Enhanced competitiveness and market penetration of custard apple in Australian and overseas markets

Roger Broadley
QLD Department of Primary Industries and Fisheries

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ENHANCED COMPETITIVENESS AND MARKET PENETRATION OF CUSTARD APPLE IN AUSTRALIAN AND OVERSEAS MARKETS

Report compiled by Roger Broadley *et al*

HAL (FORMERLY HRDC) PROJECT NUMBER: CU01001
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This is an integrated research, development and extension project where the following team members all contributed significantly to successful project outcomes.

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This is the final report for RD and E work conducted for the Australian custard apple industry from 2001-2004.

Queensland Government
Department of Primary Industries and Fisheries

NSW DEPARTMENT OF PRIMARY INDUSTRIES

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Date of report: September 2004

This report is dedicated to the memory of Dan Smith, a fine entomologist and colleague, who always put the interests of growers and industry first.

TABLE OF CONTENTS

1.0 MEDIA SUMMARY

Media Summary

The Australian custard apple industry is a well-led, organised industry. It is distributed from the Atherton Tableland in the north to the Alstonville Plateau in the south, and there are also custard apple growers in the Northern Territory and Western Australia.

The industry is breeding new varieties of custard apple for different environments, and these varieties are being tested in seven geographically separated areas. Some of these varieties have already been commercialised and are available to commercial custard apple growers. In addition, new rootstocks onto which the varieties are grafted are being sourced from Taiwan and Brazil, and are also being developed through the breeding program.

The breeding program is located at the Maroochy Research Station in southeast Queensland. Approximately 13 000 new lines have been bred and planted into the field. A small proportion of these crosses have been assessed for fruiting performance, disease resistance and eating quality. The remainder will be tested as the plants mature.

New soft chemicals have been developed for pest and disease control. The fungicides have been developed from naturally occurring fungi, and successful insecticides for scale and mealybug control have been developed from mineral oils. In addition, predatory ladybirds can be purchased off the shelf for control of some serious pests of custard apple, such as scale and mealybug.

There is considerable potential to expand sales of custard apple into domestic, as well as, export markets. Asian people in particular like custard apple, and there are significant markets in southeast Asia for custard apple. Exports of custard apple to Hong Kong and Singapore are a regular occurrence, and the large fruit produced by Australian custard apple growers command a premium price in these counties.

While there are some biosecurity barriers in place, the industry is working on developing new ways of fruit access into other Asian countries.

We thank the Australian Government through HAL and the Australian Custard Apple Growers Association for their funding support for this RD And E work.

2.0 TECHNICAL SUMMARY

Technical Summary

This three-year project has produced a number of important results for the Australian custard apple industry. These are listed below.

- New fungicide treatments for control of the important fungal disease Pseudocercospora have been developed, together with best timing of application.
- The fungicide mancozeb has been shown to be highly effective and has been registered for use on custard apples against Pseudocercospora. The narrow range oil Biopest has also been shown to be effective for control of fungal pathogens
- Possible new insecticides for control of fruitspotting bugs (serious pests thought to cause up to 50% fruit damage in New South Wales) have been identified, and we are now moving to large scale trials in high pressure bug situations
- The conditions of use of the predatory Cryptolaemus ladybird for control of mealybug in custard apples have been extensively investigated. As a result, grower recommendations for use of Cryptolaemus have been developed.
- In addition, one species of green lacewing has been tested for control of mealybug in orchard situations, but have proved not to be an effective biocontrol agent. Other lacewing species might be more adapted to custard apple.
- The development of IPM in custard apple orchards is continuing, with the major obstacle being multiple insecticide applications for fruitspotting bug, even though the soft insecticide endosulfan is being used. However it is fair to say that very little pesticide is being used for control of other pests.
- New ant bait has been tested, and shows considerable promise for ant control. Only tiny amounts of chemical are required per hectare. Registration is dependent on the chemical company, which owns fipronil.
- Alternative recommendations have been developed for control of fruit fly in custard apple, using naturally occurring chemicals
- The breeding program is advancing with about 9 superior parents identified, and about 400 crosses completed. The progeny of about 150 of these have been evaluated, with the remainder coming on stream in the next couple of years. We have developed a new culling technique, whereby we can identify characteristics of seedlings, and which allows about 30% to be culled before being planted in the field. This increases the efficiency of our program by the same percentage.
- New methodology for developing clonal plants from vegetative cuttings has been developed, but needs refining. However this breakthrough gives us the potential to clonally propagate both scion and rootstock material.
- Work on the management of large vigorous trees cultivar African Pride on deep red soils in NSW has been initiated, as many orchards consist of older larger trees. Different rates of Sunny were used to control the vigour, and promote flowering in heavily pruned trees. In the first season after pruning, Sunny and leaf stripping had at best only minor effects on fruit production. This trial work is being continued.
- Trials to assess the effects of new trellising systems on custard apple management and performance have been set up at MHRS, and will be followed by semi-commercial trials in the near future using a different variety
- Testing of previous selections at 10 regional sites is continuing. The variety Maroochy Gold appeared to be performing strongly in NQ and in other districts. The main test for many early released varieties will come in the 2004-5 season.

