
Working Paper Series

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*Improving smallholder farmer incomes through strategic market
development in mango supply chains in Southern Vietnam*

Activity: A2.3 Mango productivity and quality improvements in fresh
supply chains
Study focus - Demonstration chain
Evaluation of the financial impacts associated with enhanced
mango quality from farm to retailer in Southern Vietnam.

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Summary

This study aims to assess the cost benefits of on-farm sapburn treatment, hot-water treatment (HWT), and boxing of mangoes at the packhouse for mango value-chain stakeholders in Southern Vietnam. The goal of trialling these processes is to achieve improvements in shelf-life and overall quality of fruit, allowing farmers, packhouses, vendors and retailers to command a higher price for future harvests.

The trial focusses on the supply of treated, premium-quality mangoes for sale at four Ho Chi Minh City (HCMC) WinMart supermarket locations over a four-week period. The project team monitors the sourcing and treatment of quality fruit from the farm, its packaging and supply to the supermarket outlets, and its quality during its display. Survey data is also collected from value-chain stakeholders throughout the trial period.

The results show HWT is effective in providing partial disease suppression in the fruit, and the treated mangoes supplied for sale in specifically selected six-pack cartons were an attractive proposition to consumers. Encouraging results were further observed in relation to the value-chain, with stakeholders' willingness to adopt the new processes and commit to their use post-study noted.

The study also reveals consumers in a large city – such as HCMC – are willing to pay a higher price for treated, premium-quality fruit. For instance, the treated Cat Hoa Loc mangoes retail at VND125,000 per kilogram; almost double the price of untreated mangoes of the same variety and between five and ten times the price of other, less preferred, untreated varieties.

There are some limitations experienced during the trial, such as difficulty in sourcing a regular supply of high-quality mangoes from the farm. Supply shortages in week two of the trial result in the harvest of over-ripe fruit, negatively impacting the mangoes' shelf-life. The trial also demonstrates that while HWT is effective in suppressing disease to a point, it does not give complete disease coverage.

Recommendations:

- The supply of sapburn treated and HWT mangoes in six-pack cartons to be actively promoted amongst chain stakeholders.
- Further investigation into the improvement and standardisation of the HWT process.
- Develop a best-management practice guide to highlight the critical success factors in treatment, selection, and distribution of quality fruit.
- To further understand the price dynamics of the fruit trade in a commercial context.
- To deliver an industry-focussed workshop involving key mango-chain stakeholders engaged in the trade of mangoes from Southern Vietnam.
- Additional areas of investigation include:
 - explore the use of a PH fungicide alongside HWT in treatment protocols to bolster disease protection
 - encourage on-going record keeping of production practices and chemical applications
 - develop fruit maturity standards for Vietnamese mango cultivars, including ripening standards
 - promote the use of HWT technology at local packhouses
 - incorporate pre-ripening practices into the short chains to HCMC to optimise fruit ripening

1 Introduction

This study examines factors at the farm, packhouse, vendor and retail levels (see Table 1).

Table 1. Activity overview

Farm Level	<ul style="list-style-type: none">• Cost of the sap burn treatment.• Advantages of the treatment, such as improved quality and potential for price premiums (longer term) received for treated fruit compared to non-treated fruit.
Packhouse	<ul style="list-style-type: none">• Cost of HWT (equipment, labour).• Cost of packaging (cartons).• Potential for extending retail shelf-life and profitability of treated fruit.• Increased confidence in fruit quality; less wastage through deterioration.• Increased demand from pilot supermarket chain.• Examination of quality deterioration in transportation of fruit.
Vendor	<ul style="list-style-type: none">• Vendor experiences in supplying fruit to the supermarket.• Increased confidence in fruit quality, less wastage through deterioration.• Identification of any quality deterioration issues in the transportation of fruit.• Likelihood of adopting treated fruit into the future.
WinMart Retail	<ul style="list-style-type: none">• Price premiums for fruit retailed to the consumer.• Increased profit through higher returns, less fruit spoilage and longer shelf life.• Enhanced presentation in store (including boxing of fruits).• Increased potential demand (less time in-store) and increased turn-over (numbers).• Confidence levels in the product and willingness to expand retailing of treated fruit.

