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**VAPOUR HEAT TREATMENT OF
QUEENSLAND MANGOES FOR EXPORT:
AN ECONOMIC FEASIBILITY STUDY**

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ABSTRACT

In recent years, a world-wide decline in the acceptability of chemical disinfestation methods has occurred. Alternative methods such as vapour heat treatment (VHT) have been developed to replace chemical methods such as ethylene dibromide (EDB).

VHT is a method of insect disinfestation in fresh fruit products. The product is heated with water saturated hot air to a temperature designed to kill insects in the fruit within a stipulated time period, yet not affect the quality and post harvest life of the fruit. The temperature and time period are highly dependent on the type of fruit, the type of insect or insects which are in the fruit, and the country importing the fruit. For Queensland fruit fly in mangoes exported to Japan, this combination of time and temperature, or protocol, is 46°C for 10 minutes. To heat the mangoes to this temperature may take up to two hours.

In this paper, VHT costs of \$2.50 to \$4.00/tray of mangoes have been identified. However, VHT costs are but one of a number of costs involved in the production and export of the fruit. Other costs such as on-farm costs, freight, exporting costs and tariffs are similarly identified for eight countries which are potential importers of Queensland mangoes. Total costs are then matched against prices on offer in the respective countries to determine if exporting is feasible from a marketing viewpoint. However, a further consideration is the limited post harvest shelf life of the fruit which is exceeded if sea freight is used for some countries. Thus while it may appear that exporting is feasible from a purely marketing viewpoint, this conclusion may be negated by technical limitations for one aspect such as sea freight which are so easily overlooked or underestimated. The relatively high cost of air freight must then be taken into account.

The overriding conclusion from the analysis is that Japan is the one country where prices appear high enough to permit air freight to be used, sailing time may be short enough to permit sea freight of VHT mangoes from Australia, and there is the potential for large volumes to be exported. Japanese expressions of interest in a joint venture with Australian growers and with assured prices and volumes are encouraging but need to be carefully assessed. Export opportunities to other countries should also not be overlooked.

It is concluded that it could be feasible to locate a VHT facility in a suitable production area dedicated to the treatment of export fresh mango only. Treatment of other types of produce in the facility would be a bonus. However the economics and logistics of treating commodities other than mangoes have not been pursued in this report.

1. INTRODUCTION

In recent years a world-wide decline in the acceptability of chemical disinfestation methods has occurred. Alternative methods such as vapour heat treatment (VHT) have been developed to replace chemical methods such as ethylene dibromide (EDB).

VHT is but one of a number of heat disinfestation methods being researched throughout the world. Others include Dry Heat Treatment (DHT) and Hot Water Treatment (HWT). The Queensland Department of Primary Industries (QDPI) is currently undertaking research on VHT and HWT for mangoes and other fruit crops with a view to examining the profitability of exporting fresh fruit, and in particular tropical fruits.

There are unique challenges in exporting mangoes in the fresh fruit form. The very short harvest period, the biennial and irregular bearing patterns, and the limited post harvest life, all combine to create problems with the practical application of VHT technology and export freight arrangements. Inevitably, this results in severe limitations on export capacity.

This report identifies the cost of VHT for mangoes. It also estimates all other costs which an Australian exporter would seek to cover to make exporting profitable. This is done for a range of countries, comparing total costs against prices on offer using different types of freight.

The results are expressed in terms of economic and technical feasibility, both being required to make exporting possible to a particular country.

2. METHODOLOGY

Eight countries were selected as potential importers of Australian mangoes. These are New Zealand, Singapore, Hong Kong, Japan, Saudi Arabia, Canada, US and Europe (UK).

Prices in these countries for mangoes were determined with the assistance of Austrade. A range of prices (low to high) was identified for periods varying from one to three years.

Against these prices has been matched all costs up to the stage of landing Australian mangoes on the wharf of the importing country. These costs include the cost of production to the farm gate, VHT, freight, export agent's margin, and tariffs. A decision is then made based on both economic and technical grounds, as to whether Australia can export mangoes in the fresh fruit form to these countries.

Prices

Where possible, three years' of price data were collected. Price data collection was restricted to the period October to March to correspond with the harvest period for Australian mangoes. All price data were then converted to an A\$16.5 kg tray equivalent, using long term exchange rates and a tray weight identical to the Australian standard. A price range, low to high, was thus established.

