



USAID FIRMS PROJECT

Pakistan Mango Growers Visit to Australia

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Abstract:

This report describes the trip taken by Pakistani mango growers to Australia. It discusses the participants' observations and the lessons learned that will help in improving their production in Pakistan.

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Executive Summary

Key Findings:

1. Quality

Quality is the key focus of the trip's lessons – pre harvest and post harvest. A key issue for Pakistan is to do a quality defect analysis, accurately identify what diseases exist post harvest, maintain cool chain, and develop management to increase % export. The initial focus will be post harvest treatments, but the trip shows quality is created in the field pre harvest. Cool chain management and control of ripening is a key success factor. Alternatives to the use of carbendizum may be required.

2. Nutrition

Nutrition on alkaline soils is a key issue possibly contributing to Sudden Death susceptibility. High alkalinity will be creating significant nutritional stresses particularly in trace elements like zinc.

3. Market driven R&D

Market driven programs that drive technology will be the main issue for Pakistan. The tour showed the benefits of good market based R&D by government. For Pakistan, a focus on Europe by sea, higher end Arab markets, extending the season domestically, and domestic supermarkets are likely market opportunities.

4. Technologies from other areas

Some technologies from other developing countries may be appropriate e.g. fruit bagging for quality, soil drench imidicropilid for insect control, fruit fly post harvest fenthion, cold post harvest fungicide dips/sprays if possible.

5. Varieties and rootstocks

Long-term research by government is required for varieties that are suitable for export and for rootstocks suitable for alkaline soils. This could include a long term breeding program using the Australian program as a guide.

6. Role of the Pakistan Mango Association

A number of industry driven initiatives were discussed.

The key industry issue is the development of a Strategic Plan for the Pakistan mango industry driven by the industry and including key stakeholders like growers, wholesalers,

exporters, juice processors, funding agencies, and government and university scientists. This will provide an important background for funding bodies.

7. Relations with ASLP

The trip facilitated better understanding between ASLP and Firms. There was resolution by both to improve co-operation. Firms has a strong commercial focus and ASLP has a strong research focus. Both are complementary to each other.

1. OBJECTIVES

1. Plan and arrange itinerary for Pakistan mango growers, packers and exporters in Queensland including:

- Growing and packing in the Burdekin, Bundaberg and Mareeba areas
- Brisbane and Sydney markets
- Irradiation and VHT export facilities
- Contact with relevant research in Australia including ACIAR researchers in Pakistan

2. Organize and book transport and accommodation and suitable Halal catering where possible.

3. Provide strategic analysis for the group in understanding production, post harvest handling and marketing systems in Australia.

4. Travel with the group in Australia as tour guide.

5. Provide an overview of the Australian mango industry and the key issues that might be relevant to Pakistan growers, packers and exporters.

6. Assist to interpret technology used in Australia and the economic and marketing environment that gave rise to technical developments.

7. Assist the group in any personal issues in Australia wherever possible to make the visit satisfying for all participants e.g. in areas of medical, banking, etc.

2. KEY LESSONS LEARNED BY PARTICIPANTS

We held regularly debriefing sessions so that tour participants could learn from each other. Different growers see different aspects – learning from what each saw was an important part of the tour.

At the final de-briefing session participants were asked:

- What tour participants learned and
- What they will change in their current farm practices as a result of the tour.

- ██████████
- Need small trees for better quality,
 - More plants/ha with small varieties and pruning,
 - Reduce tree size for ease of spraying/better quality, but taking into account frost,
 - Develop a sprayer for larger trees as seen at Peter La Ferve's farm,
 - Spray pot nitrate 2-3 times in 7 days for flowering,
 - Install under tree irrigation (drip/sprinklers) not flood irrigation,
 - Use more Cabrio top in the field (max 2 sprays), with mancozeb every 10 days,
 - Use Scholar post harvest, fungicides in hot water.

Very grateful to Firms for the mango project and this trip.

- ██████████
- Treat orchard as individual trees especially diseased trees - Sudden Death,
 - Make some blocks as smaller trees – prune to reduce size,
 - Use more trace elements,
 - Persist with European market to meet specifications.
 - Give more time to managing the farm like Australian farmers do.

- ████████████████████
- Spraying systems and better chemical use especially Cabrio Top,
 - Stop using manure to manage nutrition better,
 - Develop more mechanization – over next 5 years, co-operate to design and make in Pakistan,
 - Use bigger harvest bins and forklift attachments to tractors to improve handling,
 - Pack lines – improve pack shed management,
 - Install despatch conveyors in pack shed.

- Apply technology in Pakistan - different market, different environment - we have to adapt what is good for our environment and our market,
- Improve disease management is a key learning,
- Install a desap conveyor,
- Need to get grader/sizer working better, get Australian assistance to get sizer problems fixed.
- Meeting ASLP staff was very useful for networking.

Thanks to FIRMS project for sponsoring a very valuable tour.

Dr. Waqar Ahmad

- Adapt lessons learned to conditions in Pakistan,
- Improve farm practices, Australian farmers work in the fields,
- Nutritional lessons important- especially zinc, timing etc., making trees susceptible to Sudden Death
- Rootstock and scion research – long-term work by government.
- Market linkages important – same market system in Australia as Pakistan – wholesalers, cool chain management is much better but still needs to improve in Australia,
- High level of good R&D by government.
- Opportunities for market supply to Australia out of season.
- Need to develop ASLP and FIRMS linkage- ASLP is good on research, FIRMS is good on commercial development.

