian

mango industry. On-going co-operation between AMIA, mango industry stakeholders and R,D&E providers is needed to improve and develop the AMIA website to achieve its full potential as the “one stop shop” for Australian mango information and extension resources.

Keywords

Mango, Information, Technology, Workshop, Roadshow, Extension, Electronic, Web, Video,

Introduction

Delivering Mango Information and Technology to the Mango Industry (DMT2), builds upon the achievements of the predecessor HAL projects; “Delivering Mango Technology” (DMT1) which concluded in 2011, the “Global Markets Initiative” and the “Optimising Air and Sea Freights”. DMT1 was highly successful in improving the adoption and use of information by mango growers and supply chain partners across the geographically diverse mango industry. Despite this, travel distances and resources have limited the ability of growers to achieve equal and ongoing access to technical specialist, regional workshops and information products. This is particularly pertinent to growers in more remote geographical regions who have difficulty accessing information and services.

The goal of the DMT2 project is to improve the access and adoption of information and technology by mango growers and supply chain partners across Australia, via the integration of road-shows, workshops and field days with new internet and multi-media technology. A web focus for the delivery of technology allows for significant cost savings while improving the delivery of technology and information to a much broader section of the mango industry. It provides for much greater access to information and a synergy between industry and R&D information delivery.

Many RD&E service providers are now using internet technologies to successfully deliver information products and services. Large agricultural industries including the avocado, macadamia and sugar cane industries have also demonstrated how interactive internet sites and video webcasting can be used as an effective extension tool taking advantage of new internet technology. This has facilitated improved access to relevant and timely information across supply chain partners, resulting in increased productivity and profitability for these industries. The mango industry, characterised by its broad, disparate distribution across northern Australia and its limited financial resource base will benefit greatly from an integrated extension approach with an increasing focus on electronic delivery techniques.

The objectives of the DMT2 project were:

1. Provide leadership and/or logistical and organisational support for the delivery of training workshops and regional forums to the mango industry in Queensland, including the biennial AMIA road-shows and the 9th Australian Mango Conference in Cairns and Mareeba, May 2013.
2. Prepare, test and deliver four new training/information packages for growers and supply chain partners to facilitate improved technology uptake and staff training.
3. Investigate and test various internet and multi-media technologies to facilitate improved delivery of mango information and technology to the Australian mango industry.

Methodology

Project co-ordination and priority setting

The Delivering Mango Technology 2 (DMT2) project commenced in December 2011 and was due for completion by the 29th November 2014. The project commenced with a project inception meeting held between members of the DMT2 project team (project leader and project collaborators) and the Australian Mango Industry Association (AMIA) Board of Directors at Brisbane, Queensland in February 2012. DMT2 project goals and objectives were presented and the range of potential delivery methods were assessed and prioritised. A follow-up DMT2 project meeting was held between the DMT2 Project Leader (Matthew Weinert) and the AMIA Industry Development Officer (Trevor Dunmall) at Brisbane, Queensland in early March 2012. This was conducted to help fine-tune project planning activities and to develop Annual Operating Plan timetables for the delivery of project objectives.

The DMT2 project was developed, initiated and led by Matthew Weinert (QDAF, Senior Development Horticulturist, Mareeba) until his resignation from QDAF in early September 2014. Assistance was provided for certain activities throughout this period by Terry Campbell and Geoff Dickinson (QDAF), Rowland Holmes and Scott Ledger (Hort VC Group) and Trevor Dunmall and Claire Gilmartin (AMIA). The resignation of the project leader caused disruption to the completion of this project. HIA granted an extension to the project with a new completion date of the 29th May 2015. After an unsuccessful attempt to advertise and fill this position, QDAF appointed Geoff Dickinson (QDAF, Senior Horticulturist, Mareeba) to the DMT2 project leader role in March 2015.

The goal of the DMT2 project was to improve access and adoption of information and training resources by mango growers and supply chain partners via an integrated approach including the use of road-shows, workshops and training resources with new internet and multimedia technology. Three major project objectives were developed, with the methodologies for delivering these objectives as follows:

Preparation and delivery of regional forums and training workshops.

- Provide organisational and logistical resources to assist AMIA with the co-ordination and facilitation of the biennial AMIA Road-show series in 2012 and 2014, with particular emphasis on the events in north Queensland (Ayr/Bowen) and far north Queensland (Mareeba/Dimbulah).
- Provide organisational and logistical resources to assist AMIA with the co-ordination and facilitation of the 10th biennial Australian Mango Conference and Field Days, held at Cairns and Mareeba on the 14-17th May 2013.

- Organise the delivery of one targeted workshop/information package per year. Workshop topics and events will cover new information, research findings and integrated information packages as prioritised by feedback from the national mango industry.

Development of training resources/information packages

- Deliver presentations to industry to gather feedback on the development of information and training packages within the four priority areas: harvesting & packing, post-harvest handling, pest and disease management and nutrition.
- Produce information and training resources for mango growers and supply chain partners, including presentations, videos, manuals, trainer's notes and handouts.
- Create a new range of electronic training resources for growers, supply chain partners and staff.

Delivery of electronic resources

- Investigate and identify the most suitable multi-media and internet technologies for the electronic delivery of information and training packages for Australian mango growers and supply chain partners.
- Prepare information and training resources for upload to the AMIA website, to improve its status as the first choice, "one stop shop" for mango industry information including fact sheets, publications and training videos.

Outputs

Preparation and delivery of regional forums and training workshops

DMT2 project objectives and methods were first presented to the National Mango Industry at the AMIA Darwin, Northern Territory, Mango R&D Forum held at Top End Freight Management, Humpty Doo on the 15th March 2012. Over 100 mango growers and associated industry representatives attended the forum. The presentation was delivered by AMIA Chairman (Gavin Scurr), with improved grower engagement and communication identified as one of the Australian Mango Industries five key priorities for the future (*Mango Matters Magazine*, Autumn 2012, p10).

The 2012 AMIA National Road-Show Series was conducted at three locations (Darwin, Ayr and Mareeba) throughout Northern Australia, in July – August 2012. The DMT2 project team worked closely with AMIA to help organise, promote and co-ordinate the Ayr and Mareeba events, which attracted 40 and 50 participants respectively. Strong media coverage of the Mareeba Road-show is illustrated in Figure 1.



Figure 1: Local media coverage for the 2012 AMIA Road-show held at Mareeba, 14th August 2012.

DMT2 project presentations were delivered at each venue throughout the 2012 Road-Show Series. These included; Darwin, NT, 17th July 2012, (by Rowland Holmes/Scott Ledger), Ayr, Qld, 2nd August 2012 (by Matthew Weinert) and Mareeba, Qld, 14th August 2012 (by Matthew Weinert). These presentations described the future opportunities that internet and media technology offer for the delivery of mango extension information in Australia and sought industry feedback on the methods proposed. A summary of these presentations was published in the article “Social Skills – Using social

media to deliver information and training” by Matt Weinert, published in the *Mango Matters Magazine* (Autumn 2012, p26-27). The proposed DMT2 project objective to develop new industry training resources in the four priority areas of picking, packing, pest and disease management and nutrition was also presented to the Road-Show attendees. Industry feedback from mango growers and supply-chain partners was collected from these discussions and used to further fine-tune the development of these training resources.

DMT2 Project leader, Matt Weinert and QDAF Horticulturist, Geoff Dickinson attended a series of three Mango Disease and Spray Workshops co-ordinated by Nufarm and AMIA, at Mareeba, Mutchilba and Dimbulah on the 1-3rd August 2012. Approximately 60 people attended these events. DMT2 contributions included the presentation of preliminary outcomes from the 2011/12 assessments of the DMT2 Area-wide Management of Fruit Fly Demonstration trial at Mareeba and grower discussions/feedback on the proposed DMT2 update of the P&D manual; “Field Guide to Pests, Beneficials, Diseases and Disorders of Mangoes” (NTDOR, 2010).