Source: Author's analysis

1.1 Overview

Research highlights the importance of freshness, appearance, food safety and taste as being among the highest priorities Vietnamese consumers consider when purchasing fruit. When selecting mangoes, consumers prefer yellow skin, yellow flesh and a sweet taste; all characteristics of the local mango variety Cat Hoa Loc. At the same time, the proliferation of supermarkets and mini-mart retail outlets across major cities – such as HCMC – have resulted in an emerging domination of market share towards modern retailers over traditional wet markets. Earlier research in this project shows consumers in the larger cities in Vietnam have increasingly higher disposable incomes and increased levels of fruit consumption.

The project identifies the potential benefits of enhanced mango quality and increased returns through the application of sapburn treatment and HWT to mangoes prior to retail supply.

Whilst previous research identifies the benefits of sap-burn treatment, this study aims to demonstrate that moving this process from the packhouse to the farm will help to significantly reduce the incidence of sap burn by treating it closer to the source. Similarly, we undertake HWT at the packhouse prior to the fruit's arrival at the retail outlet; analysing the resultant consumer sentiment and retail performance. By performing this study under Vietnamese conditions, the research team can monitor the value chain's response to these processes.

It is hoped the benefits associated with sapburn and HWT treatments will provide incentives for such practices to be adopted as an on-going practice as a result of increased profitability experienced by all value chain actors, complemented by increased consumer demand for high quality and visually appealing mango fruit in the retail space.

2 Method

The research followed an 'action-learning-action' approach involving the practical application of two specific mango quality treatments (sapburn treatment and HWT) undertaken weekly over a four-week period. Mangoes were sourced from local farmers who were also engaged in the harvest and quality assessment of the mangoes. Prior to harvesting, samples were sent to WinMart supermarket for an initial quality appraisal to determine if the fruit met the supermarket's quality parameters. Vendors were also involved in this approval process; this assisted the supermarket's traceability requirements.

Following the harvest and selection of fruit considered suitable for the supermarket trial, the fruit underwent sap-burn treatment on-farm. Fruit was then packed into crates and transported to the packing house where the mangoes underwent HWT and packaging into specially designed presentation cartons. Fruit was then delivered to the WinMart outlets in HCMC. Figure 1 provides a visual presentation of these steps.