- R&D is a big factor in Australia – need to improve R&D in Pakistan and need more R&D for FIRMS project.
- Need continuous improvement of farm systems – Australian farmers always improving, always changing, need to structure R&D better in Pakistan and adopt new technology.
- Focus on market base for technology development.
- Focus on Europe and Middle East markets for Pakistan – best options, what technology do we need for these markets?
- Farmers in Australia develop equipment to meet their needs.

- Improvement begins with the farmer; Australian farmers very focused on all aspects of their business and focused on continuous improvement. Farmers know all aspects of their business.
- Implement changes to improve fertilizer and pest control.

3. KEY ISSUES IDENTIFIED

The key issue for investment in any development is to start with the market, and then define what technology is appropriate or required for the market and for the economics of a profitable supply chain.

The key question chain is:

1. Which markets (domestic, export processing) do Pakistan mango growers have a competitive advantage (time, proximity, price, quality) in?
2. What are the economics of supply?
3. What is the supply chain (time, specifications, and packaging)?
4. What are the requirements of these markets especially in terms of quality, storage life, MRL (residues) and if necessary phyto-sanitary requirements?
5. Develop appropriate technology - design an R&D program to meet market and economic requirements e.g. shipping time, grade standards, MRL's, maximizing export %, phyto-sanitary requirements.
6. Invest in appropriate technology (on and off farm) for a profitable supply chain.

The key issue in Pakistan appears to be to find a price for mangoes that makes mango farming more profitable. There are deficiencies in production systems but farmers cannot invest in improved technologies if they are unprofitable. The first issue in flooded markets is to find a price that is profitable i.e. identify a profitable supply chain.

The first principle is to identify:

- what markets,
- the economics of the markets and the supply chain required,
- develop technology appropriate to profitable supply chains.

The relationship between markets – economics – technology is the key consideration.

Technology is only relevant to a profitable supply chain. There are always lots of technical problems – the only relevant problems are those that relate to profitable supply chains. It may be profitable to use low technology to supply very low quality fruit to the Pakistan market but not appropriate to produce quality fruit for this market, as there is no price/economic advantage to pay for better technology to produce high quality.

One option may be extending the season in the Pakistan market earlier and later using a range of technologies including:

- location
- management for earlier or later flowering e.g. paclobutrazol + potassium nitrate
- early and later varieties

Australia has used location, varieties and management to extend the season, expanding the domestic market with a season from September to March.

The local Pakistan market is very large and will pay a high premium outside of the normal season. Extending the season earlier or later will be a significant market initiative. The local market is the cheapest and easiest market to develop. Longer supply times earlier and later also become relevant to longer supply periods for export markets e.g. Sindri variety in Sindh is a very good export variety – how to extend this season?

Supermarkets will be a developing market for better quality mangoes that will inevitably grow in Pakistan. The inevitable trend is that as the middle class grows, they will increasingly shop at supermarkets. Customers are prepared to pay a higher price for the convenience and better conditions in supermarkets. This trend is worldwide and inevitable. Supermarkets will be a market segment in Pakistan that will pay a higher price for better quality. Meeting the quality specifications of supermarkets will become important in technology development.

There may be regions in Pakistan that don't have mangoes in their regional markets at sometimes of the year. This is often a cheap and easy market to develop at low cost.

Alternatively it may be that supplying European markets by sea freight is profitable and the project needs to look at what technologies are appropriate to that supply chain. Supplying the European market by sea freight will undoubtedly involve a cool chain and strategies to minimize post harvest disease losses. This will include both pre harvest technologies (spraying, pruning, inoculum reduction), and post harvest technologies (post harvest disease control, cooling, carton design).

The European market seems to be a good prospect given proximity for sea freight, no phyto – sanitary requirements, low cost of production and timing of Pakistan supply. The USA market based on irradiation is likely to remain small as it is dependent on expensive airfreight. It is highly likely the Arab market will grow significantly with prospects for high priced segments especially into international supermarket chains. Pakistan has a distinct advantage later in the season after Indian production has finished.

It may be that the most profitable market is supplying India after the Indian season is finished. This may require political discussions and some post harvest research in combination. It could also require a quarantine/disinfestation R&D component. The Indian market will be a low cost market, with very high demand, able to pay good prices for good fruit out of season, and familiar with Pakistan varieties/taste.

All technology is only relevant to a profitable supply chain. Technology is irrelevant by itself. Identifying the market then developing appropriate technology for a profitable supply chain is the key issue.

It is not clear if there has been a good market basis for the current efforts by various agencies, rather the work is driven by the interests and assessments of individual scientists and growers. There may be a benefit to establish a strategic plan for development of the Pakistan Mango industry that is the framework for R&D. It will be beneficial to undertake some market and economic analysis to contribute to this process. This could be an area funding agencies should consider supporting and funding.

It is clear there are some technical areas where a lack of experience limits adoption of technology e.g. using carbendizum cold rather than mixed with hot water, using blast coolers but not forcing air thru cartons, poor sizer technology.

Appropriate technologies from developing countries (Indonesia, Thailand, Mexico, Philippines) may be more appropriate to Pakistan than Australian technology. Examples include:

- Fruit bagging for quality and pest control as done in Asia.
- Post harvest cold dips for disease control as developed in Australia for Indonesia.
- Fruit fly dips/sprays (fenthion, dimethoate) for fruit fly control as for Australia.
- Actara /Confidor trunk drench as developed for Indonesia for sucking insects. Actara/Confidor may also help to control the beetle that spreads Sudden Death pathogen.

4. PRODUCTION SYSTEMS

Australian experiences that may be relevant

Pre harvest production is the key to good post harvest and market results. Post harvest technologies can only preserve the quality created pre harvest.