- An understanding of the self-setting ability of Pinks Mammoth, Hilary White, and KJ Pinks was achieved through the assistance of a visiting Japanese scientist, Kenji Beppu, and through flower tagging on a weekly basis. Observations showed that average fruit set for KJ Pinks in a difficult season was around 40%, while the other varieties were less than 1%.
- A new custard apple record management system (CARM) has been developed for testing by selected growers.

3.0 TECHNICAL REPORTS

3.1 Custard apples- one view of the future- four pillars of productivity and quality

John Chapman
Acting Director
Agency for Food & Fibre Sciences, Horticulture
Department of Primary Industries

Introduction

Subtropical and tropical Australia grows a wide range of fruit and nut crops. It is important that the community understands which of these crops have the greatest potential for commercial success, particularly with regard to future potential for international trade. Reviewing current and potential competitor countries for each commodity is an important part of the process.

The custard apple industry has every reason to believe it can be an elite and competitive tree crop industry out of Australia's subtropical climatic zone. This can be based on the inherent unique eating qualities of its delicious white flesh, of particular appeal to our sweet fruit loving neighbours in Asia, a progressive and well organised industry structure, and a commitment to long term research and development.

Theoretical yield potential of custard apples

In order to focus on competitiveness, an industry should have in its sights its theoretical potential yield that can be based on the performance of other tree crops. For example intensively spaced, well-managed apples and citrus can consistently yield 100 tonnes per hectare. Wolstenholme (1986) outlined the yield potential for a number of crops. His particular interest was avocado and he suggested that it should be possible to achieve commercial yields of 32.5 tonnes per hectare for this crop.

The much lower yield for avocado compared with citrus and apple is because it is an oil producer and it requires much more photosynthetic energy to produce oil than juice. Although at the time this was considered an extremely high yield target for avocados, it should be noted that some commercial blocks in the Bundaberg region, in California and in Israel have consistently gone past that yield target over the past three years (Whiley, personal communication.)

Macadamias are oil producers like avocados. They have the added inefficiency of having a husk as well as a shell. Therefore a target of 100t/ha loses half as husk (50t/ha). Applying Wolstenholme (1986) theory of one-third productivity for an oil producer, plus allowing for the lower photosynthetic rate of macadamias compared with avocados, calculates a theoretical yield potential for macadamias of 14t/ha nut in shell. Compare this with the current macadamia industry average of 5-6t/ha.

Custard apples are not oil producers, they have a relatively thin skin and they do not have a husk like macadamias. Tree vigour is good leading to large tree architecture.

Physiologically they do have limiting factors that reduce yield potential. They create poor light interception for fruiting sites, and carbohydrate partitioning in the tree is not as efficient as many other tree fruit crops. Despite these issues, we really have no excuse. Custard apple per hectare yield theoretically should be close to 50-60t/ha. Compare this with current average orchard yield of 10-12t/ha and you can see the problem. The genetic potential of custard apples is not even close to being realised.