Two power-point training packages were developed and tested throughout 2012 – 2014, as resources to help farm workers improve their mango harvesting and packing practices. These were; “Optimising mango quality – Training for harvesting and packing shed workers” and “Minimising quality loss during packing – Training for packing shed workers”. Both packages included slides and video footage and were delivered by Mathew Weinert to pickers, packers and growers in the Burdekin and Mareeba regions during the 2012/13 harvest season. The “Optimising mango quality – Training for harvesting and packing shed workers” package was delivered to farm workers at four mango farms (approx. 48 participants), and the “Minimising quality loss during packing – Training for packing shed workers” package was delivered to farm workers at five mango farms (approx. 60 participants). Feedback after each event was recorded and used to refine and improve the presentations between each delivery of the training. Feedback from the mango growers whose staff attended the training was extremely positive, with reduced levels of worker injuries from sap burn and a noticeable improvement in the overall quality of mangoes at picking and packing as compared to the previous season. Ultimately these training packages were developed into three 5 – 10 minute YouTube videos, with grower access via links on the AMIA website.

The 9th Australian Mango Conference “Future Mango Orchards” was held at Cairns and Mareeba, Queensland on the 14-17th May 2013 with strong support from the DMT2 project. Matthew Weinert was a key member of the organising committee for this conference and also played a role in organising and co-ordinating the Mango Grower Field Day Workshops on the 15 & 16th May, 2013 at Mareeba. Over 200 mango growers and industry representatives attended these events. The DMT2 team developed two short, 2 minute YouTube videos to help promote the Conference. These videos were; “Delivering Mango Technology” (<https://www.youtube.com/watch?v=UKHKopzAdYI>) by Matt Weinert and “IPM for Insect Control” (<https://www.youtube.com/watch?v=Fgy9sQtybbw>) by Stefano De Faveri (See Figure 2). Both of these YouTube videos were demonstrated at the Mango Conference

and were also uploaded to YouTube in May 2013, with a link on the AMIA website.

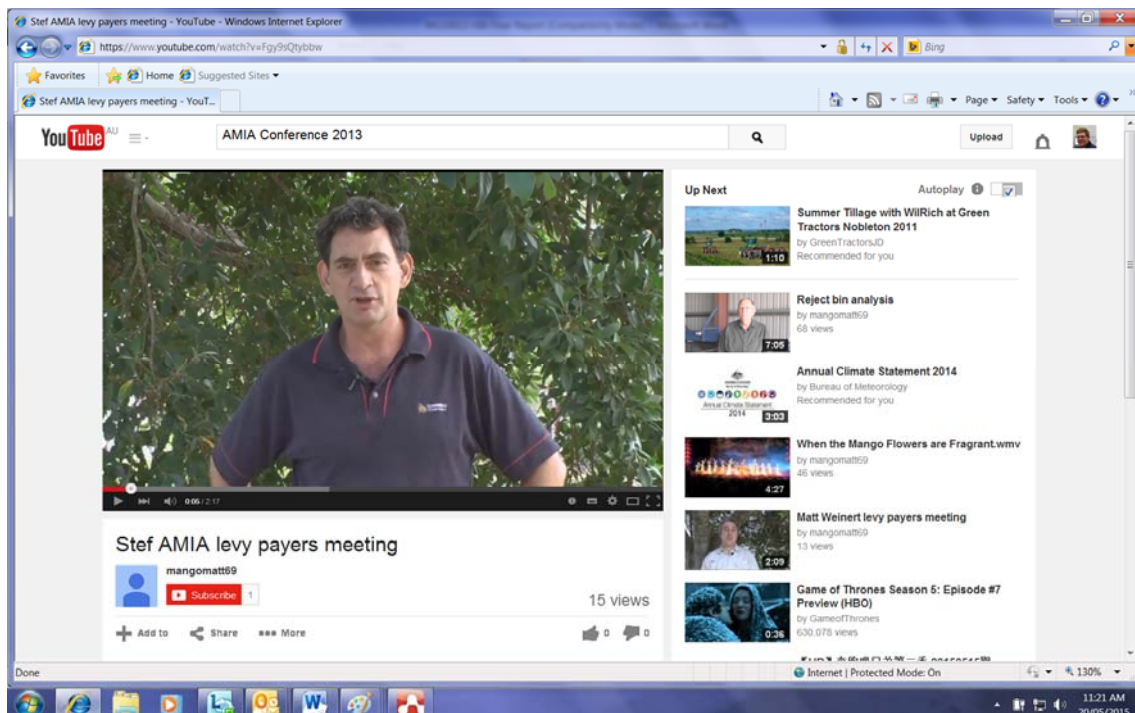


Figure 2. “Mango Conference Promotion – Mango IPM”, video hosted on YouTube (20/05/2015).



Figure 3: Summary of 9th Australian Mango Conference (*Mango Matters Magazine*, Winter, 2013).

Matt Weinert delivered six DMT2 presentations at the Mango Grower Field Day Workshops within the 9th Australian Mango Conference. These included four presentations on Pests & Disease “Suppressing fruit fly populations in mango orchards” (with Stefano De Faveri) and “Fruit spotting bugs are attacking mango fruit and may not be recognised” (with Leonie Wittenberg) and two presentations on Mango Nutrition “Food for fruit – key nutrition requirements for mangoes” (with Ted Winston), (*Mango Matters Magazine*, Autumn 2013, p14-19). The Conference was described as a great success by Gavin Scurr (AMIA Chairman) and rated by AMIA as the “Best Mango Conference Ever” (*Mango Matters Magazine*, Winter 2013, p34-35).

The 2014 AMIA National Road-Show series was conducted at six locations across northern Australia. The DMT2 project team assisted with the organisation and delivery of the road-shows at Ayr, on the 15th May 2014 and Walkamin/Mareeba on the 30th July 2014. These two events were attended by approximately 30 and 50 growers/industry stakeholders respectively. The DMT2 project nutrition management information and training package; “Food for Fruit - Matching Nutrition requirements to growth demands” was delivered by Matthew Weinert at Ayr and by Matt Weinert and Geoff Dickinson at Walkamin/Mareeba.

The 10th Australian Mango Conference “Celebrate, Collaborate and Create” was held at Darwin on the 25–28th May 2015. Over 200 growers and industry stakeholders attended the event. The new DMT2 project Leader, Geoff Dickinson attended the conference and held discussions with AMIA, QDAF and NTDFIP, regarding future mango extension priorities including the formation of a grower-based Mango Extension Reference Committee and future upgrading of the existing AMIA website.



Figure 4. Industry growers and stakeholders at the 10th Australian Mango Conference, Darwin 2015.

Development of training resources/information packages

The development and extension of resources and tools to increase the adoption of existing information and new technology in the mango industry was a key output from the DMT2 project. Four main target areas for the development of new information and training packages were identified: Picking practices, Packing and Post-harvest management practices, Nutrition management and

Integrated pest and disease management.

1. Picking Training Resources

A video information and training package “Mango picking – How to do it right” was developed to educate mango workers of the best management practices to pick mangoes both efficiently and with safety. Video footage was first collected at Katherine, Ayr and Mareeba during the 2011/12 harvest season. A power-point presentation “Optimising mango quality – Training for harvesting and packing shed workers” including both slides and video footage was developed and this was presented by Matt Weinert to teams of mango pickers at 4 mango farms at both Ayr and Mareeba in November/December 2012. There were approximately 48 participants at these events. Feedback from both the mango pickers and the supervising mango farmers was collected after each training event and used to help improve the presentation. Extremely positive feedback was received from the mango growers whose staff attending these training workshops. One grower reported that when compared to other seasons; reject bin analysis from this season has shown a significant reduction in the amount of immature fruit picked. Other growers reported that the pickers who attended the training were more efficient and reported less mango rash injuries than the pickers who had joined the picking teams later and did not attend the training.