It is not clear if a quality defect analysis has been conducted to identify what are the key quality constraints in Pakistan mango production.

Defect analysis assesses causes for quality downgrades for varieties x region x time of harvest over 2 or 3 years. This is the basis for developing strategies to solve quality issues pre and post harvest. This will identify and quantify issues like:

- the amount and types of post harvest diseases,
- latex marks.
- harvest and transport damage.
- the % class 1 pack out and reasons for downgrading to Class 2. Management techniques to maximizing % class 1 for export is a key factor in profitability of export.
- role of fruit fly- it may be that fruit fly is not an issue early in the season but critical late in the season.

Defect analysis is a simple, essential first step program that is the basis for planning any program to improve quality or to enter export markets.

4.1 Nutrition

Alkaline soils and poor water quality will create many constraints for Pakistan mango production particularly for zinc and boron. Soil tests are the best guide followed by judgment by the farmer.

Poor nutrition and alkaline soils may be contributing to Sudden Death. In Australia on alkaline soils, tree and branch death is common, caused by zinc deficiencies that can only be corrected by foliar applications (not soil) of zinc sulphate at 1% (10g/liter). Work by FAO in Saudi Arabia has alleviated problems caused by sudden death by a good zinc nutrition program.

Calcium is a very important element widely used in Australian mango production at very high levels. Fine particle size gypsum (spread or banded before flowering) and soluble gypsums applied through irrigation during fruit growth, are the main products used. Rates are high at 5-10kg/tree of fine gypsum. It is essential to maintain the Ca:Mg:K balance. Calcium is applied before flowering, and during fruit development. Magnesium

will be applied when needed but care needs to be taken with Mg applications, as the effect can be as deleterious as high nitrogen. Soil tests give the best way to decide applications.

Managing nitrogen is critical for best quality. Nitrogen is required for high production. Removing mulch under trees is important to control nitrogen. Low organic matter soils are best as mangoes perform best on poor soils. No Australian farmers use manures on mangoes. All mangoes are on low organic matter soils (0.5%-1 %) and growers remove under tree mulch to control nitrogen nutrition.

Nitrogen is applied immediately after harvest to encourage a flush along with hedge pruning. This may be as mixed fertilizer (400g-1kg/tree) and/or foliar sprays of potassium nitrate (2%), calcium nitrate (1-2%) urea (1%) and zinc sulphate (1%).

Some nitrogen is also applied before flowering generally as 2-3 foliar sprays in 7-10 days as 2% potassium nitrate. Some growers continue with up to 4-6 sprays up to fruit set, and some apply nitrogen as a soil application 1 month before flowering.

Potassium is usually applied during fruit development as potassium sulphate at 500g-1 kg /tree applied over 2-3 applications as a soil application.

Boron is applied at the rate 20-50g/tree of Solubor before flowering thru irrigation or with weed sprays. It can also be sprayed prior to and during flowering at 1 g/liter solubor.

4.2 Irrigation

Australian farmers all irrigate using under tree sprinklers for best placement of water, not flood irrigation or furrow irrigation.

Rates vary considerably farm to farm. In general less water is better for best quality. Many farmers reduce water application close to harvest for better quality.

Rain at harvest is a big problem increasing anthracnose post harvest, and causing skin browning marks as skin softens. Rain at harvest also makes scald damage from hot water treatments (52C x 5 mins.) much worse.

4.3 Pest control

The main issue in Australia (and most countries) is post harvest disease control. Information from [REDACTED] showing significant rots in Pakistan fruit (Chausa) stored 20 days after hot water dipping indicates the control strategies for disease control are not adequate for sea shipment. It is clear Sindri variety is much more resistant than Chausa.

In Australia the main strategies are:

1. Farms located in dry areas (no rain flowering to harvest) show low levels of disease. Rain at harvest is a very big risk.
2. Varieties differ in resistance e.g. Keitt has good resistance, KP is susceptible.
3. Long supply chains increase disease and different diseases become prevalent (more Botryodiplodia). Short chains reduce disease expression, especially fruit ripened quickly with ethylene.
4. Cool storage temperature (12C - 20C) reduces disease levels. Above 22C, disease incidence is high.
5. Pruning to reduce inoculum and facilitate spray penetration.
6. Small trees for spraying either pruned to 4m high or natural dwarfs like Keitt, Palmer, Brooks, and Calypso.
7. Pre harvest disease spraying control using protectants (10-14 days mancozeb, Dithane, or copper) + strobilurins (2 applications Cabrio, Aero, or Amistar). Wet areas also spray 1 application Octave (prochloras) at flowering.
8. Post harvest hot water (dip or spray at 52C) + Scholar (fludioxinol) or cold dip/spray Scholar or Prochloras (Sportak). For areas with high levels of stem end rot (Botryodiplodia spp), hot water (dip or spray 52C for 5mins) is essential.

In Pakistan there appears to be very few of these strategies utilized other than short supply chains for domestic markets. Recent work on hot water dips in Pakistan may be failing (in susceptible Chausa variety) because these are most effective with the chemical (e.g. carbendizum, fludioxinol) mixed with hot water. Where stem end rot (Botryodiplodia spp) levels are low, cold sprays of Scholar or Sportak are effective for anthracnose control. A key issue for Pakistan is to identify what are the post harvest disease species.

The standard pre harvest disease control program includes preventative copper or dithane (mancozeb sprays every 10-14 days with strobilurins (Amistar, Cabrio, Aero) applied twice – usually at fruit set and 3 days before harvest.