The problems of data collection from overseas countries became evident in that countries vary in the types of price data which they make available. For example, prices were quoted on the basis of wholesale (W), retail (R), FOB, and CIF. Further, since there are only very small volumes of Australian mangoes exported to date, the prices quoted are for varieties other than Kensington Pride, the principal Australian variety. In this report, the basis for the price quoted (for example, CIF) is outlined.

Ideally, the best price data will be obtained by building up a substantial export trade with Australian mangoes and recording the actual prices received. While this will occur sometime in the future as production expands, the only alternative in the interim is to use the best available data as outlined above.

Note that price data were also collected for the three domestic markets of Brisbane, Sydney and Melbourne.

Opportunity cost

Growers who elect to export do so with the expectation that the return will be at least equal to the price they would have received by placing that product on the domestic market. This is thought to be in the range of \$8.00 to \$15.00.

Costs of VHT

Capital costs for VHT machines range from \$762,000.00 for a 5 t/batch machine to \$2.19m for a 20 t/batch model. Allowing for installation costs and for the situation where the machine is placed in an existing packing shed with limited modifications made, total capital costs are:

5 t/batch	-	\$1.4m
20 t/batch	-	\$3.5m

For purposes of illustration a 12 t/batch machine is selected. This machine has an installed cost of approximately \$2.4m and a seasonal throughput of 1231 t calculated on the following data.

Batches/day	6	
Daily throughput (t)	72	(24 hours round the clock)
Operating days/week	6	
Total weekly throughput (t)	432	
Operating weeks/season	3	
Maximum throughput (t)	1296	
Actual throughput (5% loss*) (t)	1231	

- * A 5% loss is based on the experience gained from VHT machines in the Philippines. These damage a small proportion of fruit. The extent of losses depend upon stage of maturity of the fruit at time of treatment, operator efficiency, and other factors. In all probability, a loss of 5% is fairly high. Nonetheless, the Kensington Pride variety of Australia has a thinner skin than the Carabao variety of the Philippines.

With the above throughput, capital costs per unit of output (tray) are \$1.65/tray. This is based on a life of 15 years for the VHT machine, and a real rate of interest of 10% (including risk factor).

Operating costs have been estimated in accordance with data collected on VHT machines in use in the Philippines. Labour costs for Japanese entomologists to supervise the VHT machine have been based on data supplied by citrus growers in the Central Burnett region of Queensland who export citrus in the fresh fruit form to Japan.

Table 1 summarises capital and operating costs.

Table 1. Summary of vapour heat treatment costs

	Item	\$/tonne	\$/tray
(a)	Capital costs (depreciation plus interest and incorporating 5% loss)	253.79	1.65
	Operating costs		
	. electricity	2.75	0.018
	. water	0.15	n.s.
	. distillate	4.17	0.027
	. Japanese inspectors	19.29	0.125
	. extra casual labour	7.72	0.05
	. repairs and maintenance	15.43	0.10
	. allowance for processing losses*	2.49	0.02
	. allowance for losses of fruit sales**	77.00	0.50
(b)	Subtotal operating costs	129.00	0.84
	Total VHT costs (a) + (b)	382.79	2.49

n.s. not significant

* Not previously incorporated in operating costs.

** Provides for losses incurred for fruit which is now not available for sale at all due to VHT damage.

A cost of \$2.50/tray for VHT is used in subsequent analysis. However, if a payback period of five years rather than 15 is desired, VHT costs amount to \$4.00/tray.

Freight

Sea freight has the advantages of being relatively cheap, and has no limitations on volume. Its main disadvantage is that for certain long distance ports, the voyage length exceeds the storage shelf life of the fruit. This is 21 days in a normal refrigerated container and 28 days in a controlled atmosphere container. It is not possible to use sea freight to export to most ports in the Middle East, and all ports in North America and Northern Europe for this reason.

In the absence of a major sea port in North Queensland, all shipping containers are first road or rail-freighted for export shipment out of Brisbane. The biennial bearing pattern of mango trees creates problems with container hire, given that the limited supplies of refrigerated and controlled atmosphere containers in particular must be ordered well in advance (6-12 months).

