Northern Territory Government

Northern Territory MANGO INDUSTRY Association inc

NTMIA - DRDPIFR Mango R&D Planning Workshop

Post Workshop Report

for presentation at the 2009 Mango Post Harvest Forum

28 March 2009

NTMIA-DRDPIFR MANGO R&D PLANNING WORKSHOP

POST-WORKSHOP REPORT

MARCH 2009

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ACKNOWLEDGEMENTS

The Mango R&D Planning Workshop was jointly conceived and hosted by the Northern Territory Government Department of Regional Development, Primary Industry, Fisheries and Resources (DRDPIFR), and the Northern Territory Mango Industry Association (NTMIA), and took place on 6 and 7 February 2009 at Crocosaurus Cove in Darwin.

Thanks are due to the invited speakers, who shared their varied mango industry experience. They include Mr Peter Delis of the Australian Mango Industry Association (AMIA), Mr Bob Williams of the Queensland Government Department of Primary Industries and Fisheries (QDPI&F), Mr Peter Johnson of the Department of Agriculture and Food Western Australia (DAFWA), Mr Peter Marks and Mr Ian Baker of the NTMIA, and Mr Stuart H Smith of DRDPIFR. A very warm thank you is due to Mr Ian Linley, who generously contributed his time and energy to plan the event, and to facilitate the workshop over the two days.

The workshop required significant behind-the-scenes preparation and planning. For this, very special thanks are due to Annie Black and Linda Pearson of DRDPIFR, Cathy Saunders of the Northern Territory Horticultural Association (NTHA), and Penny Eckel of Crocosaurus Cove, for their work in organising the event.

Above all, the NTMIA and DRDPIFR extend thanks to all participants in this workshop who came from the Darwin and Katherine regions, and from beyond the NT, and contributed to shaping the way forward for future mango research and extension in the Territory.

ABBREVIATIONS

ACIAR	Australian Centre for International Agricultural Research
AMIA	Australian Mango Industry Association
APVMA	Australian Pesticides and Veterinary Medicines Authority
DAFF	Australian Government Department of Agriculture, Fisheries & Forestry
DAFWA	Department of Agriculture and Food, Western Australia
DMT	Delivering Mango Technology Project (the "Deliverance" Project)
DRDPIFR	Department of Regional Development, Primary Industry, Fisheries and Resources
HAL	Horticulture Australia Limited
IP	Intellectual property
IPM	integrated pest management
MMD	mango malformation disease
MRL	minimum residue limit
NMBP	National Mango Breeding Program
NT	Northern Territory
NTB	Nusa Tenggara Barat, Indonesia
NTHA	Northern Territory Horticultural Association
NTMIA	Northern Territory Mango Industry Association
OCPPO	Office of Chief Plant Protection Officer
QDPI&F	Queensland Government Department of Primary Industries and Fisheries
R&D	Research and development
RD&E	Research, development and extension
SPS Agreement	Agreement on the Application of Sanitary and Phytosanitary Measures
VHT	Vapour Heat Treatment

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EXECUTIVE SUMMARY

- The purpose of the Mango R&D Planning Workshop was to provide a forum for industry and government to find ways forward on mango research and development (R&D) priorities, and strategic future directions for mango R&D. Through the workshop, the aim was to identify key, and other, priorities, with a view to mango industry stakeholders progressing future projects and other activities in the areas identified.

- A further purpose of the workshop was to share information, and promote understanding, of the national context of primary industries R&D, notably of the National Agricultural R&D Framework, currently under development by the Australian Government and State and Territory Governments.

- The workshop agenda included the following sessions, together with robust discussion:

    - National perspectives on the mango industry and R&D.
    - Territory perspectives on the mango industry and R&D.
    - Interstate perspectives on the mango industry and R&D.
    - Bringing our perspectives together.
    - Ways forward for mango R&D.

- The outcomes of the workshop were that participants shared and acquired information, and shaped the directions of future mango R&D activities. Participants left the workshop having:

    - Overviewed the status of the mango industry in the NT and nationally.
    - Identified and discussed the challenges and barriers facing mango industry development.
    - Appreciated the role of science and market R&D addressing industry development challenges.
    - Identified R&D areas that may "help the industry jump", or overcome barriers to development.
    - Honed key priority areas for future mango R&D.
    - Scoped a post-workshop process for acting on R&D priorities and the workshop's outcomes.

- Key mango R&D areas identified as key priorities included:
    - Mango rootstocks.
    - Mango varieties.
    - Time of flowering.
    - Maximising marketable yield + maximising productivity.
    - Supply chain management + export development.
    - Pests and diseases.
    - Crop prediction.
    - Nutrition.
    - Sustainability.
    - Irrigation and water management.
- Mango R&D areas identified as other priorities included:
    - Harvesting technology.
    - Climate change.
    - Crop prediction.
    - Value-adding.
- As regards a post-workshop process to take further the development of mango R&D projects, the idea was raised that following the workshop, Working Groups (comprised of interested industry people and appropriate government personnel) in Darwin and Katherine would be a good way to further project development, and the search for funding opportunities. There was general agreement that this comprised a positive and constructive suggestion for industry and government to move forward.

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1 INTRODUCTION

Purpose of the Workshop

Workshop aims

The purpose of the Mango R&D Planning Workshop was to provide a forum for industry and government to find ways forward on mango research and development (R&D) priorities, and strategic future directions for mango R&D. Through the workshop, the aim was to identify key, and other, priorities, with a view to mango industry stakeholders progressing future projects and other activities in the areas identified.

A further purpose of the workshop was to share information, and promote understanding, of the national context of primary industries R&D. The National Agricultural R&D Framework, currently under development by the Australian Government and State and Territory Governments, and under industry consultation throughout 2009, will fundamentally change, and rationalise, the way primary industries R&D is done in the future. For this purpose, the workshop included presentations on the emerging Framework, as well as on mango R&D from the Queensland Department of Primary Industries and Fisheries (QDPI&F), and from the Western Australian Department of Agriculture and Food (DAFWA).

Intended outcomes

The intended outcomes of the workshop were for participants to share and acquire information, shape the directions of future mango R&D activities, and leave the workshop having:

- Overviewed the status of the mango industry in the NT and nationally.
- Identified and discussed the challenges and barriers facing mango industry development.
- Appreciated the role of science and market R&D addressing industry development challenges.
- Identified R&D areas that may "help the industry jump", or overcome barriers to development.
- Honed key priority areas for future mango R&D.
- Scoped a post-workshop process for acting on R&D priorities and the workshop's outcomes.

Workshop Agenda

The workshop agenda, provided in full as Attachment 1 to this Report, was designed to achieve the workshop's aims and its intended outcomes, while providing opportunity for participants to share and acquire information on the status of the mango industry and its development, and on current and proposed future mango R&D from national, Territory and inter-state perspectives. To this end, the agenda was crafted to include sessions on national, Territory and inter-state perspectives on the mango industry and R&D, presentations by invited keynote speakers, time for questions and discussion with speakers, opportunity for intensive work in small groups, which brought together a mix of industry and government participants to address the workshop's aims and deliver its intended outcomes. Key sessions included:

- National perspectives on the mango industry and R&D.
- Territory perspectives on the mango industry and R&D.
- Interstate perspectives on the mango industry and R&D.
- Bringing our perspectives together.
- Ways forward for mango R&D.

Further details on the workshop agenda, the participants and speakers are enclosed in, respectively, Attachments 1, 2 and 3 to this Report.

2 NATIONAL PERSPECTIVES ON THE MANGO INDUSTRY AND R&D

AMIA Perspectives on Mango R&D

Mr Peter Delis, Chairman of the Australian Mango Industry Association (AMIA), spoke on a range of issues from his personal experience of 20 years in the mango industry, including running a large private research program. The below points provide a summary of Peter's talk.