The success of the DMT2 “Optimising mango quality – Training for harvesting and packing shed workers” powerpoint training package was recognized by the Northern Territory Farmers Association, who requested permission to use this resource for their upcoming 2013 mango harvest season. The training package was provided to the NTFA and this was then incorporated into the NTFA SapSafe project, a program aimed at addressing occupational health and safety issues associated with mango picking and the health risks of mango sap. These programs were then subsequently delivered to mango farms throughout the Northern Territory during the 2013 picking season.

Further video footage of mango picking practices was shot at Mareeba during the 2012/2013 picking season. This footage was then combined with existing video footage to complete the information and training video package; “Mango picking – How to do it right”. The final video version was uploaded to YouTube (https://www.youtube.com/watch?v=0Sv8M1_3oIA) in November 2013. AMIA regularly publicised the video through the Mango Matters Magazine and via a link on the AMIA website. This picking training video has since recorded over 500 YouTube views (30/05/2015).



Figure 5. “Mango picking – How to do it right” video, as viewed on the YouTube site (20/05/2015).

2. Packing and post-harvest management training resources

Mango packing and post-harvest management information and training packages were delivered throughout the DMT2 project via a series of manuals, training workshops and videos. Initially, in response to strong demand, the highly popular hard-copy manual; “Mango Quality Assessment Manual” (QDAF, 2009), was reprinted in limited numbers for distribution through AMIA. This manual was also reformatted into a pdf format, which was then uploaded to the AMIA website in December 2012, to enable direct grower access. The new “Mango Ripening Manual” (QDAF, 2012) developed through the Global Markets Initiative was printed as a hard-copy manual in December 2012, which was also uploaded to the AMIA website at this time. The DMT2 project team facilitated the release of these two manuals to the mango industry at industry forums and workshops and also helped fast-track the uploading of these manuals to both the AMIA and QDAFF websites.

Two video information and training packages: “Mango packed product monitoring” and “Mango reject bin analysis” were developed to educate mango workers of the best management practices to pack mangoes and optimise packed mango quality. Video footage was first collected at Wamuran, Katherine, Ayr and Mareeba during the 2011/12 picking season. The first video “Mango packed product monitoring” was developed in collaboration with Jenny Jewell (Pinata Farms, Wamuran) to educate mango packers of the recommended techniques to grade and pack mangoes to ensure high fruit quality standards. This video was uploaded to YouTube in July 2012 (<http://www.youtube.com/watch?v=ELWdPfsVmqM&feature=youtu.be>). AMIA publicised the video

through the *Mango Matters Magazine* (Spring, 2013) and links on the AMIA website. The packing training video has now recorded over 70 YouTube views (30/05/2015).

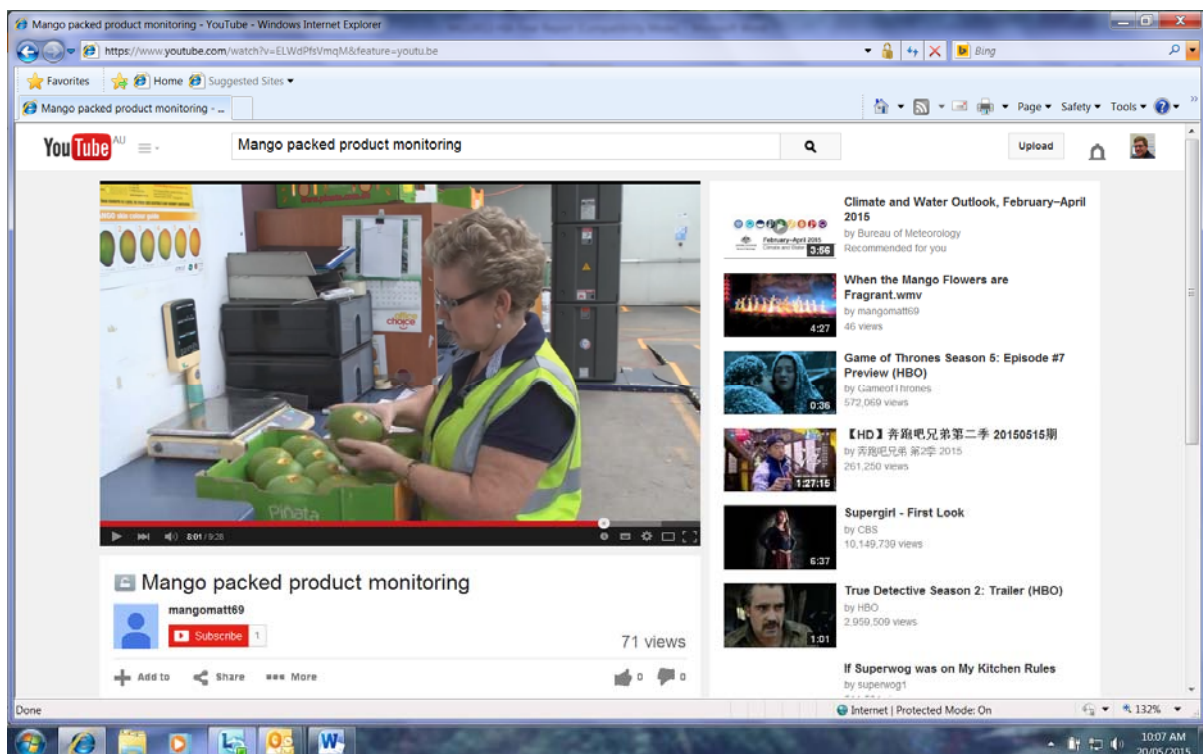


Figure 6. “Mango packed product monitoring” video, as viewed on the YouTube site (20/05/2015).

The power-point presentation; “Minimising quality loss during packing – Training for packing shed workers” including both slides and video footage was developed and was presented by Matt Weinert to teams of mango packers at 5 mango farms at both Ayr and Mareeba in November/December 2012. Approximately 50 people participated in these events. Feedback from both the mango packers and the mango farmers was collected after each training event and used to help improve the presentation. Additional video footage was then collected during the 2012/13 harvest season and used to complete a second video; “Mango reject bin analysis” in collaboration with Scott Ledger and Rowland Holmes (Hort VC Group) and Manbulloo Mangoes. The video was uploaded to YouTube (<https://www.youtube.com/watch?v=jw2KJWxq6ZU>) in May 2013. AMIA publicised the video through the *Mango Matters Magazine* (Spring, 2013) and via a link on the AMIA website. The packing training video has since recorded over 70 YouTube views (30/05/2015).