The main advantage of air freight is speed. Mangoes can be air freighted to any part of the world by air freight and still be well within the post harvest life of the fruit. The main problems are limited availability of aircraft, relatively high costs, and limited capacity per aircraft.

On face value, chartering an aircraft appears attractive because of the tonnages it can shift. However, no plane can be entirely filled with mangoes (volumetrically speaking) and still fly. This is because its uplift capacity is exceeded. Hence, chartering an aircraft invariably will result in a considerable amount of unused freight space. This tends to make it much more expensive than normal non-charter air freight, particularly for the most distant destinations.

Export agent's margins

Discussions with the citrus exporting group in Mundubbera indicate that there are two ways of determining the fees charged by an export agent. They are:

- on a commission basis, usually 10%, of the domestic price for the fruit landed in Brisbane; and
- alternatively, where a company trade office is established, the costs of the office may be directly offset against the volume transacted.

In this report, a commission basis of 10% is used, based on an average price of \$15.00/tray. This is an export agent's fee of \$1.50/tray.

Tariffs

Tariffs are only applicable in certain countries and are allowed for accordingly.

3. RESULTS AND CONCLUSIONS

Exporting of VHT treated mangoes appears profitable to the following countries:

Type of transport	Country
Sea	New Zealand, Singapore, Hong Kong and possibly Japan
Non-charter air	New Zealand, Singapore, Hong Kong, Japan, and Saudi Arabia
Charter air	Singapore, Japan and possibly New Zealand and Hong Kong

Other than to these countries, sea freight causes the storage shelf life of the fruit to be exceeded and air freight is uneconomic.

Japan is the one country where prices appear high enough to permit air freight to be used, sailing time may be short enough to permit sea freight of VHT mangoes from Australia, and there is the potential for large volumes to be exported. Japanese expressions of interest in a joint venture with Australian growers and with assured prices and volumes are encouraging but need to be carefully assessed. Export opportunities to other countries should also not be overlooked.

Total VHT treatment costs (ownership and operating costs) of \$2.50/tray have been estimated for a 12t/batch machine with an annual throughput of 1296 t and a life of 15 years. This cost is low compared with other costs such as freight. However, the high initial capital costs of VHT (\$2.4m for a 12 t/batch machine) together with the limited throughput, the uncertainty of export prices and local supply represents a considerable risk for entrepreneurs who are seeking to open up export markets. Allowing for a payback period of only five years to further compensate for the risk, the cost per tray then approximates \$4.00. Thus the range under commercial conditions is probably \$2.50 to \$4.00/tray.

There are no apparent economies of size among VHT plants of various capacities. However, variations in throughput materially alters the VHT cost per tray for a VHT plant of any stipulated size.

It is concluded that it could be economically feasible to locate a VHT facility in a suitable production area dedicated to the treatment of export fresh mango only. Treatment of other types of produce in the facility would be a bonus. However the economics and logistics of treating commodities other than mangoes has not been pursued in this report.

For a breakdown on all costs and returns in the marketing chain, refer to Tables 2, 3, and 4.

Table 2. Matching costs and returns - all destinations - \$/6.5 kg tray - using SEA FREIGHT - all \$A

Destination	Opportunity cost in Australia (\$)	Cost of VHT (\$)	SEA FREIGHT (\$)	Export agent's margin (\$)	Tariff (\$)	Australian CIF price (\$)	One/two year average price on offer (\$)	Is exporting economically feasible? (Y/N/D)	Is exporting technically feasible? (Y/N/D)	Can we export to destination? (Y/N/D)
New Zealand	8.00-15.00	NR	6.63	1.50	nil	16.13-23.13	11.77-25.87(FOB)	Y	Y	Y
Singapore	8.00-15.00	NR	6.58	1.50	nil	16.08-23.08	13.31-30.31(W)	Y	Y	Y
Hong Kong	8.00-15.00	NR	7.36	1.50	nil	16.86-23.86	17.96-27.57(W)	Y	Y	Y
Japan	8.00-15.00	2.50	7.61	1.50	1.78	21.39-28.39	27.33-51.99(CIF)	Y	D	D
Saudi Arabia	8.00-15.00	NR	7.27	1.50	nil	16.77-23.77	32.50-35.75(R)	Y	N	N
Canada	8.00-15.00	NR	8.23	1.50	nil	17.73-24.33	9.71-26.50(W)	D	N	N
USA (west coast)	8.00-15.00	2.50	8.23	1.50	0.54	20.77-27.77	18.48-37.80(W)	D	N	N
USA (east coast)	8.00-15.00	2.50	9.01	1.50	0.54	21.55-28.55	18.48-37.80(W)	D	N	N
Europe (UK)	8.00-15.00	NR	8.39	1.50	0.62	18.51-25.51	17.45-32.65(W)	D	N	N