Spraying in Pakistan is by hand gun spraying on very large trees. This is ineffective coverage and an OHS risk to workers. Spraying in Australia is to small trees heavily pruned using air blast sprayers, preferably with fans mounted on a vertical boom. Spray effectiveness is a major reason why Australian farmers have pruned trees to maximum 4m and prune heavily inside the tree for spray penetration.

Insect pest control is based on the identified pest. Pest scouts are used to monitor pest populations. The most common spray programs for insect pests include:

- Mango Scale - Supracide, Applaud, Admiral, Movento,
- Thrips, Caterpillars, Seed weevil, Hoppers - Lorsban, Carbaryl,
- Fruit Fly – Dimethoate

Soil application of Actara or imidicropilid may control many sucking insects in Pakistan – hoppers, scale, thrips and may assist control of the beetle that spreads Sudden Death pathogens.

4.4 Pruning

Australia has moved to small trees for high quality, for better spraying, easier harvest and for ease of harvest to minimize latex marks. Large trees have high yield but low %class 1. In Australia there is no profitable market for class 2.

All growers hedge prune by machine with no need for fungicide on cut surfaces. Sunburn is an issue and in Pakistan white water based paints will be required to prevent sunburn on major limbs.

Australia had large trees but quality demands increased, with a move to smaller trees – less latex damage, better spray cover, less wind damage. For Pakistan, it may be possible to sort out good quality export fruit at the pack shed and still send second class to the domestic market. In Australia there is no demand for second class fruit.

4.5 Harvesting

Septone Mango Wash detergent is the best for desapping. The critical issue is to ensure sap does not contact skin. It is the initial spurt sap that causes browning. Australian research shows ooze sap does not contain the terpenoids that cause skin browning.

Either field desap using picking aids (with mango wash) or pick into crates and desap onto pack line desap conveyor. A new system is to use cherry pickers with a soap spray for picking. Fruit are plucked straight into the soap spray. This is especially beneficial for large trees as in Pakistan. Cherry pickers dramatically improve labor efficiency as pickers don't walk or climb to find fruit (wasted time), the cherry picker moves the picker to the fruit. Picking efficiency and quality is much higher on small trees with high yields.

For quality fruit in Pakistan it is necessary to pick with cut and hold secateurs then desap probably in the shed. Desap conveyors as seen in Australian sheds may be relevant, replacing current rack system.

Australian farms use labor saving devices like bulk bins (400kg) and forklifts to handle fruit to minimize lifting and improve labor efficiency.

4.6 Post harvest systems

The main issue is disease control. In Australia hot water (52C x 5 mins) + fungicide (Scholar – fludioxinil) is the main post harvest (pack shed) control for anthracnose and stem end rot. Where stem end rot is low, cold Scholar or Prochloras (Sportak) is sufficient for anthracnose control as a 1-2 minute dip or a spray post harvest. For hot water treatments, fungicides are added to hot water, not as used in Pakistan.

It is important to note that carbendizum as used in Pakistan is banned in Australia and USA. This is a key threat especially into Europe where MRL's are closely monitored. Research is required to look at alternatives to carbendizum. The chemical options are:

1. Scholar (Syngenta - fludioxinil) at 160ml/100Liters at 52C for 5 mins if Botryodiplodia present.
2. Scholar at ambient at 260ml/100L if stem end rot levels are low, mainly anthracnose, as a pack line spray (1.2L/sec/sqm) for 1-2 mins or a pack line dip for 2 minutes. Sprays are better because volume of chemical used is lower.
3. Sportak (prochloras) at 55ml/100Litrer as a pack line spray. Not suitable as a dip as strips heavily.
4. Amistar is effective post harvest either hot or cold for anthracnose and stem end rot.
5. Cabrio (pycostrobillurin) may be effective as a post harvest treatment.

It is important to correctly identify the pathogens involved, particularly the types of stem end rot, as chemicals vary depending on species. All are effective against anthracnose.

Research work in Australia has shown Amistar post harvest is effective hot or cold and meets Codex MRL's. Amistar and Scholar do not appear to be available in Pakistan, but Cabrio (pycostrobillurin) is available. It may be worth looking at using Cabrio as a post harvest treatment with the withdrawal of carbendizum. Seeking registration of Scholar and Amistar may also be beneficial. The other alternative is to use Sportak (prochloras) as a cold spray.

All Australian pack sheds include a spray treatment of fenthion (Lebaycid 400pm) or dimethoate (Rogor 400ppm) to reduce fruit fly infestation. This is required in Australian domestic markets. It has proven to be very effective in eliminating fruit fly infestation. It is not sufficient to meet international protocols for fruit fly control (Probit 9). Residue levels for post harvest treatment are below established MRL's for field spraying these products. This may be a beneficial treatment for Pakistan to control fruit fly, especially for non phyto markets e.g. Arab markets, Europe. Some Australian farmers also use field cover sprays and bait sprays to control fruit fly in the field. However picking green hard fruit, infestation levels are low.

Sizers in Australia are mainly electronic, with each pack size over a range of around 50-80 grams with each fruit, with 2 gram weighing tolerance. There may be need for some assistance to resolve accuracy of sizers provided in the FIRMS project.

All pack lines include grading tables for sorting for quality. The future is in camera based systems for quality grading. In large pack sheds, the quality grading area is the most important part of the pack line. Small errors in quality grading e.g. putting Class 1 fruit in Class 2 can generate significant losses. The best pack sheds monitor quality continuously to ensure the grade standards are accurate. Most pack sheds require quality grading 4 ways – Class 1, Class 2, Juice fruit and reject fruit for dumping.

Carton design is critical for marketing success, particularly carton strength. The Australian industry now uses a 7 kg carton with locating lugs to ensure cartons are stacked very accurately on top of each other. Carton strength is only on the corners. Accurate stacking on corners using locating lugs reduces carton collapse by ensuring cartons are stacked accurately.