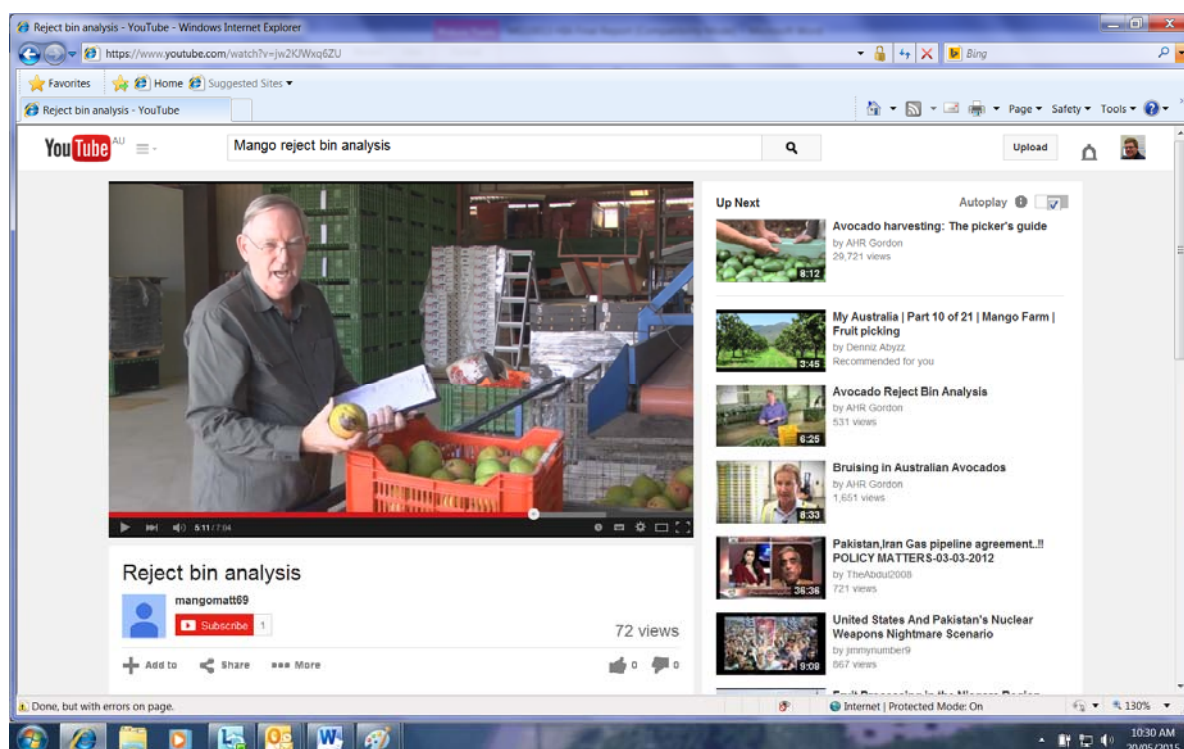


Figure 7. “Mango Reject bin analysis” video, as viewed on the YouTube site (20/05/2015).

3. Integrated Pest and Disease management training resources

Integrated pest and disease management has been a long-standing priority of the Australian mango industry. One of the first activities of the DMT2 project was the initiation of an on-farm demonstration trial of Area-Wide Fruit Fly Management techniques at a mango/mixed fruits orchard at Mareeba in late 2011 by DMT2 project leader Matt Weinert and QDAF entomologist Stef De Faveri. The preliminary results of this trial were presented by DMT2 Project leader Matt Weinert at a series of three Mango Disease and Spray Workshops organised by Nufarm and AMIA, at Mareeba, Mutchilba and Dimbulah on the 1st – 3rd August 2012. The development of new IPM tools for the mango industry including the proposed DMT2 update of the P&D Manual “Field Guide to Pests, beneficials, diseases and disorders of mangoes” (NTDOR, 2010) were also proposed at these workshops.

Significant fruit-spotting bug damage was observed on a number of properties in the Mareeba/Dimbulah region in the 2011/12 and 2012/13 harvest season. Initially the defect was diagnosed as stem-end cavity, however the symptoms were not consistent with those expected for this physiological disorder. Observations of mature FSB on mango fruit in the 2011/12 season were the first clue to the cause. Entomological cage and field trials conducted in 2012/13 season identified fruit-spotting bug as the likely cause of much of these unusual symptoms. The identification of fruit-spotting bug as the cause of this damage will enable management intervention to help reduce these defects. The results of this DMT2 study were presented to the mango industry at the Field Day Workshops of the 9th Australian Mango Conference. An information resource “Will the real stem end

cavity please stand up?" was also published by Matt Weinert, Leonie Wittenberg, Stef De Faveri and Donna Macleod in the *Mango Matters Magazine* (Autumn 2013, p26-28).

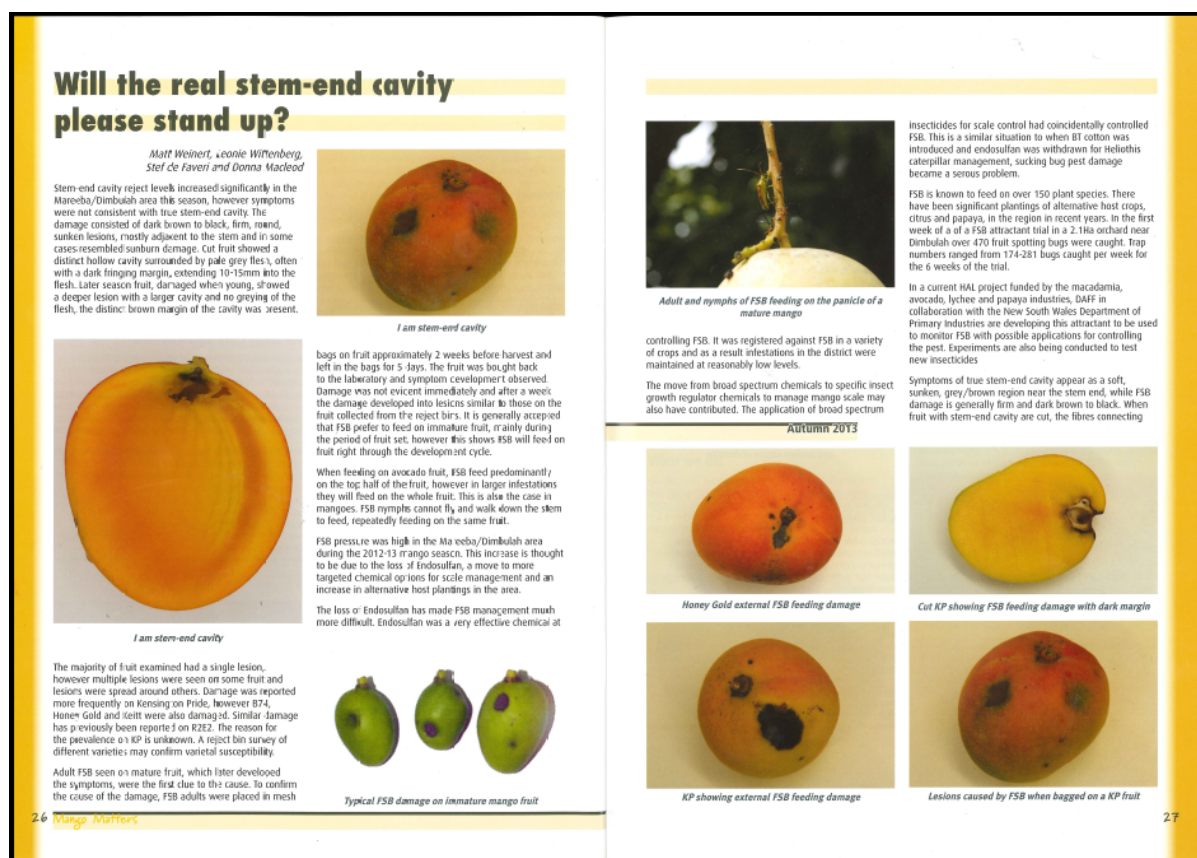


Figure 8. “Will the real stem-end cavity please stand up?” *Mango Matters Magazine* (Autumn, 2013).

The 9th Australian Mango Conference “Future Mango Orchards” was held at Cairns and Mareeba, Queensland on the 14-17th May 2013 with strong support from the DMT2 project. A short, 2-minute test-video “IPM for Insect Control” (<https://www.youtube.com/watch?v=Fgy9sQtybbw>) by Stefano De Faveri and Matt Weinert (See Figure 2) was produced for Conference promotion activities and was also demonstrated at the mango conference.