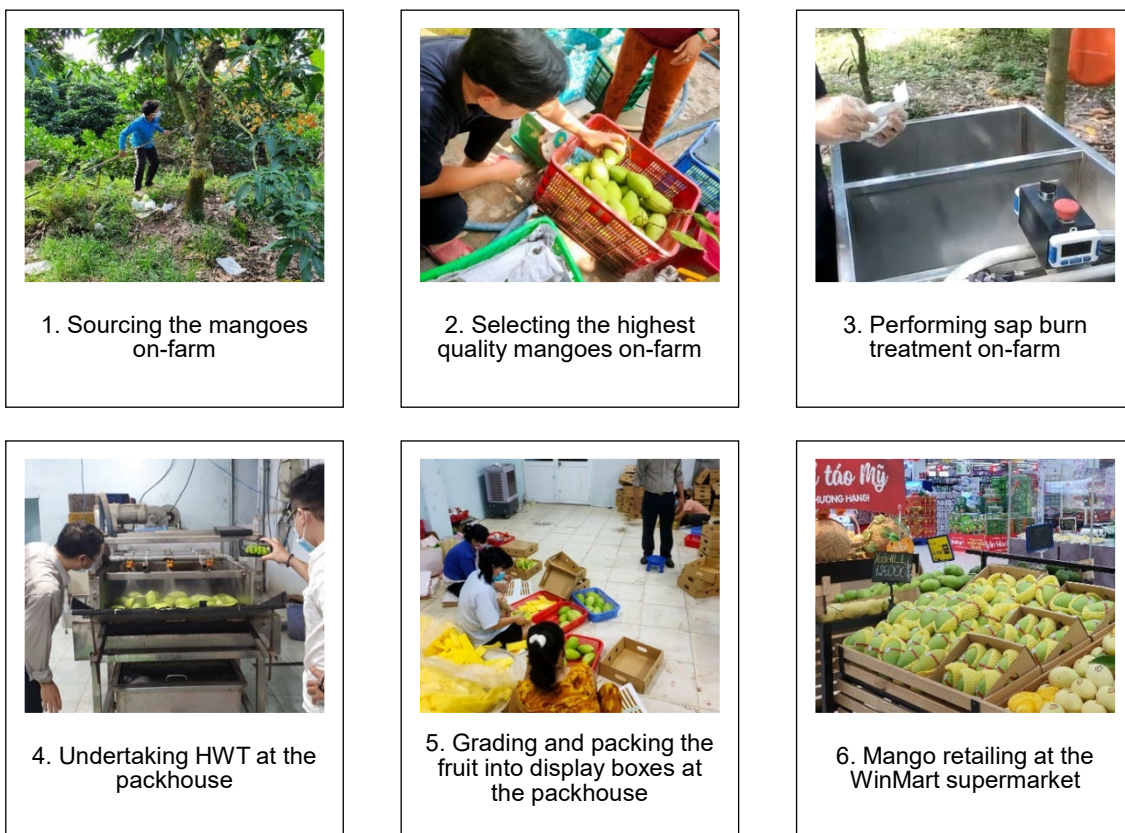


Figure 1. Overview of trial activity

Source: Author's analysis and images

A survey questionnaire given to a diverse range of mango value-chain stakeholders throughout the study's lifespan aimed to ascertain both the benefits and limitations associated with the marketing of sap-burn and hot-water treated mangoes in the local supermarkets (see Appendix 1).

The project team also completed a two-hour online training program prior to undertaking the field work.

3 Results and discussion

3.1 Results

The following represents a summary of the results arising from information gathered through personal observations, experiences and completed survey data from the study.

On-farm sapburn treatment financial assessment

The costs for undertaking sap-burn treatment were based on data collected by the team; results are presented in Appendix 2. Results indicate the cost to treat one kilogram of fruit is VND 1,204 (AUD 0.07). This figure includes all costs associated with equipment purchase, depreciation, repairs and maintenance, powder treatment solutions and labour to undertake the operations.

Packing house HWT assessment

The costs for undertaking HWT were based on data collected by the research team; results are presented in Appendix 3. These findings indicate the cost to treat one kilogram of fruit is VND 2,788 (AUD 0.17). This figure includes all costs associated with equipment purchase, depreciation, labour, repairs and maintenance.

Cost of cartons for packaging of mangoes

Small and large-sized cartons were considered for the packaging and retail sale of the mangoes; these consisting of boxes with a three-kilogram and five-kilogram load capacity, respectively. The project team decided on the three-kilogram capacity, six-pack-sized carton for the trial, having the dimensions of 335 x 275 x 125 millimetres. Refer to Figure 2 for photos of the carton.



Figures 2 (a) and 3 (b). Examples of trial 6-pack mango cartons

Source: Author's images

The estimated per-unit cost for the cartons needed for the trial was VND 38,500 (AUD 2.39), based on a print run of 195 units. This would be reduced substantially to VND 17,000 (AUD 1.05) per unit (inclusive of production, printing and delivery costs but excluding VAT) once commercial quantities in the order of 100,000 units were commissioned. Based on a cost of VND 17,000 (AUD 1.05) per carton (holding six mangoes at 500 grams per mango), the cost per kilogram of fruit equated to VND 5,666 (AUD 0.35).

Assessment of the relative advantages of the six-pack carton

The research team consulted with the different stakeholders associated with the mango value-chain and received the following positive feedback:

- Good quality carton in terms of materials used, small and compact in design.
- A visually appealing and solid design (feedback from the packhouse).
- A significant reduction in the mechanical loss during transportation of the fruit from the packhouse to supermarket (feedback from the vendor).
- Easy to display in the supermarket shelves (feedback from supermarket manager).