Cardboard quality is also critical for carton strength. In Pakistan where good quality cardboard may not be available, waxing the base will improve strength considerably. Cartons are also open top and vented ensuring good airflow for cooling and reducing CO2 build up inside the carton.

All fruit is transported on pallets (16-18 cartons high x 1ton) using strapping with corner posts or open netting. All movements are by forklift or pallet jack (electric pallet jacks more widely used).

4.7 Cooling, ripening and CO2

All growers cool fruit between 12-20C, some better than others depending on systems. It is well established that temperatures above 20C impair quality thru increased disease levels and poor skin color development during ripening. Australian systems are still improving in some areas, especially on farm forced air-cooling. Forced air coolers must force cool air thru the carton, usually by suction pressure with a supplementary fan, forcing air straight back to the condenser coils to be cooled and sent back to the room. It is clear that forced air systems in Pakistan need a supplementary fan to ensure all airflow is forced thru the carton.

Ripening is an essential part of marketing mangoes. Most Australian wholesalers now use ethylene ripening to evenly ripen fruit for sale. The main benefit of ethylene is even ripening in the carton. Australian buyers have specifications for the stage of ripening at purchase and wholesalers and growers use ethylene ripening to manage the stage of ripening at sale. There may be some benefits in reducing disease levels because fruit is ripened more quickly, before disease develops.

All ripening is done at 20C and 100ppm ethylene, preferably in a trickle system, though single shot systems are common. Key issues in managing ripening are:

- Fruit temperature must be 18-20C.
- Usually for 1- 2 days depending on the time in the season (2 days early in the season, 1 day later).
- Venting is essential in ripening rooms to expel CO₂.
- After ethylene exposure fruit must be maintained 18-20C.

Severe skin browning occurs if fruit temperature is above 22C when ethylene is introduced. Fruit should be forced air cooled to ensure fruit temperature in the carton is even and below 22C. Forced air rooms are also preferred for ripening as they ensure even ethylene distribution (and low CO₂) in the carton.

Exposure time to ethylene varies with fruit stage of maturity. At the start of the season 2 days exposure is required, at the end of the season fruit may not need ethylene.

Venting cool rooms, ripening rooms, and transport containers to remove CO₂ is critical. CO₂ levels in ripening rooms must be below 2%. CO₂ rapidly builds in rooms as fruit ripens. CO₂ is a critical issue to manage in mango supply chains. Recent work in Australia has shown severe skin browning with CO₂ levels in trucks around 20%, well above required level of 2%. CO₂ mixed with condensation on fruit creates carbonic acid which causes severe skin browning. High CO₂ alone (without condensation) leaves fruit green with poor yellow color development.

In Pakistan use of carbide at ambient temperature is likely to be increasing losses and may not be effective ripening. For export supply chains requiring high quality, forced air cooling using supplementary fans to force cool air thru the cartons is essential for even temperature. Temperature has a very big effect on CO₂ production. Cooling to below 14C is the best way to manage high CO₂ levels. At 18C, CO₂ rises to over 20% in trucks in Australia over a short period of 3-4 days. At 14C, CO₂ levels are 2%.

Forced air coolers developed as part of the FIRMS project may need a minor modification to include a supplementary fan to force/suck cool air thru cartons, with air directed straight to the condenser for cooling.

For long term sea transport low temperature below 14C will be required, especially to prevent softening. CA storage may also be required on sea journeys longer than 21 days. For long journeys Australian experience is to use step down cooling in containers first to 14C then reducing to 10C over time.

4.8 Varieties

For export, it may be beneficial to look at new varieties that are small trees for better quality, high quality % class 1, early or late maturing.

Palmer may be OK – small tree, high % class 1, resistant to sunburn.

Keitt will get too much sunburn.

Brooks will get too much seed germination.

5. PAKISTAN MANGO GROWERS ASSOCIATION

Phase 2 of the ASLP project includes a component to assist industry organizations. The Australian Industry has a strong level of industry organization nationally and regionally. This is supported by a mandatory tax on all mango sales that is used for Industry Research, Development and Marketing.

Industry organizations are critical for industry development. Decisions made by Governments and donor organizations are made in the absence of commercial knowledge and are often ineffective. Viable development requires strong industry input. A strong Pakistan Mango Growers Association is important for industry development to make financial support from government and donor agencies far more effective.

Possible work with Pakistan Mango Growers Association (PMGA) includes:

1. Look at pack lines to solve some practical issues e.g. problems with sizers, use chemicals in hot dip, better use of blast chillers.
2. Develop the Pakistan Mango Growers Assoc. (PMGA) as a lobbying body with professional staff. Seek funding from national and provincial governments to run a professional office in each region and nationally.
3. With government and stakeholders (growers, wholesalers, exporters), develop a strategic plan for development of the Pakistan mango industry that sets the basis for developing R&D plans for development.
4. Advise government on research and development priorities – form an advisory body to Minister at the national level and regionally.
5. Co-ordinate activities between agencies and projects e.g. between Firms USAID and Ausaid ASLP, or between Pakistan Govt. agencies e.g. Dept. Agriculture, Universities, Commerce Dept. etc.
6. Establish a positive profile of the mango industry in Pakistan by making good use of media relations – e.g. celebrate start of season, mango festivals, and export performance.
7. Associations Act to help distribute info – newsletters, SMS, pamphlets, farmer field schools, network of extension stations, national conference, work with exporters, stop use of carbide, website for export photos varieties etc., contact lists.
8. Conduct a regional program of activities for farmers.