- A key issue is how to get a higher percentage of class 1s from Kensington Pride (KP). Have tried many strategies without much success. The percentage of % class 1s has a big impact on the profitability of the business.
- Quality is a big issue and difficult to resolve. Jabiru Tropical Orchards invested in alot of private R&D on this issue and it is difficult with KP. Our experience with the Vapour Heat Treatment (VHT) plant clearly showed that quality was, and remains, a problem with many growers.
- Grower culture is a big impediment to growth. For example, growers are happy to market into central markets for an unknown price, but not for export even though there is an agreed shed price.
- Crop forecasting is very important. Growers should use it to plan for labour supply, transport and marketing.
- The need for more transparency in the markets is a big issue.
- Export is a big part of future of the mango industry. New varieties are important for export markets, although not so much for domestic markets. Export efficiency powers will be pursued by AMIA as a single export desk to ensure the industry gets the best export performance, and to avoid the situation where exporters are competing with each other.
- Biosecurity issues are important, an example being the recent outbreak of Mango Malformation Disease (MMD).
- The AMIA mango *marketing* levy is not enough to do all we want. Its value is being eroded by inflation.
- AMIA is increasingly involved with the Australian Centre for International Agricultural Research (ACIAR) with big benefits to the Australian mango industry.
- Peter observed that the domestic market is OK for around 2 million trays per month, and that we need to build this to 3 million trays.
- There are issues individual growers can do themselves, but there are issues we need to deal with as a group.
- We need to start this R&D planning process with a blank piece of paper and feel free to bring in a range of ideas to develop the industry.
- We need a can-do attitude.

The National Context of Primary Industries R&D

Mr Bob Williams from the Queensland Department of Primary Industries and Fisheries (QDPI&F) provided a briefing on the National Agriculture R&D Framework. Bob is the designated leader for coordinating mango research nationally under this Framework.

The Framework is a system to better coordinate R&D investments between the states. It applies across all agricultural areas. Under the Framework, there are options for different states to "Lead", "Participate" in, or "Link" into, national primary industries R&D.

Research areas relevant to the NT are

- Tropical fruits and nuts.
- Tropical vegetables.
- Tropical forestry.
- Integrated tropical pest and disease management.
- Tropical weeds.
- Tropical amenity horticulture.
- Irrigation management.

Mango R&D comes under "Tropical Fruits and Nuts". QDPI&F is the lead agency for developing up Industry R&D Plans in this area, with the NT, WA, NSW and CSIRO also contributing. The framework does not mean local research stops, but that it operates in co-operation with other states. In the longer term, it may lead to effort and resources moving between states. The push to develop the Framework arose as a result of declining R&D budgets. The important issue for the NT is to have a clear understanding of Territorian R&D needs to input into the development of Industry R&D Plans which will be part of the National Agricultural R&D Framework. It is necessary to ensure active NT participation with respect to mangoes in Framework development.

3 TERRITORY PERSPECTIVES ON THE MANGO INDUSTRY AND R&D

NT Mango Industry Overview and NTMIA Perspectives on R&D

The NTMIA perspectives on the NT mango industry and R&D in the Territory were provided by Mr Ian Baker for the Darwin region, and by Mr Peter Marks for the Katherine region.

In summary, the Territory's annual mango production is around 15,000 tons (between 13 and 22,000 tons a year), and is valued at around 40 million (between $30 and 50 million). This represents between 30 and 35 per cent of Australian production. The split between Darwin and Katherine is around 60/40. Mangoes are the largest cropping activity in the NT, and will increase further as Calypso plantings come into production extending the season into early December.

Key Darwin issues

- Disease losses in seasons when rain occurs at harvest can be significant.
- Earlier flowering and cropping for better quality, less disease, increased sales, and a longer season through varieties and management are key issues requiring R&D.
- Need to properly assess and evaluate new varieties on appropriate sites in the NT.
- Water use: more efficient use of water, more accurate water allocation models are required.
- Nutrition: effects on yield, quality, sustainability and the environment are areas requiring R&D.
- Export: market development through suitable varieties, high yields and long life is required to be price competitive.
- Canopy management: an understanding of how many leaves are optimal for yield and quality is required.
- Rootstocks: development of suitable rootstocks and their field testing is required.
- Sustainability: an evidenced-based approach, e.g. in the areas of water, nutrition, and chemical use is required.

Key factors to consider in identifying RD&E priorities

- Economic impact on the industry. For example, does an area of RD&E contribute outcomes that will lead to a longer season, earlier production, export to new markets, and varieties.
- RD&E is about innovation, a can-do approach, and long term strategic issues.
- New varieties for a longer season, early harvest and export are critical, and this needs RD&E support.
- DRDPIFR is our best and biggest resource for RD&E, however it is recognised that government cannot do everything.
- External funding is critical due to declining recurrent funds.

- Government role is to take the lead in new economic opportunities.

- Need to develop industry-government consensus on key RD&E priorities. This is not about industry telling government what to do. However, industry insights and observations are very valuable in informing and deciding RD&E priorities.

- Day-to-day management issues could be dealt with by extension or benchmarking. The AMIA Delivering Mango Technology (DMT) Project is a good model for mango industry extension. Also, grower-to-grower learning is important as all growers are innovators and informal researchers by observation.

Key Katherine issues

Mr Peter Marks spoke from a Katherine grower perspective, and from his long experience as a mango farmer. He observed that if we had held this meeting 10 years ago, our experience would have been very limited. However, we now have around 20 years experience growing mangoes in the NT, and in the room we have some 500 years of experience growing mangoes between growers, government and the commercial people.

The 2004 season was a water-shed year for the NT mango industry. We had a glut of around 2.8 million trays over a short season. This has benefits in increasing consumption for NT mangoes, with more people eating more mangoes, and that year also highlighted and identified the need for improved quality and management. We made a strong presence for NT mangoes and started the move to a more professional industry.

As growers we need to:

- Go back to basics of good farming.

- We will lose industry knowledge as growers leave.

- In some areas we have gone backwards, e.g. in using potassium chloride.

- We shouldn't over-fertilise or over-water.

- We need good management.

- A key to export development will come from better varieties with better life and higher yields.

- We need to go back to understanding basic responses e.g. potassium chloride vs potassium sulphate, we don't have any idea about basic issues like this.

In short, two area of importance to the mango industry in the Katherine region are:

- Export: development of suitable varieties for export markets.

- Nutrition.

Mango R&D in the NT

Mr Stuart H Smith, Acting Director of the Plant Industries Division of the Northern Territory Government Department of Regional Development, Primary Industry, Fisheries and Resources (DRDPIFR), provided a Territory perspective on the mango industry and R&D being progressed.

Current research

A summary of current mango R&D, and other, projects was presented. In short, DRDPIFR is presently progressing the following projects. All of these are summarised in Attachment 4 to this Report *Mango Research, Development and Extension - NT Project Summaries*.

- The Crop Forecasting Project.
- The Top End Better Mangoes Project.
- Delivering Mango Technology.
- Quality Management to Enhance Effective Supply Chains for Mangoes & Rambutans in Indonesia and Australia.
- Field Evaluation of Strobilurins for the Control of Mango Anthracnose in the NT.
- Mango Flower Insects & their Effect on Fruit Quality in the NT.
- Management & Control of Termite Pests of Horticultural Crops in the NT.
- Development of Specimen-based Pest Lists for Mangoes in ASEAN Countries.
- Elite Rootstocks for Improved Mango Productivity.
- Surveillance and Response to an Incursion of Mango Malformation Disease (MMD) in the NT.
- Diagnosis of MMD in the NT.

Further to the above, other mango work includes maintaining germplasm of diverse mango varieties, pest and disease surveillance, maintaining fruit fly trapping for market access and exotic fruit fly traps for quarantine, market access inspection and certification, residue monitoring, and monitoring of illegal chemical use.

Challenges facing NT Production

Production Issues

- Pest and disease management.
- Carbohydrate partitioning (big yield difference between cultivars).
- Control of flowering time.
- Managing nutrition for yield and quality.
- Irrigation management.

Post harvest issues

- Maintaining quality from the tree to the point of sale.
- Temperature management.
- Handling mechanical damage.
- Keeping disease and insects out.
- Maintaining sugar and taste parameters.

Broader challenges

- Being able to adapt to climate change.
- Globalisation and overseas competition.
- Maintaining biosecurity.
- Increased consumer demand for food safety.
- Trend towards 'superfoods' with enhanced health benefits.
- Genetic modification.

4 INTERSTATE PERSPECTIVES ON THE MANGO INDUSTRY AND R&D

Mango R&D in Queensland

Mr Bob Williams from the Queensland Department of Primary Industries and Fisheries (QDPI&F) provided a Queensland perspective on the mango industry and R&D being progressed in that State. Bob began by outlining QDPI&F´s mission, which is to *maximise the economic potential for Queensland's primary industries on a sustainable basis*. Four overarching priority areas are:

- Increasing productivity.
- Developing markets.
- Strengthening business adaptability.
- Enhancing sustainability

Current mango research is based on improving mango profitability through increased productivity, increased demand, new products, higher prices, reduced wastage, and increased efficiency. Current projects are in the areas of:

- Genetic improvement.
- Production.
- Supply Chain Management.
- Market Access.
- Market Development.
- Technology Transfer.
- Bio-security.