The Field Day Workshops associated with the biennial running of the 9th Australian Mango Conference “Future Mango Orchards” on the 16th and 17th May 2013, had a strong focus on Integrated Pest Management Information. DMT project activities and workshop training activities were presented in two sessions; “Better Management of Fruit Fly” and “Future Pest Management”. Matthew Weinert presented data from the 2011/12 and 2012/13 harvest seasons of the Area Wide Fruit Fly Management trial at Mareeba on both workshop days, within the workshop presentation; “Suppressing fruit fly populations in mango orchards.” Leonie Wittenberg and Matt Weinert presented new findings of increased fruit spotting bug damage in mangoes on both workshop days, within the workshop presentation “Fruit Spotting bugs are attacking mango fruit and it may not be recognized.” Copies of these two presentations were uploaded to the AMIA website after the conference.

Plant Industries Group in late May 2015. A joint panel comprising NTDFIF personnel (Brian Thistleton, Haydee Brown) and QDAF personnel (Geoff Dickinson, Stefano De Faveri, Peter Trevorrow, Kathy Grice) has committed to review and finalise this document between June – September 2015. The final version “Field Guide to Pests, beneficials, diseases and disorders of mangoes” (NTDFIF & QDAF, 2015) will then be launched at the XI International Mango Symposium, Darwin in September 2015 as an electronic document.

4. Nutrition management training resources

Managing mango nutrition is an industry priority as growers look to improve orchard productivity without compromising overall mango fruit quality. A mango nutrition information and training package “Food for Fruit – Key nutritional requirements for mangoes” was developed by the DMT2 project team to provide mango growers and associated industry stakeholders with 1) A basic knowledge of mango nutrition and the key elements involved and 2) How to design a tailored mango fertiliser program. This package was developed as a power-point presentation, consisting of two 45 minute training modules. The primary authors were Matt Weinert (QDAF) and Ted Winston (Tropical Horticultural Consulting) with acknowledgments to Rowland Holmes, Ian Bally, Lisa Still, Warren Hunt, Tim West and Gavin Scurr.

The “Food for Fruit” mango nutrition information and training package was first delivered to the mango industry at the 9th Australian Mango Conference “Future Mango Orchards” at the two field day workshops held at Mareeba on the 16th and 17th May 2013. This training was delivered by Ted Winston and Matthew Weinert, who jointly presented the two modules “General mango nutrition” and “Designing a mango fertilizer program”. Copies of the two nutrition presentation modules were uploaded to the AMIA website after the conference. These presentations were very well received by the Conference participants and in response, a short summary of the mango nutrition training package “Food for fruit – nutrition management” was also prepared and printed in the *Mango Matters Magazine* (Spring 2013, p14-19) (See Figure 10).

The mango nutrition information and training package “Food for Fruit – Key nutritional requirements for mangoes” was updated using feedback from the conference and presented again in two separate workshops at Katherine (11th December 2013) and Darwin (12th December 2013), within the NTDFIF Mango Small-group Meetings Initiative. Ted Winston (Tropical Horticultural Consulting) was sponsored by the NT project to deliver these training packages at both locations. The presentations were followed by a practical demonstration of soil and plant sampling techniques at a nearby mango farm. Both modules of the mango nutrition information and training were uploaded to the NTDFIF website after the workshops.

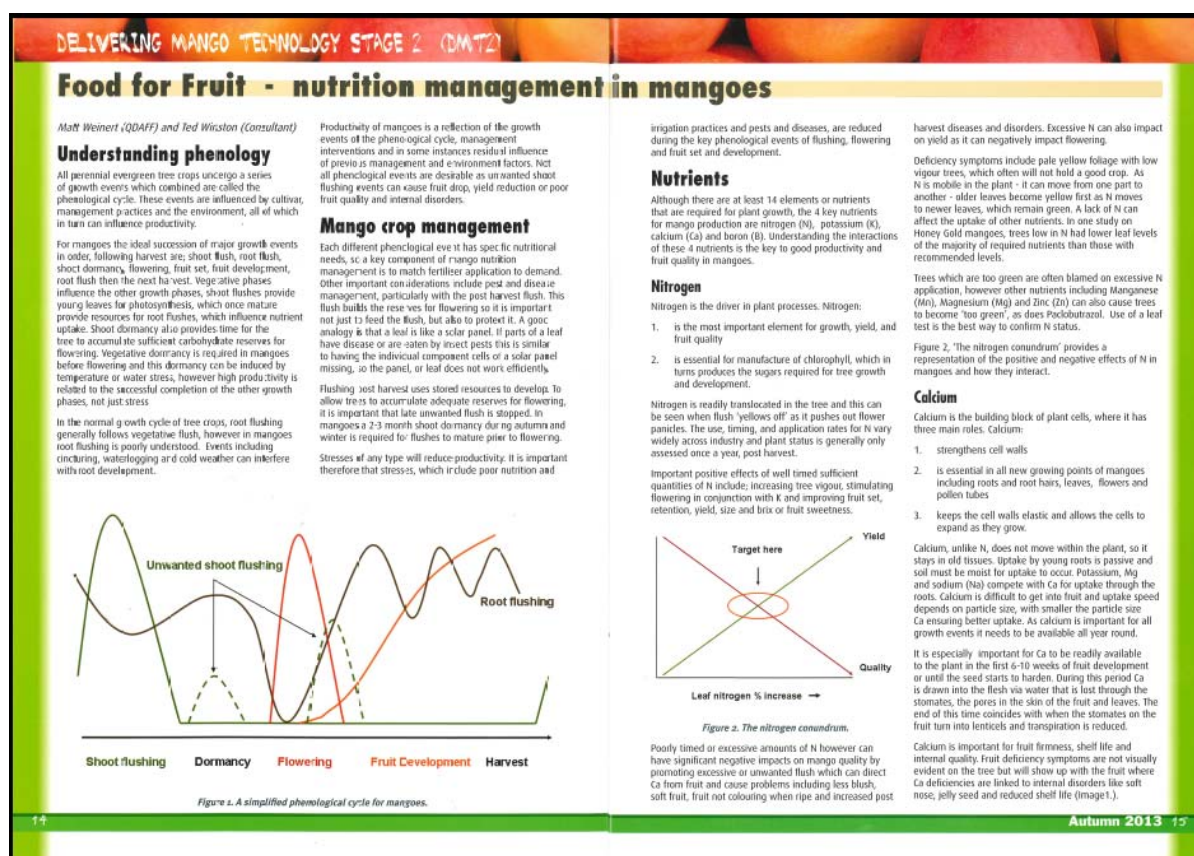


Figure 10. “Food for fruit – nutrition management in mangoes” *Mango Matters Magazine* (Spring, 2013).

A shorter version of the “Food for Fruit” mango nutrition information and training package was produced in early 2014 by condensing the two 45 minute presentations into one 45 minute presentation to suit other forums where presentation time was more limited. This condensed version of the training package was delivered by Matt Weinert to the mango industry at two venues within the 2014 AMIA Roadshow series; at Ayr (15th May 2014) and Walkamin/Mareeba (30th July 2014). The “Food for Fruit” mango nutrition information and training package comprising the two 45 minute modules was updated and reformatted in May 2015, using new government templates and logos. The two updated “Food for Fruit” modules were provided to AMIA for upload to their website in late May 2015.

The hard-copy and electronic manual “Field Guide to Pests, beneficials, diseases and disorders of mangoes” (NTDOR, 2010) as described in the Integrated Pest Management section above, also includes a section on nutritional disorders. The nutrition disorders section was updated by the DMT2 project in late May 2015, in conjunction with the review of the other sections on pests, beneficials and diseases. The revised version “Field Guide to Pests, beneficials, diseases and disorders of mangoes” (NTDPIF & QDAF, 2015) will be launched at the XI International Mango Symposium, Darwin in September 2015, as an electronic document.