Assessment of the local supermarket mango market prior to the commencement of the trial

The research team used a questionnaire to conduct a pre-trial assessment of the mangoes for sale in the four supermarkets two weeks prior to commencing the study. The results are presented in Appendix 4.

Cat Hoa Loc mangoes (the preferred local variety sourced for the four-week trial) were available in one of the four supermarkets in the two-week pre-trial period. The retail price for this variety was VND 64,000 (AUD 3.97) per kilogram; the price increasing gradually towards the end of the off-season. Some of the fruit was discounted to VND 54,900 (AUD 3.40) per kilogram. Other available local varieties ranged in price from VND 27,900 (AUD 1.73) per kilogram for the Keo variety, to VND 56,900 (AUD 3.53) per kilogram for the Australian variety R2E2. A visual example of the pre-trial fruit on display at one of the WinMart supermarkets is provided in Figure 3.



Figure 3. Mango display, WinMart supermarket, 2 weeks prior to trial

Source: Author's Images

Experiences in sourcing mango fruit on-farm

The team's original intention was to source mangoes from farmers who were involved in the sap-burn trials (linked to another activity associated with this project). Unfortunately, due to a shortage in supply of quality fruit amongst these farmers, alternative supply sources from other farmers known to the local project team was subsequently undertaken.

Once farmers were identified, the team negotiated an agreement whereby the project would purchase a minimum of 500 kilograms of fruit each week from each farmer. From the 500 kilograms purchased, the team then selected fruit that met the minimum quality requirements expected of a premium line of mangoes.

There were several challenges faced by the team in its ability to source sufficient fruit for the trial. Firstly, the study took place in the mango off-season, meaning supply shortages were an already-existing obstacle. The project team visited many additional farms attempting to source sufficient supplies, but in doing so found significant variations in crop-management practices from farm to farm. Inconsistencies in practices relating to fertilising, cultivation in orchards, use of fruit bags and

disease incidence further impacted the ability to source a consistent, high-quality fruit of sufficient size and correct ripeness for the trials. These findings reinforce the need to implement traceability protocols and sound on-farm record-keeping as part of driving best practice along the value chain.

Overview of the fruit quality and specifications supplied for the trial

The specific standards of the fruit supplied in each of the four weeks of the trial are presented in Appendix 5. Specific points of interest are highlighted in Table 2 and are expanded below in further detail.

- Of the harvested mango fruit across the four-week period, approximately 32.3 percent was selected as 'premium' for the purposes of retail sale in the supermarket. There was difficulty in sourcing sufficient quantities of high-quality fruit in the off-season, however, the quantity of suitable fruit sourced increased weekly (week one: 20 kilograms; week two: 160 kilograms; week three: 180 kilograms and week four: 220 kilograms). These figures reinforce the need to develop maturity standards for Vietnamese mango cultivars.
- Despite the team's care in selecting premium-quality fruit, indications from follow-up visits to supermarkets (four days after delivery) indicated up to 20 percent were of poor quality.
- Supermarket retailers indicated that the issues associated with quick ripening and disease incidence were two issues that needed to be addressed in the marketing of mangoes.
- Supermarket store managers commented that when the fruit arrived it looked very nice and the quality appeared good, however, the fruit tended to ripen quickly and then the fruit appeared more diseased.
- Over-ripening was most prevalent in week two of the study; some mangoes ripening excessively after only two days on display, deterring consumers from purchase (refer to Figures 4 (a) (b) and (c)).
- Whilst the supermarkets did not reject any of the fruit on delivery, they did later return a quantity of fruit to the vendor; the average return rate of fruit across the four weeks being 11.6 percent, with weekly rates of return ranging from 2.5 percent in week one to 18.3 percent in week three.
- The SIAEP team, inspecting the supermarket fruit to assess quality and shelf-life, found that up to 20 percent of mangoes were of poor quality approximately four days after supply (refer to Figure 4 (a), (b) and (c)), whilst supermarkets' average return rate one week after supply stood at 11.3 percent.
- The research team posits this deterioration of fruit quality may be due to either over-ripeness at time of harvest and/or deficiencies in HWT's disease-suppressing capabilities.
- It is unclear as to why the supermarkets did not simply discount the fruit after it had been on the shelf for several days, instead opting for the non-standard practice of returning spoiled fruit to the vendor.