9. Farmer Field Schools – facilitate farmers learning from farmers.
10. Invite technical and market experts.
11. Conduct a Pakistan Mango Industry Conference every 2 years.
12. Export market visits.
13. Closer relations with stakeholders e.g. Exporters Association., Wholesalers Association.
14. Levy on production for funding research and marketing.
15. Government to fund professional staff to conduct PMGA programs in line with Government programs.
16. Organize farmer visits within regions, to other regions in Pakistan, and to other countries e.g. Thailand, Mexico, Philippines – more appropriate technology.

6. SUMMARY OF KEY FINDINGS EACH VISIT

Brisbane Market

- Operation of wholesalers similar to Pakistan in terms of transparency and the type of trading. Wholesalers have better infrastructure (cool rooms ripening rooms).
- Observed a wide range of mango varieties and mango quality on display for sale.

ASLP Supply Chain Project

- Focus on higher priced markets in China and Malaysia – a number of trial shipments.
- Discussed disease control strategies in Australia.

Steritec Irradiation

Inside operation of an irradiation plant treating whole pallets of mango using cobalt irradiation source to meet international phyto-sanitary requirements (mainly New Zealand market).

Tropico Juice Processing

- Simple processing technology for mango juice.
- Systems to assess performance of growers supplying,
- Aseptic packaging for storage at ambient. Possible investment opportunity in Pakistan using Australian systems and technology.
- Mango processing affected by high cost of fruit purchase (\$A500-600/ton) and low recovery rate.

Derek Foley - Farmer/packer Bundaberg region

- Frost control using overhead sprinklers.
- Late varieties.
- Simple sizer using size rollers rather than more sophisticated electronic weight graders.
- Spraying equipment.

Ivan Philpot – Farmer/packer Bundaberg region

- Disease control in a higher rainfall environment.
- Inoculum reduction by pruning and remove mulch.
- Spray program including Octave and Strobilurins + protective copper/mancozeb,
- Using shade covers for higher quality.
- Spray hot water treatment (+Scholar) rather than hot water dip giving more accurate temperature control and uses lower amounts of chemicals.
- Weed control using glyphosate, Basta and small booms + electric pumps.

Calypso farm – Mark Letcher, Farmer Mareeba region

- Importance of new breeding programs focused on high yields (30 ton/ha), from small trees on high density and high percentage class 1 (80-90%).
- Competitiveness of new varieties in the market. Trend is for high yields, high quality, and small trees at high density for a market that demands high quality
- Range of harvest systems.
- New spray technology based on SARDI fans mounted on booms.

Alvis Brazalle – Farmer/packer Mareeba region

- Pack line operation and design using desap conveyors to replace rack system in Pakistan.
- high yields on poor performing varieties – using higher rates of nitrogen.
- Nutrition at the right time especially nitrogen, calcium, potassium, zinc boron.
- Remove mulch essential, mangoes are best on poor soils with low organic matter (0.5%-1%), no manures or mulches.
- Importance of nitrogen for high productivity.
- Blowers and rakes for removing mulch under trees – inoculum reduction and controlling nutrition.
- Late varieties especially Keitt, Brooks, Palmer. Trend to small trees, high yields and higher quality.

Kamai – Clare Joe Visini Farmer/packer Mareeba region

- Harvesting and desapping in the fired using Mango Wash (compared to desapping conveyors in the shed).
- Varieties especially late varieties like Palmer (no sunburn, no seed germination before harvest, high yields, high class 1 %, excellent skin color, small trees).
- Effect of cold temperatures at flowering on nubbins and fruit set.
- Pack shed operation and cool rooms including quality grading, hot water dip for disease control, sizer control, fruit stickers, palletizing.
- Carton design (with lugs) for accurate carton placement for maximum carton strength.
- Net wrap for pallets for transport.

Morris Cetnic – Farmer/packer Mareeba region

- Sizer – weights, tolerances and variances.
- Picking trolleys.
- Using same pack line for mangoes and citrus.
- Honey Gold variety.

ASLP and local research program Ian Bally and Mat Wienert

- Breeding program and large variety collection.
- Web sites for mangoes in Australia.
- Running a breeding program.
- Understanding heritability in mango gene pool.

TGT Horticultural Suppliers

Fertilizers, chemicals and equipment available from commercial horticultural supplier.

John Nucifora – Farmer/packer Mareeba region

- Nursery practices on farm – shade, distant from orchard, plastic pots, and no soil potting mix.
- Pruning – hedging and inside tree pruning.
- Keitt as a late variety – relevance to market in Australia for this region.
- Economics of mango production – include farmer wages, depreciation, return on capital
- Hospitality of farmers.
- Farmers learn a lot from farmers.
- Many issues faced are similar in Pakistan – low prices, over production.
- Possible effect of sprays on lenticel mark.

Etienne Theart – Farmer/packer/dried mango Mareeba region

- Pack line – especially hot spray system.
- Mango drying technology including mango peeler and slicer for drying.
- QA/HACCP systems – National Freshcare System including residue testing for MRL.

Diamond Starr

- High quality for Japanese market.
- Quarantine facility using Vapor Heat Treatment for Japan.

ASLP Production project – Dr. Chrys Ahkem

- Extensive brief on phase 1 & 2 of ASLP production project – sudden death, clean nurseries.
- Need to improve relations with FIRMS.
- Phase 2 – malformation, midge, irrigation, nutrition.

Peter La Ferve – Farmer/packer Burdekin region

- Large trees like Pakistan.
- Equipment for large trees – spraying and harvesting.
- Organic production.
- Changes in mango economics and markets.
- Well designed forced air cooling system.