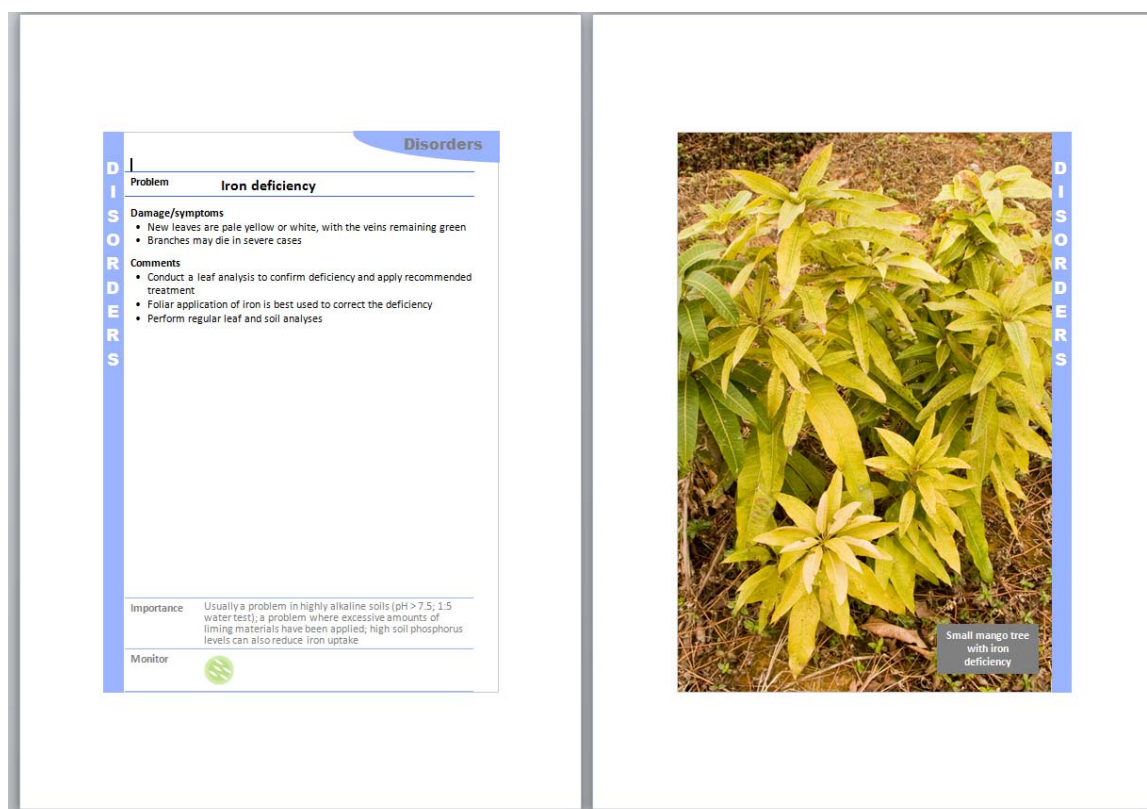


Figure 11. Nutrition disorder description example in the new draft of the “Field Guide to Pests, Beneficials, Diseases and Disorders of Mangoes.”

Delivery of Electronic resources

Effective web-based delivery of electronic resources is highly dependent on the establishment of a long-term, well maintained system which is regularly updated with new and relevant information and is easily accessible to the web user. In Australia there are three websites where mango growers have traditionally turned to find information on mango production and marketing activities. These are the Australian Mango Industry Association website (<http://www.industry.mangoes.net.au>), the Queensland Department of Agriculture and Fisheries website (<https://www.daf.qld.gov.au/plants/fruit-and-vegetables/fruit-and-nuts/mangoes>) and the Northern Territory Department of Primary Industries and Fisheries website ([http://www.nt.gov.au/d/Primary_Industry/index.cfm?header=Fruit – Mango](http://www.nt.gov.au/d/Primary_Industry/index.cfm?header=Fruit%20Mango)). The AMIA website was identified as the most suitable repository for mango information resources as it is grower managed, is regularly updated and is not restrained by government protocols which may restrict the sharing of information or the listing of external information resources.

A key focus of the DMT2 project was to pilot electronic information delivery through the AMIA website as a tool to build industry knowledge and resources. The objectives, methods and delivery of electronic resources the DMT2 Project, “Social Skills – Using social media to deliver information and training” by Matthew Weinert was published in the *Mango Matters Magazine* (Autumn 2012, p26-27).



Figure 12. “Social skills – using social media to deliver skills and training”, *Mango Matters Magazine* (Autumn, 2012).

1. AMIA Website

The AMIA website (<http://www.industry.mangoes.net.au>) was of basic structure and design at the start of the DMT2 project in December 2012, however was relatively easy to navigate and was developing as a growing repository of AMIA media documents and useful grower information resources. The goal at the time was to continue to develop the website so as to become a “one-stop shop” for all Australian mango information resources. Throughout 2012 and 2013 the DMT2 project continued to work with AIMIA to identify and prioritise existing mango information resources and to progressively upload electronic copies of these resources to the AMIA website to enable easy grower access. Examples of documents added to the AMIA website throughout 2012 and 2013 included:

- “Mango Quality Assessment Manual” – DEEDI, 2009.
- “Orchard Biosecurity Manual for the Mango Industry” – DEEDI, 2011.
- “Mango Ripening Manual” – QDAFF, 2012.
- “Mango Packed Product Monitoring” Video – QDAFF, 2012
- “Mango Reject Bin Analysis” Video – QDAFF, 2013

- 2 x “AMIA Conference Promotion” Videos – QDAFF, 2013
- “Proceedings of the 9th Australian Mango Conference, 14-17th May 2013” – AMIA, 2013.
- “Mango Picking – How to do it right” Video – QDAFF, 2013
- Miscellaneous post-harvest hand-guides/posters/forms including – “Packed product inspection record form, Bulk and reject analysis form, Mango skin colour guide, Defect circles guide and the Mango handling guide.”

The AMIA website underwent a complete restructure and reformatting at the beginning of 2014. All existing information resources on the old AMIA website were archived. Unfortunately due to time and resource constraints, very little of these existing information resources have since been reloaded onto the new website. A few key resources, including the DMT2 video “Mango Picking – How to do it Right” have been reloaded, however significant updating still need to be conducted. At present (May 2015) there are still very few documents listed on the AMIA website with a publishing date prior to 2014.