How can the theoretical yield be achieved and surpassed?

Continuous improvement in all aspects of the custard apple production system is required in order to achieve a difficult target. One way of considering this is to structure four pillars of improvement as follows:

- The genetics of the scion
- The genetics of the rootstock
- The health of the soil
- The health of the tree

Scion genetics

The custard apple industry has relied, for a long time, on two main varieties in Pinks Mammoth and African Pride.

Pinks Mammoth is a large attractive fruit that eats very well but has the serious drawbacks of, poor yield requiring hand pollination and mediocre performance in post harvest shelf life. African Pride has offered better yield but higher seediness and some physiological problems.

The Qld Department of Primary Industries through the persistence of Dr Alan George has maintained a small, poorly funded breeding and selection project during the eighties. Out of that have come new selections of which Maroochy Gold is the best. Keith Paxton's KJ Pinks has also become available. These varieties represent a much-needed burst of new genetics to take the industry forward towards that greater yield potential.

I commend the commitment by the custard apple industry to the major breeding project commenced in 1996, part funded by industry and Horticulture Australia Ltd, that is now a vital part of the industry's future. Ten thousand hybrids is a good-sized breeding project by any tree crop standard. Hybridisation is like selling insurance - the bigger the numbers the higher the chance of success. Patience is the key as breeding is always long term. Ten to twelve selections have already been identified in the project, so chances of long-term success are very high.

Even the apple, the focus of improvement programs through breeding, for centuries, is still revealing winners. The Western Australian bred Pink Lady apple has become a world cultivar in recent years. This should give encouragement to breeders everywhere and help industries to maintain their commitment. It does not appear that any other country is making an investment in custard apple breeding comparative to Australia. Therefore competitive benefits will happen with time as long as we remain patient and committed.

Rootstock genetics

The power of rootstocks has long been demonstrated in crops such as apples, stonefruit and citrus. Productivity, fruit/nut quality, tree size control, root and fruit disease resistance are characteristics that can be very significantly enhanced by rootstocks. Notable advances have been made in recent year with rootstocks in avocados.

A definitive paper (Thomas, 1993) described how individual tree yields were recorded on a block of eighty-six trees for six years. The trees, on a deep volcanic soil, were Sunblotch viroid tested Hass on seedling Guatemalan rootstock. The three highest yielding trees averaged 219, 230 and 214 kg/tree/annum while the three lowest yielding trees averaged 74, 30 and 50 kg/tree/annum. This meant that production differed by 416% between the highest and lowest yielding groups.

The major difference was the variability of the seedling rootstocks. Whiley (1997) stated "The power of tree manipulation through selective use of rootstocks or rootstock/scion combinations has long been recognised by other fruit industries, and substantial gains have been made in fruit quality and yield through this approach."

More recently a further breakthrough has occurred with a fungicide experiment by DPI on Hass avocado (Willingham *et al.,* 2001). Investigations into why great variation in disease incidence was occurring in response to fungicide treatments, revealed that half of the trees in the experiment were on Velvick rootstock and half were on 'Duke 6'. On a low copper fungicide regime, Velvick rootstock trees increased fruit acceptability by 79% compared with 'Duke 6'.

This was largely due to fruit from trees on Velvick rootstock having significantly less severe (61% lower) and lower incidence (35% lower) anthracnose than fruit from trees grafted to 'Duke 6'. Investigations of the chemical characteristics of the rootstocks showed that Velvick had a significantly higher concentration of Diene (a natural defence compound) compared with 'Duke 6'. Velvick also showed higher calcium and lower nitrogen content than 'Duke 6'. The rootstock Velvick is shaping to be a wonderful medium long- term answer to the need for a high performing rootstock in avocado.

The custard apple industry is currently heavily reliant on genetically variable seedling rootstocks. It has no tested high performance clonal rootstocks to recommend. This is a major gap in the industry's potential for competitiveness that needs urgent correction. While the industry and HAL do not have the funds for an expensive rootstock-breeding project, a less expensive pathway is available.