John Patterson – Farmer/packer Townsville region

- Pack line technology.
- Growing mangoes on flooded soils – small trees, high yields, early.

Sydney Markets Southern Cross and Perfection Fresh

- Vertical integration is the new trend.
- Large investment in cold rooms and ripening rooms.

- Wholesalers critical to success of supply chains.
- Adding value to supermarket sales.
- Export opportunity to Australia.

7. The Australian Mango Industry

Total Production	40- 50,000 ton (5-7 million trays)
Total Value	\$80 million
Period of Production	September - March
Export	3-5000 ton (5-7%)
Main Export Markets	New Zealand, Hong Kong, Singapore, Arab States, China, Japan, Korea
Mango Imports	Mexico (Tommy Atkins) – June- August

Varieties

Kensington Pride – 70%
 Calypso – 20% (increasing)
 R2E2 - 5%
 Keitt – 2%
 Honey Gold – 2%
 Others -1%

Production regions

Northern Territory

3- 4 million trays
 September – late November
 Darwin and Katherine Regions

Queensland

2.5-3.5 million trays
 November – March
 Burdekin – Nov to Dec, 1.6 million trays
 Mareeba – Dec to March 1.8 million trays
 Southern regions Jan to March, 0.5 million trays

Western Australia

Oct – March, around 0.5 million trays
 Kununurra – Oct-Nov
 Carnarvon –Nov- Dec

Economics

Sale Price

Price varies with harvest time and quality \$14-18/7kg tray.

As high as \$50 in September, as low as \$5/tray for class 2 in December

Class 1 – \$20-50/tray

Class 2 – \$5-15/tray

Yields

KP – 3-10t/ha average 5.5t/ha

Calypso – 25t/ha

Keitt – 25t/ha

R2E2 – 5-7t/ha

Major costs

Growing costs – depends on productivity \$4.50-8/tray (approx. \$25-30,000/ha/year)

Picking Labor varies with productivity \$1.50-\$3/tray.

Packing Labor – \$1.20-\$1.50/tray.

Labor cost/hr. - \$22/hr. base rate. Supervisors – \$60-70,000/yr., Managers - \$100,000/yr.

Cartons – \$2.20/tray

Freight – varies with market and production region. \$1.50-2.50/tray

Depreciation - \$1-1.50/tray

Cost of capital at 6% - \$1-1.50/tray

Australian websites

- The mango growing guide is at <http://era.deedi.qld.gov.au/1647/> - download each chapter as a pdf
- The mango posters are at http://www.nt.gov.au/d/Primary_Industry/Content/File/horticulture/Mango_seed_weevil_poster.pdf (seed weevil) and http://www.nt.gov.au/d/Primary_Industry/Content/File/horticulture/Mango_scale_management_poster.pdf for the scale poster
- The pest, beneficial, disease and disorders field guide is at http://www.nt.gov.au/d/Content/File/p/Fruit/Mango_Field_Guide.pdf

Australian Mango Industry Assoc. www.mangoes.net.au

DEEDI (Queensland) www.deedi.qld.gov.au/horticulture

NT (Northern Territory) www.nt.gov.au/d/Primary_Industry/Content/File/horticulture

WA (Western Australia) www.agric.wa.gov.au

Mango research www.horticulture.com.au/industries/Mango

Varieties

- Kensington Pride – very good taste, low yields, low class 1 %, large trees
- Calypso – very high producing and very high % class 1, low brix, poor taste, excellent appearance, small trees
- R2E2 – large, red midseason for China export, low yields, low class 1%, low Brix, poor taste

- Palmer – late maturing, high yields, high %class 1, small trees, good taste, excellent appearance,
- Keitt – late maturing, high yields, sunburn susceptible, small trees
- Brooks – late maturing, high yields, high class 1 %, may get seed germination

New breeding varieties – 1243 (early maturing), 4069 (mid season)

Spraying

Fungicides

Anthracnose and Stem end rot – Dithane (Mancozeb), Copper (Copper hydroxide, copper oxychloride, liquid copper), Amistar (azoxystrobin – Syngenta), Aero (Cabrio, pyraclostrobin), Octave (prochloras).

Program

Dithane (or copper) sprayed 10-14 days from flowering to harvest up to 3 week withholding before harvest

Amistar/Aero – 1 spray fruit set, 1 spray 3 days before harvest.

Octave – 1 spray at flowering. Optional in wet areas.

Pruning and removing mulch under the tree are important for disease control. Pruning also helps spray penetration.

Insecticides

Mango Scale - Supracide, Applaud, Admiral, Movento,

Thrips, Caterpillars, Seed weevil, Hoppers - Lorsban, Carbaryl,

Fruit Fly - Dimethoate

Pest scouts are common particularly in Mareeba area

Fertilizing

No manure and no mulch for disease inoculum reduction, and to control nitrogen status.

Nitrogen – manage carefully and depends on varieties. Mainly 1 month after harvest and just prior to flowering either soil applied or foliar spray (potassium nitrate, calcium nitrate). In the range 100-300gN/tree total N per year. Potassium nitrate sprayed at 2% (20g/liter) just prior to flowering. Some growers apply 50-100 g N at 1 month before flowering.

Calcium – heavy use of gypsum (fine particle size) at 5-10 kg/tree/yr. and some use of soluble gypsum (Gypflo) thru the irrigation during fruit growth.

Phosphorus – very little use and soil levels are low. Mainly after harvest. Some applied foliar as Mono Potassium Phosphate at 10g/liter to harden vegetative flush.

Potassium – mainly during fruit development as 2-3 applications of potassium sulphate, total 500g – 1 kg/tree potassium sulphate.