Mango R&D programs in Queensland

The *Genetic Improvement Program* is based on breeding, and understanding mango genetics to make best use of the gene pool. In partnership with NT DRDPIFR, DAFWA and CSIRO, three varieties are currently in the process of being commercialised. There is a second round of breeding continuing with DAFWA. QDPI&F have invested in identifying genetic markers for desirable traits to help the National Mango Breeding Program (NMBP).

The *Production Program* is focussed on N & K nutrition to synchronise flushing and flowering, and disease and quality. The Program also focuses on better control of mango scale, mango seed weevil and new chemistry for spotting bug, seed weevil, and pulp weevil, as well as on reducing disease through resistance, fewer inoculums, alternative fungicide strategies and plant defence activators.

The *Supply Chain Program* is based on work in the domestic market (B74 and Honey Gold), and for export market development (Singapore, China, and Japan).

The *Market Access Program* is focussed on market access for B74, heat treatment response of new varieties, developing alternative treatments for market access and a fruit fly program for area freedom using new male and female lures, and sterile release.

The *Market Development Program* is expanding export market opportunities and the *Biosecurity Program* is focussed on mango pulp weevil, red banded caterpillar and bio-security surveillance and technical support for bio-security.

Future mango R&D priorities will be to:

- Increase mango yield to 40ton/ha through a focus on varieties and management.
- Reduce pesticide use.
- Develop mango exports via increasing life to 45 days, improved export varieties, better management, better harvest and post harvest management and better supply chains.
- Develop better export market access protocols and alternative access like area wide pest management.

Queensland is running a large mango R&D program of around $2.7 million. This is their largest fruit crop R&D program, more than double the next largest R&D program (strawberries at $1.3million), and much larger than the banana program ($1 million), which is a much larger industry. Funding is 60 per cent from external sources, with most of this coming from ACIAR (ACIAR funding accounts for 80 per cent of external funds). Despite declines in R&D in most areas, the Queensland mango program has expanded considerably, largely due to external funding.

In QDPI&F, R&D that is pursued is classed as:

- Innovative, tactical, or evolutionary.
- Short, medium, or long term.
- Having varying investment ratios of government to external funds.

Investment by QDPI&F in R&D is:

- 100% government investment if the R&D is high risk, long term, very innovative, has intellectual property (IP), environmental issues and/or deals with market failure.
- 50:50 with industry if there is benefit to both government and industry.
- 25:75 if limited benefit to the government.
- 0:100 if main benefit is to industry. This is generally short term R&D.

Mango R&D in WA

Mr Peter Johnson from the Department of Agriculture and Food, Western Australia (DAFWA) provided a WA perspective on the mango industry and R&D being progressed in that State. In WA, the mango industry is in a growth phase. WA mango production takes place across a wide range of geographical areas, from Kununurra to areas just north of Perth. Production is currently around 4,000 tons. It is expected to rise to some 15 - 20,000 tons over the next 10 years.

Current R&D in WA

Currently, the main R&D areas in WA are in the following areas:

- New improved cultivars.
- Increased labour supply and/or improved labour efficiencies, increase mechanisation.
- New market access.
- Improvements in supply chain management and development for domestic and export markets.
- Improved technology transfer.
- Increasing supply base.

The mango R&D program is run with around 4 staff. The program is heavily dependent on external funds, with ACIAR the main source of external funds. There is a high level of co-operation with Queensland in ACIAR projects.

<u>New improved cultivars</u>

DAFWA are partners in national breeding work. They are also conducting research on post harvest characteristics of varieties from the National Mango Breeding Program (NMBP), and assessing their export potential (ACIAR funded). They are partners with QDPI&F in the next stages of breeding looking at F2 populations and determining the genetic heritance of desirable characteristics.

<u>Mechanisation and labour saving for mango production</u>

This area includes introducing picking aid technology and modifying existing aids to reduce losses and improve labour efficiency. This is being done under AMIA funds through the Delivering Mango Technology (DMT) Project.

<u>New market access</u>

In the area of market acess, DAFWA and QDPI&F collaborate in developing access protocols for China, Taiwan, US, and South Korea. They are also involved in developing irradiation and other alternative treatments. This is primarily for protocols for Med fly. As part of an ACIAR project, DAFWA are assessing pheromones for control of Red Banded Caterpillar.

Improved Supply Chain Management

DAFWA have had a strong commitment to developing sea freight to Europe for WA and NT mangoes. In addition they have been involved in assessing quality risks in domestic markets and assisting growers to meet Vapour Heat Treatment (VHT) and irradiation protocols.

Improved technology transfer

The DMT Project, funded by AMIA in each state, assists technology transfer. In addition, DAFWA have trials in Gin Gin, north of Perth, on *Pseudomonas* control and area assessing the disease profile in Carnarvon.

Increasing the supply base

Working with grower groups across all production regions, with a long supply period from Sept to April, DAFWA is co-ordinating developments across the State to capitalise on market opportunities domestically and for export, based in part on seed weevil freedom.

5 BRINGING OUR PERSPECTIVES TOGETHER

The below summarises key and other priorities identified during the above workshop. A summary of non-R&D priority issues raised is also provided.

Summary of Research Priorities Identified

Key R&D priorities

Mango rootstocks

- Nationally coordinated work to determine which mango rootstock varieties have the best influence on e.g.: time of harvest[1], pest and disease management, plant nutrition, canopy management and yield.
- This was seen to be long-term work for the Department, with the importance of a national approach, with local trialling, being recognised.
- Much work has already been done on rootstocks. Key questions are:
  - 'How does industry make use of the available technology and information? For example, we need to have rootstock x variety x site trials to assess optimal combinations.
  - Long term use of molecular marker technology to identify suitable traits in new rootstocks varieties is also required.
  - When releasing new varieties, need to know which are the best accompanying rootstocks.

Mango varieties

- Nationally coordinated work to determine which varieties provide the best outcomes for time of harvest, quality and marketable yield.
- Which varieties are best for export? Appropriate variety development for export markets is critical.
- Which varieties are best for dealing with emerging issues like climate change, and the need to adapt the industry to changing climate variability which is likely to result in altered flowering and therefore fruiting patterns?
- The varietal influence of timing of flowering, and extending the season both early and late, requires R&D support.

- *Notes:* (1) Commercialisation of new varieties is a critical means of ensuring research impacts, and benefits, are realised by industry. (2) A key part of an effective commercialisation process is a supporting R&D program in parallel with commercial release. (3) When releasing new varieties, need to know which the best accompanying rootstocks are. (4) Need a process to prove/test new varieties in NT.

Time of flowering

- Role of varieties.
- Management systems for earlier cropping. E.g.: flowering consistency and manipulation (relate to timing of harvest). Need to understand the research behind the relative importance of

[1] Note: Timing of harvest is critical – the holy grail in horticulture is to get harvest happening in market windows that generate the highest returns.

horticultural practices (e.g. etheryl use) vs choice of varieties, and too to extend this knowledge.
- Geographical regions for extending harvest period, early and late.

Maximising marketable yield + maximising productivity

- Yield enhancing R&D to maximise productivity. A 40 ton/ha target is proposed.
- Identifying drivers of yield, e.g.: disease, nutrition, canopy management and irrigation.
- Identifying drivers of yield decline, e.g. via harvest damage and (in)efficiency – research and extension roles identified.
- Raising quality via greater proportion of Class 1s is hugely important for industry economic impacts.
- Understanding the impact of climate change on marketable yield is of emerging importance: for example, negative impacts of higher rainfall on quality and post-harvest life, and negative impacts of higher temperatures during the dry season on flowering and therefore yield.

Supply chain management + export development

- Supply chain management for domestic and export markets.
- Managing quality along the supply chain - benchmarking from paddock to shelf.
- A state by state approach was proposed as more appropriate for domestic markets.
- A coordinated national approach was seen as appropriate for export led supply chains.
- Export market research - especially for Katherine fruit.
- Consumer research, market development research, and on-going market intelligence research in export markets.
- How can NT maximise its mango exports to key markets? VHT plant use is central to enhancing mango exports to 4 key export markets (China, Japan, S Korea and Taiwan, and maybe India). How does NT get more fruit going through the VHT? This is, in large part, a quality issue, and relates to other priority areas identified.