NR = not required
 FOB = Free on board

Y = Yes
 W = Wholesale

N = No
 CIF = Costs, insurance, freight

D = Doubtful
 R = Retail
 NA = not available

Notes on Table 2

- The variable cost of production of \$8.00/6.5 kg is an estimate only.
- VHT costs are based on a 12t/batch machine with an annual throughput of 1296t.
- There is no provision for transshipment costs in the above table. These can be considerable in some ports.
- The tariff is based on the price on offer in the country of destination (midpoint of range is used).

New Zealand = 0%	Japan = 6%	Europe = 6%
Singapore = 0%	Saudi Arabia = na	
Bangkok = na	Canada = 0%	
Hong Kong = na	USA = 8.27c/kg	
- Technical feasibility is based on whether or not post harvest life is exceeded during transit.
- When determining export feasibility, care must be taken in comparing the basis of the price on offer with the Australian CIF price.
- The USA prohibits the entry of Australian mangoes because of mango seed weevil.

Table 3. Matching costs and returns - all destinations - \$/6.5 kg tray - using NON-CHARTER AIR FREIGHT - all \$A

Destination	Opportunity cost in Australia (\$)	Cost of VHT (\$)	NON-CHARTER AIR FREIGHT (\$)	Export agent's margin (\$)	Tariff (\$)	Australian CIF price (\$)	One/two year average price on offer (\$)	Is exporting economically feasible? (Y/N/D)	Is exporting technically feasible? (Y/N/D)	Can we export to destination? (Y/N/D)
New Zealand	8.00-15.00	NR	5.11	1.50	nil	14.61-21.61	11.77-25.87(FOB)	Y	Y	Y
Singapore	8.00-15.00	NR	6.02	1.50	nil	15.52-22.52	18.31-30.31(W)	Y	Y	Y
Hong Kong	8.00-15.00	NR	7.26	1.50	nil	16.76-23.76	17.96-27.57(W)	Y	Y	Y
Japan	8.00-15.00	2.50	12.47	1.50	1.78	26.25-33.25	27.33-51.99(CIF)	Y	Y	Y
Saudi Arabia	8.00-15.00	NR	11.34	1.50	nil	20.84-27.84	32.50-35.75(R)	Y	Y	Y
Canada	8.00-15.00	NR	12.54	1.50	nil	22.04-27.04	9.71-26.50(W)	N	Y	N
USA (west coast)	8.00-15.00	2.50	12.54	1.50	0.54	25.08-32.08	18.48-37.80(W)	N	Y	N
USA (east coast)	8.00-15.00	2.50	12.54(?)	1.50	0.54	25.08-32.08	18.48-37.80(W)	N	Y	N
Europe (UK)	8.00-15.00	NR	19.46	1.50	0.62	29.58-36.58	17.45-32.65(W)	N	Y	N

FOB = Free on board W = Wholesale CIF = Costs, insurance, freight R = Retail

Notes on Table 3

1. The variable cost of production of \$8.00/6.5 kg is an estimate only.
2. VHT costs are based on a 12t/batch machine with an annual throughput of 1296t.
3. There is no provision for transshipment costs in the above table. These can be considerable in some ports.
4. The tariff is based on the price on offer in the country of destination (midpoint of range is used).

New Zealand = 0% Japan = 6% Europe = 6%
 Singapore = 0% Saudi Arabia = na
 Bangkok = na Canada = 0%
 Hong Kong = na USA = 8.27c/kg

5. Technical feasibility is based on whether or not post harvest life is exceeded during transit.
6. When determining export feasibility, care must be taken in comparing the basis of the price on offer with the Australian CIF price.
7. The USA prohibits the entry of Australian mangoes because of mango seed weevil.