Table 2. Analysis of trial mango quality and prices

Characteristic		Fruit supply to the supermarket				Average value
		Week 1	Week 2	Week 3	Week 4	
1	On-farm price for mangoes VND (AUD)	70 000 (4.34)	90 000 (5.58)	90 000 (5.58)	95 000 (5.89)	86250 (5.35)
2	Wholesale (vendor) price to supermarket VND (AUD)	95 000 (5.89)	95 000 (5.89)	95 000 (5.89)	95 000 (5.89)	95 000 (5.89)
3	Supermarket retail price to consumer VND (AUD)	125 000 (7.75)	125 000 (7.75)	125 000 (7.75)	125 000 (7.75)	125 000 (7.75)
4	Supermarket retail profit margin* VND (AUD)	30 000 (1.86)	30 000 (1.86)	30 000 (1.86)	30 000 (1.86)	30 000 (1.86)
5	Observed quality - four days after delivery to supermarket	>80% premium	70% premium 10% average	60% premium 20% average	80% premium	
6	Quantity fruit selected for sale out of total harvested (kg)	120 kg / 547 kg	160 kg / 557 kg	180 kg / 500 kg	220 kg / 500 kg	170 kg/fruit 526 kg/fruit
7	Harvested crop sold to supermarket (%)	21.9	28.7	36.0	44.0	32.3
8	Quantity (kg) of poor-quality fruit returned to vendor	3	28	33	17.5	20.4 kg
9	% return rate of poor-quality fruit	2.5	17.5	18.3	8.0	11.6%

Source: Author's analysis

Note: *publishing this value needs to be confirmed with WinMart (potentially commercial intelligence)



Figures 4 (a), (b) and (c). Examples of diseased fruit rejected by the supermarket and returned to the vendor

Source: Author's analysis

Summary of treatment and packaging costs

A summary of the costs associated with the sap-burn treatment, HWT, and the provision of the six-pack cartons for the retailing of the mangoes are provided in Table 3. The additional costs added 11.2 percent to the base price paid to farmers for the supply of the mangoes. When considering prices received by the different stakeholders along the mango supply chain, it appears that the value-adding costs were not factored into the price dynamics; the packhouse/vendor would have made a loss – particularly when transport and other transactional costs are taken into account (see

Table 3). It is also noted that, in some instances, nine mangoes were packed into the cartons designed for six; a number chosen primarily to better display the fruit to consumers on supermarket shelves.

Table 3. Cost to value-add mango trade from Southern Vietnam

Sapburn treatment	Hot water treatment	6-pack carton boxes	Total costs
VND 1 204/kg	VND 2 788/kg	VND 5 666/kg	VND 9 658/kg
AUD 0.07/kg	AUD 0.17/kg	AUD 0.35/kg	AUD 0.60/kg

Source: Author's analysis

Value of mangoes along the supply chain

The relative increases in the value of the mangoes along the supply chain are presented in Table 4. The farmer received a price premium of 14.9 percent through supplying the treated mangoes in comparison with the average price normally received for smaller sized, visually damaged and non-sap-burn treated mangoes.

The packhouse/vendor, once the costs of the HWT and carton costs were taken into consideration, received a margin of just 0.6 percent. The exact distribution of this figure between the packhouse and vendor was unclear, however, the vendor indicated the opportunity cost of participating in the trial was an acceptable investment to prove the value of marketing treated mangoes to the local supermarkets. It should be noted that the research team bore the cost of purchasing the cartons and this expense was not later passed on to the packhouse/vendor. It is, however, accounted for at this point in the value chain.