Pests and diseases

- An on-going and immediate need for disease and disease management research to minimise production losses. New pest management strategies, including integrated pest management (IPM) approaches, and new chemical approaches for pests and diseases.
- Research on existing and emerging pests, and emerging biosecurity threats.
- Research on allowable chemicals for domestic and export markets.
- Disease control post-harvest, e.g. for stem end rot and anthracnose, especially in relation to rain at harvest in Darwin. This area crosses over with supply chain management, and was identified as an immediate and on-going need.
- Area freedom - for Katherine and possibly for arid areas. Important for pest and disease issues relating to local and export market development.
- Disease management research more of an issue for the Darwin region over Katherine.
- Extension seen as important.

Crop prediction

- A national approach to crop forecasting – important for time of harvest knowledge, harvest management, e.g.: useful for labour and transport planning.

Nutrition

- Nutrient management for best flowering, fruiting, yield and quality outcomes.
- Area-specific nutrient management

Sustainability

- Research and extension at the interface of production and its environmental impacts was identified as a key priority. Biosecurity research and extension, water management and irrigation research and extension, nutrition –the interface between production and the environment (impact of nutrient leaching in the environment), and climate change.
- Irrigation and water resources management work required.

Irrigation and water management

- Impacts on yield and quality.
- Water use efficiency and crop factor determinations for water allocation plans.
- Climate change.
- How much water does a mango tree need?

Other R&D priorities

Harvesting technology

- Research on best technology for production efficiency and fruit quality outcomes.

Climate change

- Understanding the implications for production, management, varietal selection, and so on, of a changing climate.
- Facilitating industry's adaptation to increased climate change and variability.

Crop prediction

- A national approach to crop forecasting – useful for labour and transport planning.

Value-adding

- Research on alternative markets, including the potential for value-added products

Summary of Other (non-research) Priorities Identified

The below is a summary of non-RD&E issues raised during the workshop.

Mango varieties

- Commercialisation so growers get benefits
- Consumer education and market research relating to new varieties

Developing value-added products in the NT

Biosecurity

- Area freedom. This is a critical issue for Katherine, and further south, particularly in terms of seed weevil.
- Biosecurity and market access. Importance of regulatory role recognised.

Extension

- Generally in relation to above research areas, and in relation to Department's regulatory roles.

Communication

- For example on biosecurity issues.
- Also on funding available for research and extension, on supply chain issues, consumer and market (domestic and export) information.
- Perceived need to lobby government and AMIA for more funding.

Abandoned orchards

- How are these dealt with? This is a local issue with biosecurity, pest and disease implications.

Mango levy

- A proposal that AMIA increase the mango levy for more resources for R&D and marketing.

Communication

- What is the role of NTHA in mango industry development?
- What is the best way for the AMIA to interface with the NT?
- Why does NTMIA not have an IDO?
- We need an effective process for collaboration and cooperation (industry and government & grower-to-grower & with interstate partners) for R&D activities and outcomes?
- Scientists need a forum to communicate and cooperate across state borders.

6 WAYS FORWARD FOR MANGO R&D

Post-Workshop Process for Furthering Mango R&D Priorities

Issues identified during the course of workshop discussions

Facilitated discussion on the post-workshop process generated the following ideas. These were all captured during the course of the workshop, as follows.

Proposals for post-workshop Working Groups

- For key priority areas, the idea was raised that following the workshop, Working Groups - with interested industry people, and government personnel - may be a good way to further research project development.
- There was general agreement that this comprised a positive and constructive suggestion for industry and government to move forward.

Work in the area of rootstocks

- Marie Piccone raised what the next step for rootstock work would be, and how rootstock work could be taken further. A possible idea was floated for a Rootstock Working Group to work out the next step. It was proposed that such a group should comprise all 3 states (NT+ Qld + WA), with the ball currently being in the NT court. Molecular marker work could make a contribution to this area of R&D. The NT would be on board with an evaluation site(s).

Work in the area of mango export development

- Several people raised exports, and whether we need to review NT activity in the area of exports. A suggestion was put forward for a Qld + WA + NT Export Working Group to be pursued post-workshop.
- Also in the area of exports, the NT has participation in a Qld-led project on Global Mango Export Development. The question was raised whether more effort is needed on this project from the NT.

Miscellaneous ideas

- Peter Delis noted *Let's have a can-do attitude.*
- Ian Baker said that DRDPIFR can't do it all. Some areas of R&D and other activity will be done by other players – non-government.
- We need to think creatively about how we do primary industry RD&E in future in world of declining dollars and a skills shortage. More external funds, for example via ACIAR and other funding bodies will be an important component of the way forward.
- Succession planning is an issue, both for government and industry.

- Thea Williams noted that for some of the R&D work already taking place, we need to make sure DRDPIFR is: 1. communicating with and extending to industry, and 2. drawing on Qld and WA knowledge and experience of relevance and benefit to the NT. In other words, a more coordinated extension effort is needed in priority areas. For some things, in some priority areas, the Delivering Mango Technology Project will be the best vehicle for communication and extension. For other areas, other processes/groups might be necessary.

- A key implication for post-workshop work is the need to ensure good communication and relationship building takes place *by all* agencies and organisations.

- With respect to the R&D priority areas identified during the workshop, a question from the floor concerned whether the NTMIA wished to take ownership of these priority areas. Peter Marks responded that, yes, the priorities should be a part of NTMIA's Strategic Plan.

- A suggestion for furthering mango R&D was that the AMIA needs to review its low levy base, particularly given that ACIAR is not an bottomless funding source.

NTMIA-DRDPIFR MANGO R&D PLANNING WORKSHOP

POST-WORKSHOP REPORT - MARCH 2009

ATTACHMENTS

Attachment 1	Workshop Agenda
Attachment 2	Workshop Participants
Attachment 3	Workshop Speakers
Attachment 4	Mango Research, Development and Extension: NT Project Summaries
Attachment 5	Overview of Mango RD&E Investment Priorities in the Northern Territory

Attachment 1

WORKSHOP AGENDA

NTMIA-DRDPIFR MANGO R&D PLANNING WORKSHOP

AGENDA

6 & 7 February 2009

Venue: Crocosaurus Cove, corner of Mitchell St & Peel St, Darwin

Facilitator: Mr Ian Linley

Friday 6 February 2009		
8 for 8.30 am	Arrival & coffee	All
INTRODUCTION		
8.30 am	Welcome & opening	Mr Richard Galton, Chief Executive, DRDPIFR
8.40 am	Looking forward to the future: Introductory remarks	Mr Rod Gobbey, Executive Director Primary Industries, DRDPIFR
8.50 am	Introduction to the mango R&D planning workshop ▪ Purpose of the workshop - Why are we here? What do we wish to achieve? ▪ Overview of workshop - What can we expect?	Dr Thea Williams, Industry Development Manager, Plant Industries Division, DRDPIFR & Mr Ian Linley, Facilitator
NATIONAL PERSPECTIVES ON THE MANGO INDUSTRY & R&D		
9 am	AMIA perspectives on mango R&D ▪ National overview of the mango industry ▪ Challenges facing the mango industry - Barriers to industry growth & development ▪ Why R&D is important to our industry, & how our growers use R&D ▪ Future mango R&D directions we consider strategic, important, & why	Mr Peter Delis, Chairman, Australian Mango Industry Association (AMIA)
9.20 am	The national context of primary industries R&D ▪ Overview of the National Agricultural R&D Framework ▪ What this means for mango R&D ▪ Setting the scene & context for future research activities	Dr Bob Williams, Science Leader, Queensland Department of Primary Industries & Fisheries (QDPIF)
9.40 am	Time for questions	Mr Ian Linley, Facilitator