Zinc – As a foliar spray, especially on alkaline soils, at 10 g/liter zinc sulphate heptahydrate. Some soil zinc applied on acid soils around 100-200 g zinc sulphate. Can also use zinc nails into the tree trunk. Chelated zinc soil application is used on alkaline soils.

Boron – soil applied via irrigation or with weed spray at around 20-50g solubor/tree, 1 month before flowering. Also some foliar sprays at 1g/liter during flowering

Copper – rarely used but may apply 100-200 g/tree.

Fertilizing programs differ with varieties e.g. small trees like Palmer, Keitt rates are lower. For Keitt nitrogen causes internal disorders.

Injecting through irrigation is commonly used for nitrogen, potassium and calcium especially during fruit development.

Foliar sprays are used especially Zinc, Mono Potassium Phosphate, Boron, potassium nitrate, calcium nitrate, some calcium foliar but not very effective.

Herbicides

Mainly glyphosate, some Basta.

Pruning

4 m high with hedging tops and sides – especially large vigorous varieties like R2E2, Kensington Pride (KP)

Dwarf varieties like Calypso, Keitt, Palmer, Brooks require very little pruning.

Reducing disease inoculum is important by hand pruning inside the tree and removing all mulch under the tree. Pruning is essential for spray penetration.

Pacllobutrazol

Pacllobutrazol (Cultar, Astar) is widely used for earliness and for higher production. Rates vary with high rates on vigorous trees and tropical areas (100+ml/tree) to low rates in cooler areas (15-20ml/tree). Dwarf varieties use very low rates (5ml) or may use none.

Post harvest treatment

Fruit fly – usually fenthion (Lebaycid- Bayer) sprayed at 400ppm for 10 sec at 1.2 L/sqm/sec. This is a required treatment for entry into some markets. Some growers apply dimethoate cover sprays starting 6 weeks before harvest.

Fungicides – different in different areas but the main 2 disease controls are for anthracnose and stem end rot. For anthracnose Scholar (fludioxinil - Syngenta) and Sportak (prochloras) are the main chemicals. For stem end rot the main control is hot water at 52C for 5 mins. In areas where both anthracnose and stem end rot is present Scholar is used in hot water. For other areas Scholar is used cold but at a higher rate or Sportak (prochloras).

Month Australia	Month Pakistan	Growth Stage	Fertilizing	Spraying	Pruning	Irrigation
January	August	End harvest. Vegetative	Nitrogen, phosphorus, zinc, calcium	Caterpillar	Apply cultar Hedge top and sides	Rain
February	September	Vegetative			Major prune inside tree	Rain
March	October	Vegetative	Spray MKP			Rain
April	November	Dormancy				Dry
May	December	Dormancy	Boron, nitrogen, spray potassium nitrate	Scale, thrips		Dry
June	January	Dormancy				Dry
July	February	Flowering	Potassium sulphate, calcium	Hoppers, fungicides		Irrigate
August	March	Fruit Set	Potassium sulphate, calcium	Fungicides, Amistar/Aero		Irrigate
September	April	Fruit growth		Fungicides. Hopper sprays in some areas	Light pruning inside tree	Irrigate
October	May	Fruit growth		Fungicides Fruit fly sprays		Irrigate
November	June	Harvest		Amistar		Dry
December	July	Harvest		Amistar		Dry

8. ANNEXES

8.1 Annex A – Itinerary of the Visit.

Tues 27 Dec.

- Arrival in Brisbane

Wed 28 Dec.

- Brisbane Markets, FAVCO – John Nardi
- ASLP Supply Chain Project, Tim Ximing Sun and Tony Cook
- Steritech Irradiation Facility

Thurs 29 Dec.

Drive to Nambour (1.5hrs.)

- Tropico Fruit Processing
- Drive to Childers (3 hrs.)
- Farms and pack house Derek Foley and Ivan Phillipot

Fri 30 Dec.

- Drive to Brisbane (4hrs.)
- Fly Brisbane to Cairns (2 hrs.)

Sat 31 Dec.

- Drive to Dimbulah (1.5hrs.)
- Calypso Farm Mark Letcher
- Alvis Brazzalle farm and pack house

Sun 1 Jan.

- Free day Cairns

Mon 2 Jan.

- Drive to Mareeba
- Morris Cetnic farm and pack house
- Kamai – Joe and Clare Visini farm and pack house

Tues 3 Jan.

- Drive to Mareeba
- ASLP and Mango research Ian Bally and Matt Wienert
- Etienne Theart farm, pack house and mango drying
- TGT Horticultural Suppliers
- John Nucifora farm and pack house

Wed 4 Jan.

- Drive to Mitchilba (1.5hrs.)

- VHT Export facility Diamond Star
- Drive to Townsville (5 hrs.)

Thurs 5 Jan

- Drive to Ayr (1.5hrs)
- ASLP Staff Dr Chrys Ahkem, Rowland Holmes

Fri 6 Jan – Drive to Ayr (1.5hrs.)

- Peter La Ferve farm and pack house
- John Patterson farm and pack house

Sat 7 Jan

- Drive to Cairns (4 hrs.)
- Fly to Sydney (3 hrs.)

Sun 8 Jan

- Free day, report writing

Mon 9 Jan

- Sydney Markets
- Southern Cross Wholesalers
- Perfection Fresh

Tues 10 Jan

- Wrap up meeting and report writing

Wed 11 Jan

- Return to Pakistan

Participants

Waseem Badozai

Zainul Abdin

Syed Wajahad Gardezi

Major Tariq Khan

Dr Waqar Ahmad

Umair Piracha

Junaid Shah

Ian Baker

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