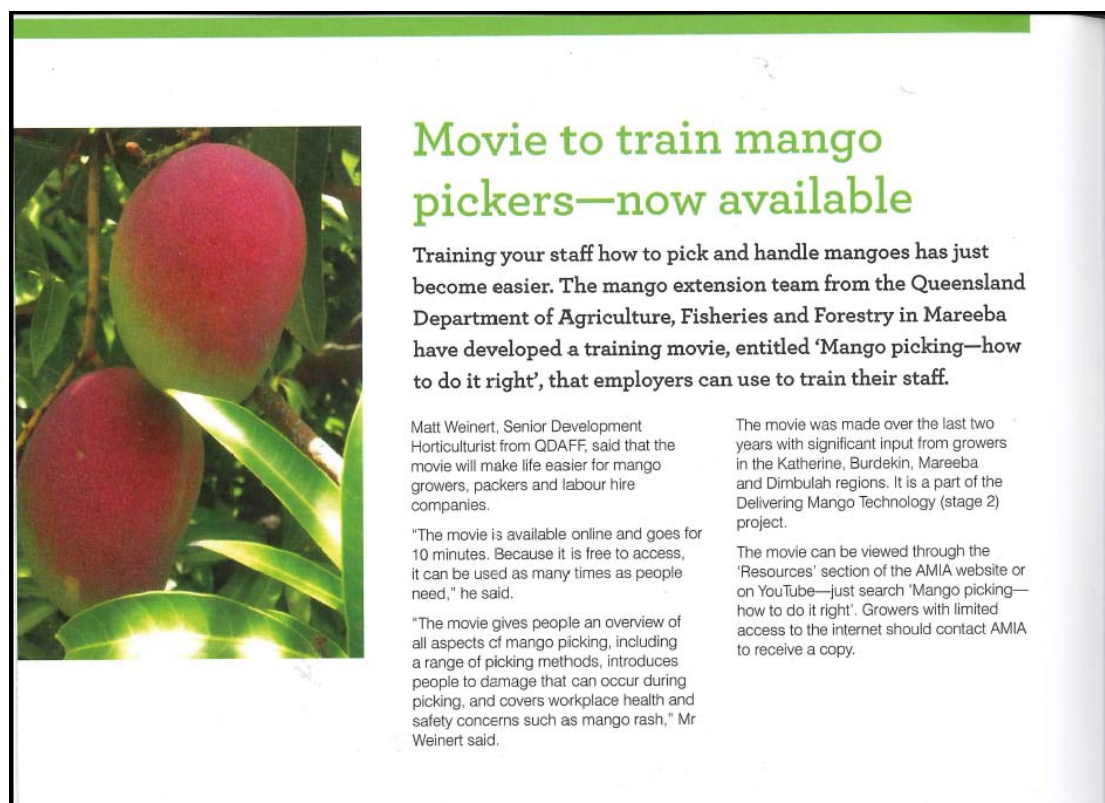


Figure 12. AMIA promotion of the video “Mango picking – How to do it right”, *Mango Matters Magazine* (Spring 2014).

2. NTDPIF Website

The NTDPIF website is a large repository of the majority of the mango R, D & E resources produced by the NT government over the past 30 years. It has over 100 of the NT governments mango-related

electronic resources including fact sheets, project reports, workshop power-point presentations, manuals, videos and media releases. There are two locations on the NTDPIF site with links to mango resources. These are the NTDPIF Plant Industries – Growing Advice – Fruits – Mangoes section ([http://www.nt.gov.au/d/Primary_Industry/index.cfm?header=Fruit – Mango](http://www.nt.gov.au/d/Primary_Industry/index.cfm?header=Fruit%20-%20Mango)) and the NTDPIF Technical Publications portal (<http://www.nt.gov.au/d/publications>). The Plant Industries portal is the most prominent of the two sites, has an appealing front-end interface including an information noticeboard which appears to be updated most weeks. The website however is difficult to search and many of the resources (particularly those > 5 years) are identified only by a project code number or by a minimalist title which is not very descriptive. The Technical publications portal is located on the NTDPIF home page and is less prominent to visitors, however it includes a useful keyword search engine, which provides a much easier way to locate specific NTDPIF mango information resources.

3. QDAF Website

The QDAF mango website (<https://www.daf.qld.gov.au/plants/fruit-and-vegetables/fruit-and-nuts/mangoes>) has undergone many changes over the past 10 years. Over this time, the level of technical content listed on this website has declined. Much of the information that is presented appears aimed at a very broad audience, ranging from home gardeners to commercial mango growers. The site is not regularly updated, with the most recent update of new information conducted in June 2014 (11 months ago). There has been a particularly noticeable move away from the listing of documents for which the information may become dated quickly. This includes removal of many of the traditional Horticulture information resources including Fact Sheets and Pest and Disease Chemical spray recommendations. Many of the recent peer-reviewed mango research reports and technical publications including conference and journal papers have now been moved to the QDAF E-Research Archive site (<http://www2.dpi.qld.gov.au/extra/era/index.html>).

Outcomes

Workshops and roadshows

A total of 24 presentations were delivered to over 500 attendees from within the National Mango Industry at venues in Queensland and the Northern Territory over the duration of the DMT2 project. These presentations included six regional forums/road-shows, nine conference/workshop presentations and nine training workshops. The wide geographical coverage of these presentations, the good grower attendance at these events, and the regularity of presentations in each of the four main growing regions (North and Far north Queensland, Katherine and Darwin) would indicate that the DMT2 project achieved direct delivery contact (often multiple times) with a large proportion of mango growers and mango industry stakeholders in Australia. Feedback from attendees at these events was used to improve subsequent presentations and to help develop and complete the four information and training packages delivered throughout the DMT2 project. The publication of number of these presentations in *Mango Matters Magazine* achieved further industry coverage to those who could not attend these events and provided a useful summary of the presentation for all growers to keep for future reference. Key Mango Matters articles produced by the DMT2 project were:

- “Social Skills– Using social media to deliver skills and training” Autumn 2012.
- “Will the real stem-end cavity please stand up?” Autumn 2013.
- “Food for fruit – Nutrition Management in Mangoes” Spring 2013.

Information and Training packages

Four Information and Training packages were delivered throughout the DMT2 project.

The “**Picking Training Package**” has been widely appreciated and utilized by the mango industry. Highly positive feedback was received from the mango growers whose staff attending the 4 power-point training workshops. One grower reported that when compared to other seasons; reject bin analysis from this season has shown a significant reduction in the amount of immature fruit picked. Other growers reported that the pickers who attended the training were more efficient and reported less mango rash injuries than the pickers who had joined the picking teams later and did not attend the training. Elements of this picking-training package were also incorporated in the NT Farmers Association SapSafe mango laborer workforce training package, which was delivered across many NT mango farms during the 2013 picking season. The redevelopment of the picking training package from a power-point into a video training package has greatly extended the accessibility of this package. The YouTube Video “Mango-picking – How to do it right”, has now had over 500 downloads. Grower feedback indicates that growers are primarily downloading the video for presentation at shed-staff training and induction exercises, usually coinciding with the commencement of the mango pickers employment. Other growers have forwarded the link to prospective and existing farm laborers,

prior to commencing work at the property. This has been confirmed by views in Europe including Estonia.

The **“Packing and Post-harvest Management Training Package”** developed by the DMT2 project, has greatly enhanced grower access to key post-harvest information resources. These included the highly popular “Post-harvest manual” and the “Ripening manual” which were made available for download through the AMIA and QDAF websites. The improved availability of other packing shed resources including posters and hand guides was also facilitated through this project and links to the AMIA and QDAF websites. The two packing videos “Mango Packed Product Monitoring” and “Mango Reject Bin Analysis” provided further training resources for mango pack-shed workers. Both videos have had over 70 downloads. Packing and post-harvest management information and training remains a key priority of mango grower and supply-chain partners and was raised as a priority area for future activity at the 11th AMIA National Mango Conference, Darwin 25-28th May 2015.

The **“Pest and Disease Management Training Package”** has improved grower knowledge of systems management techniques for controlling insect populations of two important mango insect pests; Fruit Flies and Fruit Spotting Bug. The establishment and management of the Area Wide Fruit Fly Management demonstration site at Mareeba and the subsequent presentations made at grower workshops and the 2013 National Mango Conference has helped inform growers of the emerging range of innovative techniques for managing fruit flies. Momentum developed at these events, played a large role in the initiation of the HAL/QDAF “Farm-wide fruit fly management systems for east-coast Australia” which included the establishment of multiple new demonstration and trial sites in Queensland. The two Fruit Spotting Workshop presentations and the Mango Matters Magazine also raised awareness for the accurate monitoring of this pest and the development of a management systems approach to minimize the risks of fruit damage by FSB. The revision of the “Field Guide to Pests, Beneficials, Diseases and Disorders of Mangoes” (NTDOR, 2010) due for publication in September 2015, updates and improves the guides applicability across all northern Australia mango growing regions. The addition of the new “Biosecurity threats” section to this guide also improves the mango industries preparedness and defense against a range of exotic pest threats.

The **“Nutrition Management Training Package”** has been delivered as a power-point presentation at six workshops, to over 350 workshop attendees at Mareeba, Ayr, Darwin and Katherine. A grower-friendly, hard-copy, summary of this training package workshop was also published in the 2013 Mango Matters Magazine article, “Food for Fruit – Nutrition Management in Mangoes” which was distributed to all Mango growers. Electronic copies of the full power-point training packages are freely available for downloading from the AMIA and NTDPIF websites. The delivery of this training and ready access to the nutrition package on the internet has facilitated a greater awareness and understanding of the importance of mango nutrition management amongst growers.