Friday 6 February 2009		
TERRITORY PERSPECTIVES ON THE MANGO INDUSTRY & R&D		
9.50 am	NT mango industry overview ▪ Who are we? Where are we in the NT? ▪ What do we look like as an industry? ▪ Where have we come from? ▪ Where are we going? ▪ What's the role of R&D to help us get there?	Mr Peter Marks, President, Northern Territory Mango Industry Association (NTMIA) & Mr Ian Baker, Board Member, NTMIA
TERRITORY PERSPECTIVES ON THE MANGO INDUSTRY & R&D		
9.50 am	NTMIA perspectives on R&D ▪ Challenges facing the NT mango industry - Barriers to industry growth & development ▪ Why R&D is important to us, & how our growers use R&D ▪ Future mango R&D directions we consider strategic, important, & why	Mr Peter Marks, President, Northern Territory Mango Industry Association (NTMIA) & Mr Ian Baker, Board Member, NTMIA
10.15 am	Mango R&D in the Northern Territory ▪ Challenges facing the mango industry - Barriers to industry growth & development ▪ Current mango R&D activity in the NT: Overview of DRDPIFR mango R&D - What projects are we doing? ▪ Future mango R&D directions we consider strategic, important, & why ▪ Funding & resources for mango R&D	Mr Stuart H Smith, A/Director, Plant Industries Division, DRDPIFR
10.35 am	Time for questions	Mr Ian Linley, Facilitator
10.45 am	MORNING TEA	
INTERSTATE PERSPECTIVES ON THE MANGO INDUSTRY & R&D		
11.15 am	Mango R&D in Queensland ▪ Challenges facing the mango industry - Barriers to industry growth & development ▪ Current mango R&D in Queensland: Overview of QDIF mango R&D - What projects are we doing? ▪ Future mango R&D directions we consider strategic, important, & why ▪ Funding & resources for mango R&D	Dr Bob Williams, Science Leader, QDPIF
11.35 am	Mango R&D in WA ▪ Challenges facing the mango industry - Barriers to industry growth & development ▪ Current mango R&D in WA: Overview of WA mango R&D - What projects are we doing? ▪ Future mango R&D directions we consider strategic, important, and why ▪ Funding & resources for mango R&D	Mr Peter Johnson, WA Department of Agriculture

Friday 6 February 2009		
11.55 pm	Time for questions	Mr Ian Linley, Facilitator
12.05 pm	Panel discussion: Interactive session with presenters ▪ Open discussion on proceedings so far ▪ What have we heard & learnt?	Mr Ian Linley, Facilitator
12.45 pm	LUNCH	
BRINGING OUR PERSPECTIVES TOGETHER		
1.45 pm	Introduction to afternoon group work	Mr Ian Linley, Facilitator
2 pm	Group work: Workshop break-outs into small groups Discuss and summarise reactions and responses to what we've heard and learnt today on: ▪ Territory & interstate R&D ▪ The National R&D Framework ▪ Challenges facing industry ▪ What's required for industry growth & development? What are some of barriers to be overcome? ▪ Which of these requirements and barriers may be addressed by: - Scientific & technical R&D? - Extension? - Other means?	Mr Ian Linley, Facilitator
2.45 pm	Reporting back of small groups to all participants Group reps to report back summarising above	Mr Ian Linley, Facilitator
3.30 pm	AFTERNOON TEA	
3.45 pm	Group work: Workshop break-outs into small groups Discuss & summarise: ▪ What are the areas of R&D & extension that would "help the industry jump"?	Mr Ian Linley, Facilitator
4.20 pm	Reporting back of small groups to all participants Group reps to report back summarising: ▪ What are the areas of R&D & extension that would "help the industry jump"?	Mr Ian Linley, Facilitator
5 pm	Workshop close for the day	Mr Ian Linley, Facilitator
5pm	NTMIA COCKTAIL NIBBLES & DRINKS AT CROCOSAURUS COVE	

Saturday 7 February 2009		
WAYS FORWARD FOR MANGO R&D		
8 for 8.30 am	Arrival and coffee	All
8.30 am	Welcome & opening of day 2	The Hon Kon Vatskalis MLA, Minister for Primary Industry, Fisheries & Resources
8.40 am	Introduction to day 2 ▪ Recap of day 1 & overview of day 2 ▪ Where we need to be by the day's end	Mr Ian Linley, Facilitator
8.50 am	Group work: Workshop break-outs into small groups Discuss in relation to the areas of R&D identified yesterday: ▪ Which R&D areas are key priorities? And which are other priorities?	Mr Ian Linley, Facilitator
9.40 am	Reporting back of groups to all participants & facilitated discussion Groups report back on: ▪ Which R&D areas are key priorities? And which are other priorities?	Mr Ian Linley, Facilitator
10.30 am	MORNING TEA	
11 am	Joint reporting back summary: What we've heard & learnt ▪ Summary from NTMIA ▪ Summary from DRDPIFR ▪ Facilitated discussion - all	Mr Peter Marks, President, NTMIA & Mr Stuart H Smith, A/Director, Plant Industries Division, DRDPIFR Mr Ian Linley, Facilitator
WHERE TO FROM HERE?		
11.45 am	Where to from here? ▪ Scoping a post-workshop process for acting on, and implementing, mango R&D priorities	Mr Stuart H Smith, A/Director, Plant Industries Division, DRDPIFR & Mr Peter Marks, President, NTMIA
12.30 am	LUNCH	
1 pm	Workshop close	
THANK YOU		

Attachment 2

WORKSHOP PARTICIPANTS

INDUSTRY ATTENDEES	GOVERNMENT ATTENDEES
ANDREOU, Dora	BLACK, Annie
ARMSTRONG, Tom	CHIN, Deanna
BAKER, Ian	CONDE, Barry
BLACKBURN, Kevin	DONEY, Libby
BUSSEY, Heather	FOSTER, Helen
CORMACK, David	GALTON, Richard
CORMACK, Ruth	GOBBEY, Rod
CURTIS, Ian	HAMILTON, David
DELIS, Peter	HOULT, Mark
DESPOTIS, Chris	JOHNSON, Peter
DUNMALL, Trevor	KHAN, Shahid
ELLIOT, Tim	LIBERATO, Jose (Dr)
FOO, Bill	McLENNAN, Austin
GILBERT, Bill	MOORE, Chelsea
HANCOCK, Andy	QURESHI, Sohail
HIGGINS, David	SAWYER, Bruce
HIGGINS, Norma	SMITH, Stuart H.
HILL, Darren	STEPHENS, Peter (Dr)
KARLSSON, Marcus	THISTLETON, Brian
LAKE, Trevor	TRAN-NGUYEN, Lucy (Dr)
LENG, David	VATSKALIS, Kon, The Hon
LEWIS, Matthew	WILLIAMS, Bob (Dr)
LINLEY, Ian	WILLIAMS, Thea (Dr)
LINTON, Murray	
MARKS, Peter	
NUCIFORO, Nino	
OWENS, Greg	
PARADISIS, Jack	
PEAK, Kate	
PICCONE, Marie	
POFFLEY, Mike	
RAYNOR, Ken	
SANDREY, Bob	
SCURR, Gavin	
SINNOT, Peter	
STEWART, Dan	
STEWART, Joan	
VIVIAN, Phil	
WEST, Tim	
WESTRA van Holthe, Willem	

Attachment 3

WORKSHOP SPEAKERS' BIOGRAPHIES

MR RICHARD GALTON

Following graduation as a civil engineer from the University of Sydney in 1972, Richard worked with the Department of Main Roads in NSW as a design and site engineer on motorway and bridge construction projects for ten years. In 1982, he was seconded to the Department of Transport and Works, NT, to manage two complex bridge construction contracts. Within three years he had moved into senior management roles in the NT public sector, completing an MBA by correspondence in 1994. Since that time, Richard has been in Chief Executive or Deputy roles in public housing, work health, sport, power and water, infrastructure and planning, corporate services, land development, business and industry development, and now regional development and primary industries.

MR ROD GOBBEY

Rod joined the NTG in early may 2005. During the 10 years prior to moving to the NT Rod held a number of senior positions with the Tasmanian Government. Those positions included positions Director of Food Quality and Safety and Director of Agriculture. Rod also acted for significant periods as Manager of Animal Health, Manager of the Tasmanian Animal Health Laboratory. The above recent experience when considered against the background that Rod commenced his career in Government in 1975 as a technical officer in the AQIS meat inspection program gives him a strong appreciation and understanding of the breadth of issues of his current job of Executive Director, of Primary Industries.

DR THEA WILLIAMS

Thea joined the Department last April as Industry Development Manager. Her role focuses on extension, on developing and implementing extension and capacity building policy and practice for primary industries. While she's based in the Plant Industries Division, her role also extends across other Divisions. She studied plant science, and some 10 years later she returned to study and completed a Masters and PhD in agricultural economics, working on analyses of agricultural productivity and the future of family farming in Eastern Europe. She came to Australia and spent 11 years in South Australia in research and consulting roles for State Government, CSIRO and the private sector. Prior to coming to Australia, Thea also worked in research and consulting – always in relation to agricultural development. Her work took her to Eastern Europe and Latin America. She likes peaceful pursuits like pottering about in gardens, painting and walking. She's done many New Zealand walks, has walked 550kms from France and across Spain, and has her beady eye on the Territorian Larapinta Trail sometime soon.