The research team conducted price negotiations with farmers prior to the fruit being physically inspected – a shortage of available fruit during the off-season could have potentially inflated prices the team had to pay. Ideally, the trial should have been held three to four weeks earlier when there was a greater supply of available fruit.

Table 4. Prices received for mangos from Southern Vietnam

Farmer Untreated Mangoes	Farmer Treated Mangoes	Packhouse Treated Mangoes	Supermarket Treated Mangoes
VND74 000/kg	VND86 250/kg Includes sap burn cost VND1 204 Price premium – 14.9% over untreated mangoes	VND95 000/kg Price from supermarket Less VND2 788 HWT and VND5 666 carton cost Retail margin 0.6%	VND125 000/kg Retail margin 31.6%
AUD4.59/kg	AUD5.35/kg Includes sap burn cost AUD 0.07 Price premium – 14.9% over untreated mangoes	AUD5.89/kg Price from supermarket Less AUD0.17 HWT and AUD 0.35 carton cost Retail margin 0.6%	AUD7.75/kg Retail margin 31.6%

Source: Author's analysis

Experiences and feedback from the value chain stakeholders

The team sought feedback from the different value-chain stakeholders (farmers, packhouse, vendor and supermarket retailer) in relation to their experiences associated with the procurement, treatment, and marketing of the treated mangoes over the four-week trial period (see Table 5). All points of feedback, gathered again using survey questionnaires, are presented in Appendix 7.

Table 5. Value chain stakeholder experiences from the trial supply of treated mangoes

Farmer	Packhouse	Vendor	Supermarket
<p>Recognise the opportunity in treating mangoes.</p> <p>Price premiums difficult to achieve, reduces incentives for producing high quality fruit.</p> <p>Recognise the need to manage mangoes with care during harvest process to avoid damage to fruit.</p>	<p>Confident a 10 to 20% price premium is achievable in selling premium quality treated mangoes.</p> <p>HWT is proven, minimal scald damage.</p> <p>Committed to continuing HWT.</p> <p>The '6 pack' mango box is a great innovation.</p> <p>Ideally treated mangoes should be transported via refrigerated transport.</p>	<p>Treated mangoes had far better appearance, were more appealing to consumer and had longer shelf-life.</p> <p>Packaging of fruit into six-pack cartons increased retail value.</p> <p>Damaged fruit due to over-ripening caused a significant quality issue, with week two fruit the worst.</p> <p>Treated fruit achieved 20 to 30% price premium.</p> <p>Care in transport and handling of fruit is essential to minimise damage and enhance quality at retail end.</p> <p>Providing training to farmers on mango crop management is recommended to help produce consistent high-quality fruit.</p> <p>Committed to sourcing sap burn and HWT mango fruit in the future.</p> <p>Concerned about future costs and profitability especially to northern Province markets including Hanoi (refrigerated transport, longer shelf-life requirements).</p>	<p>Treated fruit more visually appealing.</p> <p>Supplying over-ripened fruit led often to a 20% return to vendor.</p> <p>Sale of mangoes need to have a high turnover rate to avoid extended display and deterioration.</p> <p>The packaging of the mangoes into six-pack cartons was very appealing to the consumer.</p> <p>Cultural factors influence cyclicity of mango sales; sales are higher at the end of the week, on weekends, during full moons, and at the middle and end of the month.</p> <p>Committed to continued access to treated mango fruit in the future.</p> <p>Following experiences from week one, an extra two supermarkets added to the trial.</p>

Source: Author's analysis

Attitudes towards mango treatments

Farmers and supermarket managers were invited to complete an attitudinal response survey relating to a range of statements associated with the treatment of mangoes and their experiences associated with the exercise. Whilst the sample population is relatively small (four farmers and four supermarket managers), the responses provide useful insights, nonetheless. Results are presented in Appendix 6. Highlights from the attitudinal survey are provided but should be considered in the context of a small response population.