Just like Graham Thomas and others in avocados, a good grower will often have recognised the occasional high performance tree in the orchard. If the scion genetics and the environmental conditions appear the same, then it may well be that the tree is powered by a superior root system that is worthwhile cloning to make available to the entire industry. It would not cost a lot of money to identify say ten of these high performers, vegetatively propagate them and trial them in orchard conditions for

performance. A clonal rootstock could make a big difference to performance and the financial bottom line.

Soil health

The importance of soil health is sometimes ignored in the average orchard. Even the average citizen would know that to create a thriving garden soil, organic matter in generous proportions, calcium (usually in the form of lime) and micronutrients are critical. Success in developing a very healthy garden soil can be measured by teeming earthworms and a light friable texture. An orchard soil should be treated in the same way to maximise root and scion health.

The lighter/sandier the soil the more organic matter is required. The avocado industry was forced into developing a culture of high levels of organic matter for Phytophthora control, long before phosphonates became available for chemical control. Custard apples require similar soil conditions to avocados to really thrive

The calcium (Ca) story is significant in tree crops. It has been shown repeatedly that it is critical for fruit quality, but the challenge for growers is its poor uptake and slow movement in the plant's vascular system. The ratio of calcium with two other major cations, magnesium and potassium, must be balanced. It is now available as superfine formulations for application via the irrigation system and easier plant availability.

Calcium applications annually have proven very successful in mangoes at an annual rate of 5kg/tree of gypsum, for control of internal fruit disorders. In avocados, calcium has a proven role in the prevention of fruit breakdown and is linked to the natural disease defence compound Diene. Similarly custard apples are showing a correlation between internal fruit disorders and poor calcium supply. I suspect that good rootstocks are out there waiting to be found that will power calcium into your fruit and do it free of charge.

The presence of nitrogen is always a challenging balance between the need for it to stimulate vegetative growth to supply future fruiting wood and at the same time minimising it to enhance flowering, nut set and nut quality. Leaf and soil analysis are essential monitoring tools.

Trace elements are important and a simple rule of thumb says that the sandier the soil the more important trace elements are. Zinc and boron are regularly needed in our acidic soils.

Tree health

Aspirin also known as Salicylic acid continues to amaze scientists as a wonder drug contributing to both plant and human health. Some example studies (Osfield, 2000) on human health have shown that it helps prevent Alzheimers Disease , possibly by reducing brain inflammation or inhibiting the key protein Amyloid. Aspirin is noted for its capacity to lower heart attack rates via its blood thinning capacity. Studies also suggest that aspirin lower the incidence of cancer in the colon, stomach and oesophagus (Osfield, 2000).

In plant health, the interest in Salicylic acid and related compounds has heightened in recent years. It is a very effective protectant against disease and often occurs naturally in plants. Strawberries, for example, have high levels of Salicylic acid as part of their plant disease defence. This group of related compounds are known as "Systemic Activated Resistance Compounds" or SARS (a most unfortunate acronym given recent world events with a deadly respiratory virus).

Some commercial formulations being used experimentally include Bion® and Boost® that, with or without fungicides, stimulate plant defence against disease. Plant Pathologists in the Agency for Food and Fibre Sciences of DPI continue to explore this interesting area.

Attention has recently focused in various laboratories around the world on plant disease defence compounds that occur naturally in plants. A key characteristic is that the concentration of these compounds reduces quickly as the fruit ripens. The Queensland Department of Primary Industries has recently opened a natural defence laboratory at the Indooroopilly Science Centre in Brisbane. Scientists know that the key compound protecting avocados is Diene and the key compound protecting the fruit in mangoes is Resorcinol. However no research appears to have been done at this point into what compound, if any, protects the custard apple from fruit rot diseases.