MR IAN LINLEY

Ian has worked within the primary industry sector in a variety of roles. He was a dairy producer (10 years) and cattle producer (20 years) in north east Victoria. Whilst farming, Ian also managed primary industry TAFE and higher education training campuses, programs and staff across northern Victoria. He then worked state-wide, supporting primary industry Vocational Education and Training in TAFEs and universities across Victoria.

In 2003 Ian worked with Bonlac/Fonterra dairy producers to assist them to develop quality, environmental and safety assurance plans and processes to enable them to produce industry

accredited Food Safety Plans. Since then Ian has worked as a State Industry Landcare Coordinator with DAFF's National Landcare Program, now known as the Caring for Our Country Programme in Victoria and the NT. This aims to support primary industry to develop profitable and sustainable farming systems. Now, for something quirky that not many people will know about Ian: when at university Ian debated the need for ultra marathoners to have lavish ground support crews. To prove his point Ian ran from Melbourne to Warrnambool and back (over 600kms) with no support crew and his $s in his sock. As Ian ages he wishes he had never done it.

MR PETER DELIS

Peter is currently chairman of the Australian Mango Industry Association, the AMIA. Peter has had a long history in the mango history, developing his family farm into one of the largest, and developing one of only 2 vapour heat treatment (VHT) plants in Australia, here in the Top End. He has held leadership positions in the NT, and at national level with the Australian Mango Industry Association. He's pretty busy these days, with some suggestions that he could do with a return to mango farming, as he'd have more time as a grower. Peter brings unique innovative business perspectives to many issues. Today, he'll give an overview of AMIA's R&D program and bring his perspectives to developing an R&D plan for the NT mango industry.

DR BOB WILLIAMS

Bob is the Science Leader for Horticulture and Forestry Science with the Queensland Government Department of Primary Industries and Fisheries. He's been engaged in a broad range of R&D endeavours geared toward supporting plant-based industries, here in Australia and overseas, and is now in a senior leadership and management role at QDIF. It was touch-and-go whether he'd make it out of cyclone ravaged Queensland for this event. Needless to say, we're delighted Bob made it. And perhaps Bob could shed a few things about himself by way of an introduction.

MR PETER MARKS

Peter is one of the early mango pioneering growers in the NT, coming from South Australia where the family farming business grew potato and onions. While he originally came to Katherine to grow potatoes and onions he soon switched to melons and mangoes and now has over 200 ha of orchard in Katherine. Peter is current NTMIA President and an AMIA board member. Peter's down-to-earth management approach is always a valuable contribution. Now, something that not many people will know about Peter is that he's a speed demon. He fancies himself as a closet racing car driver (the Stig?), and has been known to make it from Katherine to Adelaide in 21 hours. He recently spent an hour and a half in a fighter jet simulator, during which time he managed to fly under Sydney Harbour Bridge. He also took out Newcastle Bridge. Three times.

MR IAN BAKER

Ian was the NT Department's first perennial crops scientist in the very early days of the NT mango industry. He was the first CEO of the NTHA and spent the last 9 years involved in the management of Jabiru Tropical Orchards. He has extensive international consulting experience in many countries. His long experience across government research, industry and running a large orchard brings a unique breadth of perspective. Now, something that not many people will know about Ian, is his familiarity with druggie's measuring scales. Before any possible preconceptions of Ian's dodgy brother nature are confirmed, I should add that the job-lot of Vietnamese scales he procured, designed

(we understand) for use in relation to illicit substances, were actually destined for dry matter testing by Territorian mango growers. So, he really does have the industry's best interests at heart.

MR STUART H SMITH

Stuart is one of two Stuart Smith's in the Department, both of whom will be known to many of you here today. This Stuart is currently acting in the role of Director of the new Plant Industries Division in the Department of Regional Development, Primary Industries, Fisheries and Resources (DRDPIFR). Way back when, he studied agricultural science and business administration at the University of Tasmania. He has worked as a horticultural researcher and consultant in the export and processing vegetable industry in NW Tasmania for some 6 years, and as a Consultant and small business owner providing consulting services in agriculture and natural resource management for another 6 years. Since moving to the Territory, Stuart has worked as a merchandise manager and agronomist for Elders Darwin for 2 years, before joining the Department. Now, something that not many people will know about Stuart is that he had a beautiful soprano voice till 15.

MR PETER JOHNSON

Peter is based in Kununurra in the Eastern Kimberley, where he works for the Department of Agriculture and Food, Western Australia (DAFWA). He has a great deal of experience with mangoes and mango R&D, and has pioneered work on supply chain management and transport logics for mango export development.

Attachment 4

MANGO RESEARCH, DEVELOPMENT AND EXTENSION

NT PROJECT SUMMARIES

The below project summaries outline mango research, development and extension projects currently underway at the Northern Territory Government Department for Regional Development, Primary Industries, Fisheries and Resources (DRDPIFR), in the Plant Industries Division (formerly the Crops, Forestry and Horticulture (CFH), and Diagnostic Services (DS) Divisions, which are now amalgamated), and the Biosecurity and Product Integrity (BPI) Division.

PROJECT THE CROP FORECASTING PROJECT

Funding source: HAL - mango industry levy, and contributions from DRDPIFR NTG and participating growers (2005-2009)

Lead agency: DRDPIFR NT

Partners: HAL, AMIA, DRDPIFR NT, participating growers

Project Description: The Crop Forecasting Project provides an accurate prediction for the timing and volume of the Darwin, Katherine and Kununurra mango production seasons. For the first time, the 2007 season included the Burdekin and Mareeba forecasts, making it almost a true national forecast. The forecast is presented at the NTMIA pre-season forums as well as at the NT Horticulture Association's pre-season harvest and transport forums as a tool to effectively organize resources and avoid bottlenecks. Forecasts are generated from heat sums and flowering surveys submitted by growers in all regions. The surveys were made available on line in 2007 and will remain available in both on-line and traditional form for the 2008 season. The early forecast is generated based on historical average temperatures, and is subsequently updated fortnightly with real temperatures. The full set of mango crop forecasts is available on the Department's website, www.horticulture.nt.gov.au . This project, MG05004 is facilitated by HAL in partnership with AMIA. It is funded by the mango industry levy and by contributions from the NT Department for Regional Development, Primary Industries, Fisheries and Resources, and from cooperating growers. The Australian Government provides matched funding for HAL R&D.

PROJECT THE TOP END BETTER MANGOES PROJECT

Funding source: HAL - mango industry levy, and contributions from DRDPIFR NTG and participating growers (2006-2009)

Lead agency: DRDPIFR NT

Partners: HAL, AMIA, DRDPIFR NT, participating growers

Project Description: Entering its third and final year, this project looks at fruit transport and ripening systems to increase the Saleable Life Index (SLI) of the fruit. Based originally on the Queensland concept, it has focused on regional issues, particularly the longer travel time for fruit to get to markets and the disease loads inherent in longer transportation periods. Fruit from Darwin, Katherine and Kununurra can take anywhere from 6-10 days to get to market, sometimes 2 weeks. The supply chain systems used have been benchmarked. To date it appears that there is no "one size fits all" and what may be an advantage in one

situation is not necessarily in another. For example gas ripening pre-transportation can provide an advantage in some circumstances. However, in times of transport shortages, fruit can be kept on hold for considerable periods of time, in which case gas ripening on location provides poor outcomes. The benchmark for SLIs is set at 7 days. Fruit should be at least 60% ripe for 7 days before rots are visible, less than 7 days is a weak performance, 20 days is the ultimate goal. The 2007 season was dominated by weather effects, with rain providing high disease incidence in fruit that far outweighed individual differences in performance. This project, MG05005, is facilitated by HAL in partnership with AMIA. It is funded by the mango industry levy, by contributions from the NT Department for Regional Development, Primary Industries, Fisheries and Resources and from cooperating growers. The Australian Government provides matched funding for HAL R&D.