Table 4. Matching costs and returns - all destinations - \$/6.5 kg tray - using CHARTER AIR FREIGHT - all \$A

Destination	Opportunity cost in Australia (\$)	Cost of VHT (\$)	CHARTER AIR FREIGHT (\$)	Export agent's margin (\$)	Tariff (\$)	Australian CIF price (\$)	One/two year average price on offer (\$)	Is exporting economically feasible? (Y/N/D)	Is exporting technically feasible? (Y/N/D)	Can we export to destination? (Y/N/D)
New Zealand	8.00-15.00	NR	11.57	1.50	nil	21.07-28.07	11.77-25.87(FOB)	D	Y	D
Singapore	8.00-15.00	NR	8.63	1.50	nil	18.13-25.13	18.31-30.31(W)	Y	Y	Y
Hong Kong	8.00-15.00	NR	8.63	1.50	nil	18.13-25.13	17.96-27.57(W)	D	Y	D
Japan	8.00-15.00	2.50	10.08	1.50	1.78	23.86-30.86	27.33-51.99(CIF)	Y	Y	Y
Saudi Arabia	8.00-15.00	NR	29.28	1.50	nil	38.78-45.78	32.50-35.75(R)	N	Y	N
Canada	8.00-15.00	NR	25.77	1.50	nil	35.27-42.27	9.71-26.50(W)	N	Y	N
USA (west coast)	8.00-15.00	2.50	25.77	1.50	0.54	38.31-45.31	18.48-37.60(W)	N	Y	N
USA (east coast)	8.00-15.00	2.50	25.77(?)	1.50	0.54	38.31-45.31	18.48-37.60(W)	N	Y	N
Europe (UK)	8.00-15.00	NR	33.20	1.50	0.62	43.32-50.32	17.45-32.65(W)	N	Y	N

FOB = Free on board W = Wholesale CIF = Costs, insurance, freight R = Retail

Notes on Table 4

- The variable cost of production of \$8.00/6.5 kg is an estimate only.
- VHT costs are based on a 12t/batch machine with an annual throughput of 1296t.
- There is no provision for transshipment costs in the above table. These can be considerable in some ports.
- The tariff is based on the price on offer in the country of destination (midpoint of range is used).

New Zealand = 0%	Japan = 6%	Europe = 6%
Singapore = 0%	Saudi Arabia = na	
Bangkok = na	Canada = 0%	
Hong Kong = na	USA = 8.27c/kg	
- Technical feasibility is based on whether or not post harvest life is exceeded during transit.
- When determining export feasibility, care must be taken in comparing the basis of the price on offer with the Australian CIF price.
- The USA prohibits the entry of Australian mangoes because of mango seed weevil.

4. DISCUSSION

Reports of a static nature such as this invariably suffer from the 'snap-shot' approach. That is, the results quickly tend to become dated.

However, the environment of international trade for food products is very dynamic. Variation in prices, exchange rates, costs of production, seasonal conditions, technology, etc, are continually occurring. This results in trade opportunities opening and closing in both the short and medium term.

I believe that the concept of supplying a short term 'market niche' or 'window of opportunity' has limited relevance in exporting horticultural products. Rather, what is required is a situation satisfying the following criteria.

- A clearly defined set of product specifications agreed to by both the exporter and importer. This will include variety, size, shape, colour, type of packaging, delivery dates, quantities, etc.
- A scheme in place which satisfies these specifications. This requires a coordinating body and preferably a number of large scale producers willing to comply. Thus from the earliest stages, agronomic, marketing and transport procedures are in place to make sure these product specifications are met.
- A joint venture between Australian growers and the importers which assures a given price for an agreed volume over a stipulated period, preferably one complete season. Prices and quantities are then negotiated on a seasonal basis. The initial capital investment is shared by both parties.

VHT plants may have their greatest application in large orchards where the quality of the product is known, the owner is committed to exporting, and there is a large assured throughput. Only top quality fruit should be used for exporting. The concept of supplying first grade fruit for the domestic market and second grade or 'left-over' fruit for export or processing will simply not work in the real world.