After years of limited new products many new chemistry fungicides with low mammalian toxicity have been coming onto the market place. One group known as Strobilurins, are derivatives of toadstool compounds. Registered trade names include Amistar, Flint and Stroby. They are highly effective broad-spectrum fungicides but the strong possibility of resistance developing must be planned for in their use. They are also relatively expensive to date.

Conclusion

The intention of this paper is for someone with a broad research perspective and no claim to expertise in custard apples to be challenging you to recognise your industries possibilities and potential. You have a robust approach to research and development. Your partnership with DPI Horticulture, that brings together multiple research and extension disciplines into one project, is an example for other medium sized fruit industries. Commitment from you maintains commitment from us.

Finally, continuous improvement should be the norm for the custard apple industry. I expect you will be a very significant industry in the decades to come.

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3.2 The big picture of horticulture

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Introduction

This is a discussion paper designed to stimulate thinking about the current strategies industries are using to try to maintain or expand their industries. It presents some alternative ways of looking at and examining the key issues. Our approach has been to start with the global perspective and look inwards as we believe that global forces will have an increasingly greater impact on industry survival in the near future.

World scene – the key global drivers

1. globalisation, deregulation (no tariff barriers), freer trade
2. fewer but larger supermarket chains (currently 60 chains to be reduced to 10 in the next 10 years), supermarket chains will market 85% of all fruit and vegetables even in the developing countries
3. the formation of 5 – 10 international global marketing, distribution and supply companies and alliances (Hendrickson, 2001)
4. direct selling to supermarkets
5. fewer but larger growers/companies eg in California 10% of growers produce 90% of the production
6. emergence of China as a large producer and exporter and importer of fruit eg China now produces 25% of the world production of apples (Segre, 1998).
7. patenting and licensing of varieties/technologies (only selected growers/groups will access to the best varieties)
8. improved disinfestation treatments (this will allow greater access of foreign producers into Australia)
9. sustainability issues
10. food safety issues
11. supply chain issues

Larger supermarket chains want:

1. continuity of supply from northern and southern hemispheres
2. to deal with fewer players
3. specific quality specifications and safe food
4. to pay the lowest price to agents to remain competitive

Some key points about the Global drivers

Steve Blank, University of California economist in his book `The End of the American Farm', suggests that horticultural industries in developed countries must make serious changes to ensure a successful future. The `Blank' report says that the returns on horticultural investments are less then 1% (on average 0.4%) compared with 9.0% for food processing, 10.6% for retail, and 16% for food service. In the USA, 78-85% of value added in the agrifood chain is not done on the farm. Horticultural industries in developed countries are under severe threat of disappearing due to increasing globalisation (Blank, 2003).

In the global economy, small farms will be replaced by large farms, which in turn will be controlled by giant multi-national corporations (Ikerd, 2002). In both the USA and European Union (EU) about 25% of horticultural producers account for 75% of total fruit and vegetable production (Ikerd, 2002). Under globalisation, small independent farms quite simply will not have access to markets for internationally traded commodities (Ikerd, 2002). Small horticultural farms, which focus on niche markets, are most likely to survive.

In the USA whilst the overall inflation form the 1980s to 2000s was 67% (about 3% per year), the inflation rate for fruit and vegetables was nearly double (103%) ie the farmers returns have declined in real terms (Johnson, 2002). In virtually all developed countries the supermarket share of trading has increased form 50%in the 1950s to 80% in the 2000s. In the USA, in the 1990s, the farm share of the retail dollar for fresh fruits dropped from 23% to 18%, for fresh vegetables from 28% to 23% and for processed fruit and vegetables from 26% to 20%. This has occurred in spite of a 15-20% improvement in fruit and vegetable quality over the past decade. In summary, prices have remained static, in other words declined at the rate of CPI. All increases in farm incomes have occurred as a result of increases in productivity (Mullen, 2002).