PROJECT DELIVERING MANGO TECHNOLOGY

Funding source: HAL - mango industry levy, and contributions from DRDPIFR NTG and participating growers (2007-2010)

Lead agency: QDPI

Partners: HAL, AMIA, QDPI, DRDPIFR NT, WA Ag

Project Description: The aims and intended outcomes of this project are to improve the profitability of mango production through the adoption of research findings and best management techniques in the field to the pack house. Regional steering groups of growers and packers have been established to provide direction for the project, notably to identify and prioritise the main issues and constraints to profitability. Through the regional steering groups, a participatory research approach has been fostered, with demonstration sites and on-farm trials, for example on nutrition and irrigation in the NT, to improve adoption and understanding of key management practices. As part of this extension-focused project, workshops and other information products, and an effective communication strategy, are geared towards improving the effective uptake of information by the mango industry. The project also offers a forum for exchange of information and experience between states, as well as 7 regions in Queensland, NT and WA.

PROJECT QUALITY MANAGEMENT TO ENHANCE EFFECTIVE SUPPLY CHAINS FOR MANGOES AND RAMBUTANS IN NUSA TENGGARA BARAT (NTB), INDONESIA AND AUSTRALIA

Funding source: Australian Centre for International Agricultural Research (ACIAR, 2008-2010)

Lead agency: DRDPIFR NT

Partners: Assessment Institute for Agriculture Technology (AIAT) – Nusa Tenggara Barat (NTB), University of Mataram (UNRAM), Provincial Agricultural Agency, Nusa Tenggara Barat (NTB)

Project Description: The project aims to develop effective, competitive supply chains that deliver high quality mango and rambutan fruit into profitable, higher value, markets from NTB. This will be achieved, through the improvement of pre- and post-harvest quality management strategies, linked to the development of effective supply chains penetrating markets in Indonesia and internationally. This project seeks to use known technologies in an adaptive research manner to improve pre- and post-harvest management and develop a more coordinated supply chain model to improve capability to access higher value market. Specifically, post-harvest strategies will be evaluated as a means of increasing mango shelf life, allowing fruit to travel further to export markets. On farm, Integrated Pest Management (IPM) approaches will be evaluated as a low technology means of controlling insects associated with fruit damage. Using this approach, the project will increase the capacity of the government to manage additional market access issues such as

Minimum Residue Limits (MRLs). New science emerging from this project will include protocols to control post harvest fruit rots, protocols and strategies to control specific pests and pathogens using low input systems which will be beneficial for the Australian mango industry. The project will address common key issues that influence mango and rambutan supply chain development in both the NTB and Australia. For both countries, key issues that will be addressed are supply chain development, with specific components of improving pre- and post-harvest fruit quality.

PROJECT FIELD EVALUATION OF STROBILURINS FOR THE CONTROL OF MANGO ANTHRACNOSE IN THE NORTHERN TERRITORY

Funding source HAL (2008-2009)

Lead agency DRDPIFR NT

Project Description The aim of this project is to reduce the major losses to mango production in the NT caused by *Colletototricum gloeosporoides* (causative agent of anthracnose) and stem end rots. This work was conducted in a commercial orchard with overhead irrigation to simulate rainfall and allow maximum disease pressure. Strobirulins (azoxystrobin and pyraclostrobin + metiram) and grower's standard treatments were sprayed in the field and combined with standard post-harvest treatments were evaluated in controlling post-harvest mango diseases.

PROJECT MANGO FLOWER INSECTS AND THEIR EFFECT ON FRUIT QUALITY IN THE NORTHERN TERRITORY

Funding source NT Government (2004-2007)

Lead agency DRDPIFR NT

Project Description In the last few years there has been growing concern about the effect of thrips and dimpling bugs in mango flower panicles. Growers were concerned that flowers contained a vast number of thrips and or dimpling bugs. To address this concern, the Department carried out trials on the flower panicles, following through any damage to the skin of the fruit, from fruitlet stage to post harvest. These trials, which were part of an ongoing IPM programme, were carried out during the flowering and fruit development from 2004 to 2007 and assessments of fruit quality were also made post harvest. The work culminated with intensive studies in Darwin during 2006 and Katherine in 2007. This work is continuing during 2008 as part of the ACIAR funded project on "Quality management to enhance effective supply chains for mangoes and rambutans in Nusa Tenggara Barat (NTB), Indonesia and Australia".

PROJECT MANAGEMENT AND CONTROL OF TERMITE PESTS OF HORTICULTURAL CROPS IN THE NORTHERN TERRITORY

Funding source NT Government (2001-2007, completed)

Lead agency DRDPIFR NT

Project Description The Giant Northern Termite (*Mastotermes darwiniensis* Froggatt (Isoptera: Mastotermitidae) is the most destructive species of termite in tropical Australia. In the NT, this species accounts for substantial annual production losses in horticultural tree crops and is also responsible for losses in vegetable and agricultural crops. Until recently the main product registered for use in horticulture against this pest was Mirant® containing the organochlorine mirex. An alternative chemical, fipronil, has been tested in on a range of crops, including a number of trials on mangoes. Based on the research results, assistance

was given to the Northern Territory Horticultural Association (NTHA) in applying for a Minor Use Permit from the Australian Pesticides and Veterinary Medicines Authority (APVMA) for the use of fipronil as a soil or trunk injection for control of *M. darwiniensis* mangoes. This permit was issued in July 2007. A Minor Use Permit for the use of fipronil in aggregation drums is also relevant to the mango industry and Minor Use Permits have now been issued by the APVMA for a number of other crops.

PROJECT DEVELOPMENT OF SPECIMEN BASED PEST LISTS FOR MANGOES IN ASEAN COUNTRIES

Funding source AusAID (2006-8)

Lead agency RMIT International Pty Ltd

Partners Office of Chief Plant Protection Officer (OCPPO), Australian Government Department of Agriculture, Fisheries & Forestry (DAFF), and DRDPIFR NT

Project Description For international trade, countries need to provide their trading partners with accurate lists of pests for each crop in accordance with the requirements of the Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement). One of the objectives of the recently completed "Strengthening ASEAN Plant Health Capacity Project (AADCP Project)" was to facilitate and support the establishment and updating of national and regional specimen-based pest lists in accordance this agreement. Participating countries decided at the outset that pest list survey methodology should be developed using mangoes, and at an initial workshop in April 2006 training was provided by 3 Australian collaborators to an entomologist and a plant pathologist from each of the ASEAN countries. Participants then had 22 months to plan and carry out surveys to develop the pest lists. During this time entomology and plant pathology support was given by mentoring visits to Cambodia, Laos, Myanmar and Vietnam, tailored training in taxonomy and a second pest list development workshop for all ten countries. The emphasis was on training in techniques for collecting, storing and identifying the specimens and a range of paper and electronic resource materials were supplied to each of the participants. An Excel based database and an online photographic web album were also developed. A final pest list workshop was held in February 2008 to review the project and collate findings.

PROJECT ELITE ROOTSTOCKS FOR IMPROVED MANGO PRODUCTIVITY

Funding source DRDPIFR NT (1998-2008)

Lead agency DRDPIFR NT

Project description The project consists of two sites in the Katherine district: Zimmin Drive, Katherine, on a shallow “Tippera” clay loam; and Fox Road, the Venn, on deep, sandy “Blain” red earth. All soil types in the district are characterised by high pH (vis. 8), but low conductivity and organic carbon. The Zimmin Drive trial has 64 stock treatments replicated with five, single datum trees and the Fox Road site has 100 stock treatments replicated as for the previous site. Treatments 1 to 64 are the same stock treatments for both sites as is the scion, which is Kensington Pride (Katherine Research Station clone ex Ian Curtis). Data has been collected for tree size ie: canopy area and trunk girths, fruit number/datum tree (counts/tree by 2 experienced mango workers and averaged), average fruit weight/datum tree and limited post-harvest data such as days to soft ripe from harvest, ^{0} brix and internal flesh colour and external colour/blush. After several years data collection from the Zimmin Dr. site, data more recently has concentrated on the 20 best and the 5 worst performing stocks from previous years. Likewise, not all treatments at the Fox Rd. site were studied as several poor performers have been excluded from more recent annual evaluations. Current reporting of this work includes: "Field Evaluation of 64 Rootstocks for Growth and Yield of 'Kensington Pride' Mango" published in HortScience Journal . Past years data sets are reported in the NT DRDPIFR Technical Annual Reports We

now have good data on the influence of rootstocks on KP scion and have a sub-set of promising stocks worthy of semi-commercial evaluation. Data collection from these trials has ceased and we are now securing elite stock cultivars as mother source trees. NT DRDPIFR would like to acknowledge the continuing support of the following collaborators: Ken Rayner, mango breeder and nurseryman; ~~A~~ Sevenfields, Katherine Farm and David Higgins, Greenvale Farm, Katherine.