Farmers agree that:

- the sap-burn treatment prevents the mango fruit from deteriorating (or being downgraded)
- that in the future the sap burn treatment may result in receiving higher prices for mangoes they sell
- farmers are able to receive higher prices for higher quality mangoes
- if they had more money, they would like to expand the area of mangoes they farm
- farmers are not entirely convinced they would like to continue the sapburn treatment

Supermarket representatives agree that:

- the quality of the treated mango fruit is much higher than untreated mango fruit

- consumers are increasingly demanding higher quality mango fruit
- consumers are willing to pay a higher price for high quality mango fruit

Supermarket representatives were undecided that:

- the treated mango fruit was able to maintain quality longer than most other local fruit sold
- the treated mango fruit had less wastage in comparison to untreated fruit
- treated mangoes should have a higher retail price than untreated fruit
- that the sale of treated mangoes will necessarily increase consumer demand for treated mangoes in the future

3.2 Discussion

The trial successfully demonstrated that sap-burn and hot-water-treated mango fruit supplied in six-pack cartons were an attractive proposition to consumers. The trial also demonstrated that the HWT was somewhat successful in suppressing disease but did not give complete protection. The next logical step is to explore opportunities to incorporate post-harvest fungicides with the HWT. It is anticipated this may greatly improve the shelf-life of the mango fruit and provide the industry with a higher level of confidence to explore the opportunity to supply fruit to longer-distance markets.

- Through working closely with value-chain stakeholders throughout the trial, the research team observed a high level of cooperation along the mango value chain. However, there were some challenges associated with the trial activity that future research should consider, namely: the ability to secure sufficient supplies of mango fruit; much of the sourced fruit was of advanced maturity which negatively impacted the fruit's shelf life
- the exploration of incorporating fungicidal treatment in conjunction with HWT to boost the latter's moderate ability to suppress disease compared with untreated mangoes.
- the importance of quality (including disease control) in gaining price premiums, and consumer and retail sector confidence.

There were disparities in the benefits gained from the retail sale of treated fruit amongst the different value-chain stakeholders. The following are some contributing factors:

- a shortage of high quality, premium-grade fruit on-farm resulted in some fruit supplied having a higher degree of ripeness than what would normally be desirable
- delays in undertaking the trial meant it was conducted in the mango growing off-season, exacerbating fruit shortages
- the research team's prices offered to farmers were 'sight unseen' and may have been artificially inflated (unconfirmed)
- in approximately 500 kilograms of the fruit harvested in each of the four weeks, an average of only 32.3 percent were considered to be of suitable premium quality for treatment and supply to the supermarkets
- the retailer achieved the highest margin in the sale of the fruit (31.6 percent)
- the packhouse and vendor would have made a financial loss in the exercise, once all of the costs of mango treatment, supply of six-pack cartons, transportation and other overheads were taken into consideration
- the per kilogram retail price of treated Cat Hoa Loc mangoes (VND125,000 (AUD7.75)) was almost double the price of untreated Cat Hoa Loc (VND64,000 (AUD3.97))
- It was also noted that, in one of the supermarkets, the price of the untreated mangoes had increased to between VND90,000 and VND95,000 (AUD 5.58 to 5.89) per kilogram
- The price of other mango varieties sold in the weeks leading up to the trial ranged from VND27,900 (AUD1.73) (Keo variety) to VND56,900 (AUD3.53) per kilogram.
- WinMart plan to expand the number of stores selling treated mangoes – (two additional stores commenced selling treated mangoes during the trial period alone- and have arranged for samples of treated mangoes to be sent to some of its Hanoi stores for assessment though the vendor.

4 Conclusion and recommendations

4.1 Conclusion

The trial is of significant benefit in terms of successfully demonstrating the potential benefits of sap burn and HWT of mangoes. Despite some limitations, the progress and acceptance of the treatment procedures by all value chain stakeholders is encouraging, having signaled a commitment to continue the practices post-trial. This is one of the most promising outcomes that could have been anticipated.

The research activities demonstrate the challenges in sourcing consistent high-quality fruit of sufficient size and correct ripeness for trial, especially in the mango growing off-season. This reinforces the need to implement traceability protocols and sound on-farm record-keeping as part of driving best practice along the value chain.