Delivery of Electronic Resources

Feedback from mango growers at the 2012 Roadshows and 2013 Australian Mango Conference was that a “One-stop Shop” website would be the most desirable vehicle to deliver electronic information resources to the mango industry. It was recognized that the use of social media tools by mango growers at this time, was very low and that the proposed ideas of an “Australian Mango Blog” or “Australian Mango Grower Facebook” site or the development of Applications would currently not have wide utilization across the mango industry.

The AMIA website is currently the most suitable repository for mango information resources as it is grower focused, is regularly updated and is not restrained by government protocols which may restrict the sharing of information or the listing of external information resources. The AMIA website remains current as it is updated at least weekly with AMIA media stories and grower news, including the weekly “My Mango” e-newsletter (during harvest season) and the monthly “The Slice” e-newsletter. Consequently mango growers and industry stakeholders are likely to regularly visit this site and should feel comfortable navigating within this site to discover useful information resources.

Throughout 2012 and 2013 the DMT2 project worked with AIMIA to identify and prioritise existing mango information resources and to progressively upload electronic copies of these resources to the AMIA website to enable easy grower access. A large quantity of the best available and current mango extension resources had been uploaded (or had been linked) to the AMIA website by the end of 2013. The complete redesign and restructuring of the AMIA website at the beginning of 2014 however resulted in the removal of most of these electronic resources at this time.

The new AMIA website was planned to incorporate a “Grower Resource” section, with plans to include a comprehensive catalogue of mango extension resource materials. This section was to be restricted to levy payers only, with access via a username and password. Unfortunately due to limited resources the website has not evolved to this point and the resources section is still under development. Currently very little of the pre-2014 information resources have since been reloaded onto the new AMIA website. A few key resources, including the DMT2 video “Mango Picking – How to do it Right” have been reloaded, however significant updating still need to be conducted. The new AMIA website needs considerable redevelopment before it can be considered a true “one stop shop” for mango information and extension resources.

Evaluation and Discussion

Regional forums and training workshops

Regional forums, road-shows and workshops have long been popular mechanisms for the delivery of mango information and training resources to the mango industry. Attendance numbers across these events during the DMT2 project were high (> 500) and feedback from those who attended the DMT2 presentations was generally very good. This suggests that there is a strong case to continue the use of these extension delivery techniques. These type of events are however expensive to deliver and logistics are often quite complex to co-ordinate, particularly across disparate regional areas. This has been further amplified by reduced resourcing for extension activities and consolidation of resources to fewer regional centers. The continuation of the biannual AMIA National Mango Conference, alternating with the AMIA National Roadshow series is still seen as a high priority. The delivery of additional workshops, forums and special project presentations as resources permit, will further enhance face-to-face grower contact with R&D providers.

Effective presentation planning and delivery will be of critical importance to maintaining good grower attendance at future regional forums and workshops. Given the increasing restrictions on a grower's free time, presenters need to structure their presentations to meet audience needs and expectations. Prior to the event, there needs to be clear communication between workshop coordinators and presenters to ensure each presentation is interesting and relevant. Personal delivery systems such as videos and webinars offer an alternative delivery method which are often more efficient and can be equally effective as the personal presentation. Careful event planning to meet participant's needs and expectations is more necessary than ever if workshops, roadshows and conferences are to continue as viable information delivery systems.

Information and Training Packages

There remains a strong industry demand for access to information and training packages for priority areas such as picking, packing and post-harvest management, nutrition and integrated pest management. The four information and training packages delivered in the DMT2 project incorporated an integrated approach including the use of guides, manuals, posters, power-point presentations and videos.

The information and training resource packages developed in the DMT2 project, were delivered as both hard-copy and/or electronic forms. There is an increasing preference amongst the community for access to information via electronic delivery techniques. Within the DMT2 project there has been an emerging demand for the supply of mango information manuals and training packages in electronic forms. The mango nutrition management package "Food for fruit – nutrition management in mangoes" is available as a power-point pdf. The new edition of the "Field Guide – Pest, beneficials,

diseases and disorders of Mangoes” will only be published in electronic form. Electronic delivery has many advantages over hard copy formats, including reduced formatting and printing costs, the greater access and timeliness for distribution to stakeholders and their ability to be easily updated as required. Electronic delivery can also be a means to enable a dynamic personal training experience via animations and video.

Well-structured, professional videos such as the “Mango picking – How to do it right” video has gained some of the greatest exposure and grower use within the DMT2 project. Grower feedback has been very positive and the video has been used widely for picker orientation and training exercises. The other two videos “Packed product monitoring” and “Mango reject bin analysis” however, have had much lower exposure and grower use. Video production is an expensive and time consuming exercise, it requires specialist video and editing skills, and the content and recommendations captured in the video can become out-of-date quite quickly. It is important to carefully evaluate the costs/benefits of using video technology in comparison to the use of other communication tools, before making the final choice on an information delivery system.

Electronic delivery systems

Feedback from mango growers throughout the DMT2 project was that a “One-stop Shop” website would be the most desirable vehicle to deliver electronic information resources to the mango industry. The variable performance of the AMIA, QDAF and NTDPiF websites over the 3 year duration of the DMT2 project provides a sound warning that these systems must balance continuity and growth to serve effectively as a long-term information storage and delivery tool. The AMIA website with its grower focus, independence from government restrictions and regular maintenance program sets it as the most suitable website repository for mango information resources. However, the removal of the majority of existing grower information resources during website restructuring in 2014 and the limited progress to date to reload these valuable information resources, indicates greater prioritization and long-term resourcing of website content needs to occur. The new AMIA website needs considerable redevelopment before it can be considered a true “one stop shop” for mango information and extension resources.

New internet and multi-media technologies including the development of blog sites, a grower Facebook page or Applications were not viewed favorably by mango growers, who considered these would not be effective methods for communicating within the broader Australian mango industry, at the present time. It is unfortunate that webinar techniques were not tested within the scope of the current DMT2 project. A successful AMIA Webinar titled “What causes green ripe mangoes?” was delivered in December 2014 by Terry Campbell from QDAF as a highly interactive power-point slide presentation. Eighteen growers, advisors and supply-chain partners participated in the 60 minute event. The success of this webinar was touted by AMIA and QDAF at the 2015 National Mango Conference. The greater use of webinar technology should be investigated further, as an effective and

efficient method for future information delivery to the mango industry.

Recommendations

Recommendations from the DMT2 project are as follows:

- Regional forums, road-shows and workshops, remain an important and effective method for the delivery of information and technology to the mango industry and need to be continued. The biannual Australian Mango Conference, alternating with the AMIA National Roadshow series are the principal events, and when combined with the delivery of smaller, project-focused workshops, provide a sufficient level of contact between information providers and mango industry stakeholders.
- The development of information and training packages for specific topics in the mango industry are seen as a high priority by mango industry stakeholders. Current high priority topics include, picking, packing and post-harvest management, nutrition and integrated pest and disease management.
- Mango industry stakeholders appreciate and will use a wide variety of information delivery methods including posters, field guides, manuals, power-point and video to build their information resources.
- The delivery of electronic mango information resources is gaining increasing acceptance by both information providers and users, due to increased efficiency, speed of delivery and the ability to update resources quickly.
- The use of webinars has great promise for the efficient and effective delivery of mango information across the geographically diverse Australian mango industry and should be included in future communication packages.
- The AMIA website with its grower focus, greater independence and regular maintenance program is the most suitable website repository for mango industry information resources, if it continues to have funding and support. The website has lost significant resources since redevelopment in 2014 and it needs restructuring before it can be considered a true “one stop shop” for mango information and extension resources.

Scientific Refereed Publications

None to report

Intellectual Property/Commercialisation

No commercial IP generated

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