PROJECT SURVEILLANCE AND RESPONSE TO AN INCURSION OF MANGO MALFORMATION DISEASE IN THE NORTHERN TERRITORY

Funding source DRDPIFR NT (2007-on-going)

Lead agency DRDPIFR NT

Project Description Symptoms of mango malformation disease (MMD) were detected on a research station near Darwin, Northern Territory (NT) in November 2007. A fungus, *Fusarium mangiferae* known (with other *Fusarium* species) to be associated with MMD overseas was isolated. MMD occurs in most of the mango growing countries of the world, and is listed as an emergency plant pest (EPP) in the National Mango Industry Biosecurity Plan. The site was quarantined and since the mango block had been used in mango breeding programs and as a source of budwood material, extensive traceback / traceforward procedures were instigated. Surveillance showed that twelve trees of about 2000 in the mango block displayed symptoms. Subsequently, all mango trees on the station were removed. Commercial orchards in the immediate vicinity were surveyed but no symptoms of the disease were detected. Associated trees on properties that had received propagating material from the research station were examined and owners requested to notify the Department if unusual symptoms were observed. Information leaflets on the detection of this new disease of mangoes were produced and distributed widely. Mango farmers and owners of backyard trees throughout the Territory were asked to check their trees and report any unusual symptoms. There is ongoing surveillance for MMD across the NT. Suspect samples of deformed mango shoots or flower panicles are presented to the Diagnostic Division for analysis.

PROJECT DIAGNOSIS OF MANGO MALFORMATION DISEASE IN THE NORTHERN TERRITORY

Funding source DRDPIFR NT (2007-on-going)

Lead agency DRDPIFR NT

Project Description Mango malformation disease (MMD) was discovered in Darwin, Northern Territory (NT), in November 2007. It is recognised as one of the most serious diseases of mango (*Mangifera indica*) worldwide. MMD is listed in the National Mango Industry Biosecurity Plan as an emergency plant pest (EPP) (http://svc218.wic010v.server-web.com/project_documents/uploads/Mango%20IBP.pdf). Fruit yield can be reduced by up to 90%. It also impacts in the propagation of trees, as infected seedlings cannot be used for rootstocks or infected trees as a source of budwood (Ploetz 2001). The disease is characterized by two distinct stages of malformation; vegetative and floral. Swelling of vegetative buds in the leaf axil or at the apex of seedlings and the production of small shootlets bearing small, scaly leaves with a bunch-like appearance comprises the vegetative malformation. In a malformed inflorescence, the flowers are enlarged and crowd the hypertrophied axes of the panicle, thus bearing no fruits or fruits that are aborted early (Kumar & Beniwal 1987, Kumar *et al*. 1993).

MMD has been shown to be caused by the fungi *Fusarium mangiferae* (Britz *et al*. 2002, Freeman *et al*. 1999), *F. sterilihyphosum* (Lima 2006) and two new, as yet undescribed, species of *Fusarium;* one from Mexico (Rodríguez-Alvarado *et al*. 2007) and one from Brazil (Lima 2006, Lima *et al*. 2006). It is believed a different species of *Fusarium* is associated with MMD in Malaysia. However, as there are only three isolates, the authors (Britz *et al*. 2002) considered this collection insufficient in number to justify a formal description of a new species. Bhatnagar & Beniwal (1977) reported *F. oxysporum*, which does not belong to the *G. fujikuroi* species complex, as a causal agent of MMD. However, according to Ploetz & Prakash (1997) and Ploetz (2001), the causal role of this species has not been clearly demonstrated. Also, Bhatnagar & Beniwal's report has not been corroborated and may be due to the misidentification of the pathogen. According to Leslie *et al*. (1995), ten isolates of *G. fujikuroi* associated with MMD in Malaysia and belonging to the *D* mating population probably should be classified as *F. proliferatum*. Although those authors have not positively identified the isolates as *F. proliferatum*, Marasas *et al*. (2006), based in Leslie *et al*.'s paper, included *F. proliferatum* as one of the species associated with MMD. There is an ongoing surveillance of MMD. Diagnoses are done based in DNA sequences of three genes (EF, Beta-Tubulin and Histone-3) of *Fusarium* cultures isolated from deformed mango shoots and flowers. The plant pathogenic fungus *Fusarium mangiferae* was found to be associated with MMD in the Northern Territory.

Attachment 5

OVERVIEW OF MANGO RD&E INVESTMENT PRIORITIES IN THE NORTHERN TERRITORY

Prepared by the Department of Regional Development, Primary Industry, Fisheries and Resources

Mango RD&E priorities in the Northern Territory aim to integrate industry needs, environmental and community concerns, in order to facilitate and enable industry development. Importantly, they aim to reflect and further the Departmental priority for regional development. The mango RD&E priorities were scoped and defined by staff of the Crops, Forestry and Horticulture, and Diagnostic Services Divisions who are engaged in mango RD&E.

Key priorities identified for mango RD&E relate to:

- Water and irrigation
- Adapting to climate change and variability
- Supply chain management and quality management
- Orchard management
- Extension for the mango industry
- Mango industry statistics

WATER AND IRRIGATION

Why this is a priority	*RD&E areas*
▪ Recognition of limited water availability ▪ Water allocation planning processes underway, and require science-based input ▪ Growing regulatory demands ▪ Link to land clearing for industry development	▪ Relationship between water use, and yield and quality ▪ Water use requirements for different varieties and soil types ▪ Water use efficiency, irrigation efficiency and best practice irrigation ▪ Role of rootstocks

ADAPTING TO CLIMATE CHANGE AND VARIABILITY

Why this is a priority	*RD&E areas*
Lack of knowledge of: ▪ Impacts of increased climate variability on mango physiology - vegetative growth, flowering, fruiting, and on pests and disease ▪ Impacts of increased climate variability on mango crop productivity and profitability ▪ Adaptation approaches to increased climate variability	Understanding impacts, and how to manage impacts on: ▪ Crop production of higher CO_2 ▪ Vegetative flushing, flowering initiation and induction, and whether trees mature quicker ▪ Heat sums and timing of flowering and fruiting ▪ Pests and diseases ▪ Potential for new cultivars and breeding

SUPPLY CHAIN MANAGEMENT AND QUALITY MANAGEMENT

Why this is a priority	*RD&E areas*
▪ Dollar impacts to industry of, e.g. anthracnose and stem end rot, are significant ▪ Post-harvest management is key to quality ▪ Food safety and consumer concerns	▪ Evaluation of chemicals, e.g.: strobilurins ▪ Evaluation of chemicals for leaf hopper control ▪ Efficient chemical use of fertilisers, herbicides, fungicides and pesticides ▪ Coordinated extension and training for pickers, packers, wholesalers and retailers to address dollar impacts to industry of, e.g.: anthracnose and stem end rot

ORCHARD MANAGEMENT

Why this is a priority	*RD&E areas*
▪ Production efficiency is being driven by declining terms of trade (cost-price squeeze) ▪ Sustainable production is being driven by environmental and community concerns	Sustainable production RD&E: ▪ Production efficiencies in input use ▪ Relationship between chemical use and environmental and water quality ▪ Integrated Pest Management ▪ Canopy management: managing growth to achieve best yield and quality outcomes

EXTENSION FOR THE MANGO INDUSTRY

Why this is a priority	*RD&E areas*
▪ Non-adoption of available knowledge constrains industry development ▪ Capacity building to adapt to on-going change is an on-going need ▪ Need for extension as a 2-way process to understand industry priorities for RD&E	For greatest outreach and highest impact: ▪ Capturing grower knowledge, and disseminating via best practice grower groups and benchmarking approaches ▪ Capturing and disseminating knowledge via new e-extension approaches: CDs, DVDs, web, YouTube

MANGO INDUSTRY STATISTICS

Why this is a priority	*RD&E areas*
▪ Robust up-to-date mango industry stats are key to RD&E design and to targeting effort ▪ Non-English Speaking Background sector not currently represented	▪ Improved knowledge of industry structure would inform extension approaches to achieve greatest outreach and highest impact ▪ NESB sector is an extension priority