The trial further highlights the need to actively source a regular supply of high quality of mangoes in a timely fashion, that is, when there is adequate fruit available on-farm, and importantly when the fruit is in the early stages of ripening. Over-ripe fruit harvested due to under supply results in quality issues relating to the mangoes' shelf life, as experienced most notably in week two of the trial. It is further inferred over-ripeness inhibits the HWT's ability to inhibit disease.

There are some complexities associated with the price dynamics of the mango fruit that occurs along the value chain. Observations from the trial indicate the price data obtained along the supply chain is not necessarily representative of a real-world commercial environment. This primarily relates to limitations in terms of a lack of profit margin for the packhouse and vendor once treatment costs are taken into consideration, even if sap-burn treatment costs are covered by the farmer. However, under simulated conditions, market forces may rectify these concerns.

Further, as the terms of trade were altered to one of selling on consignment between the vendor and WinMart, the retailer was not incentivised to discount 'slow-moving fruit', opting instead to return deteriorating fruit to the vendor. The supermarket also set the price prior to the trial, indicating the relative power influenced by the supermarket. These behaviours need to be addressed in any future activities.

It is evident from this study consumers in large cities such as Ho Chi Minh are willing to pay a higher price for premium quality treated fruit. The treated Cat Hoa Loc mangoes retail at a price of VND 125,000 (AUD 7.75) per kilogram, almost double the price of untreated mangoes of the same variety and between five and ten times the price of other, less preferred, untreated varieties. It is anticipated the prices for the mango variety Cat Hoa Loc could be even higher in the out-of-season trade, possibly in the VND 60,000 to 160,000 (AUD 3.72 to 9.92) range, depending upon the season and timing.

There is an opportunity – and need – to explore the treatment of harvested fruit with fungicides to achieve increased disease suppression in future mango value-chain studies. The modernised retail sector recognises disease control as an important element of quality, and with that quality comes the opportunity to command price premiums. Actions to enhance quality are crucial in gaining both consumer and retail sector confidence.

4.2 Recommendations

1. The supply of sap-burn treated and HWT mangoes in 6-pack cartons should be actively promoted amongst the mango value chain stakeholders based on their successful implementation in this study.
2. Further investigations are required to fine-tune the HWT of mangoes: supplied fruit in the trial still suffered damage from disease despite being treated, posing a threat to the opportunity to out-scale this technology.

3. Based on the experiences of this activity additional research and development is required:
 - Explore the incorporation of a PH fungicide into treatment protocol (whilst the process for trials and registrations is already under way, demonstrating such a practice in a commercial value chain environment is warranted).
 - Encourage on-going record keeping of production practices and chemical applications (it is essential that one must know the history of the fruit to assess its disease risk and supermarkets are requiring greater evidence of traceability) and promotion of better in-crop disease management as standard practices by farmers.
 - The need to develop and implement fruit maturity standards for Vietnamese mango cultivars, including ripening standards for future markets.
 - Wider dissemination of HWT technology within local packhouses; currently this is not practiced by all.
 - Explore the opportunity for incorporating pre-ripening practices into the short chains to HCMC as a means of optimising fruit ripening at the point of retail.
 - Consider the weights of Cat Hoa Loc mangoes (500 grams or above) as larger mangoes indicate the greater maturity, potentially shortening their shelflife.
4. The development of a 'best management practice guide', highlighting the critical success factors in treatment and selection of quality fruit on-farm and distributed to value chain stakeholders. This would help address challenges encountered during the trial. For example, the application of the good practice program VietGAP, or similar standardised procedures will help ensure the consistent quality and supply which is urgently required.
5. The price dynamics of the fruit (in terms of the sharing of margins as value is added to the mango product along the mango value chain) requires further investigation to explore how more equitable outcomes from the value-add proposition can be achieved on a commercial basis.
6. A workshop involving all the mango value chain stakeholders engaged in this trial activity is recommended to allow all interested parties to share their experiences, address specific constraints and barriers and examine opportunities for out-scaling of this practice on a larger commercial basis during the future main mango harvest season when more fruit will be available.