TABLE 1 A selection of major global retailers

Company	Home market (%)	Non - domestic sales (%)	Store numbers	No. of countries	Sales 2000-2001 Euro millions
Wal-mart	US	14	3989	10	208 533
Carrefour	France	38	9600	28	64 802
Casino	France	19	5423	11	64 802
Ahold	Netherlands	75	7853	27	52 471
Metro	Germany	39	2114	21	43 804
Costco	US	22	313	7	34 464
Aldi	Germany	33	5556	11	30 013
Tesco	UK	10	821	10	29 752
Tengelmann	Germany	51	6689	11	27 300
Delhaize	Belgium	80	2360	11	18 206
Woolworth	Australia	0	585	1	9 560
Coles/BiLo	Australia	0	427/163	1	7 408

Australian scene – the key drivers

1. oversupply
2. high labour costs compared with competitors eg Asia, Chile etc.
3. increasing costs of production (mainly wages)
4. decreasing returns (prices static, not keeping up with inflation)
5. uncoordinated marketing
6. many small growers
7. variable fruit quality
8. no control of product ex farm gate particularly if product are sold via agents
9. export market niches into Asia and Europe (these are virtually untapped)
10. poorly supported or ineffective R&D (all industry money going into promotion/IDOs)
11. superseded varieties

Some key points about the Australian drivers

Basically the Australian drivers are similar to the American drivers. Just like their American counterparts, Australian fruit and vegetable growers are caught in a *cost/price squeeze* – costs of production have gone up in the past 10 years, and prices have remained static – in real terms fallen.

In addition, consumption rates for *Australian-produced fresh fruit and vegetables* in Australia has been static for the past 10 years (135 kg of fruit/person/annum; 162kg

vegetables/person/annum) (ABS survey figures 1999). Note: **Apparent increases** in consumption rates for fruit in recent years has been due to imported (about 600 000 tonnes annually) processed orange juice, which equates to about 30kg per capita. Even if we could increase domestic market consumption by 10%, given that 60% of Australian are already obese, this would have only minor impact, due to the small size of the Australian market, on individual grower returns, increasing it by about $5 000 per annum.

TABLE 2 *Comparative labour costs for different countries and the cost of producing a tray of fruit assuming that labour constitutes 65% of the variable costs*

Country	Farm size	Labour cost per day	Estimated Cost of producing a tray of fruit
Australia	Small grower (<10 000 trees)	$146	$10
	Very large grower >1Million tree	$146	$5.3
Chile	Small grower (<10 000 trees)	$15	$4.3
Thailand	Small grower (<10 000 trees)	$10	$4.0
China	Small grower (<10 000 trees)	$3-5	$3.5

*Even with large economy of scale, Australian costs of production exceed its major competitor, Chile

CURRENT STRATEGIES USED BY AUSTRALIAN HORTICULTURAL INDUSTRIES - WHY THEY MAY NOT BE SUCCESSFUL

1. ***Producing what the consumer wants***

The Australian consumer is faced with a overwhelming variety of food products; in 1960s there were about 600 food lines on shop shelves, today there are over 12 000, and growing (Stanton, Snack Fruit Conference, Brisbane, 2002). Consumers are demanding faster, more convenient food lines that are easy to prepare.

One of the most touted solutions to increasing the consumption of fruit is to produce a fruit product that meets consumer needs. In spite of improvements in fruit quality of 15-20% over the past 20 years, farm gates prices have declined. It appears that fruit quality and price are often poorly related (see paper and thesis Kate Owen, 2000). Owen's thesis is only one of two in depth studies on consumer behaviour patterns in the purchase of fruit in Australia. Finding out what the *consumer wants* and producing a product to meets that specification *does not automatically guarantee* that the grower will receive a higher price. Three other factors are important – *supply*

volumes, consumer behaviour and supermarket pricing strategy (see above, see Owens thesis)

Owen (2000) suggests that the price that buyers are willing to pay for high quality may be low because the buyer is often conditioned to buy good quality fruit at low prices when the supermarkets run their lines of special. Many fruits (eg apple, pear, banana, peach, plum etc) can also *easily substitute* for one another so that when prices are high for one their purchase is delayed until they come on special, and alternative fruit type is purchased. The practice of price discounting although highly cost-ineffective confuses the buyer and serves only to delay the purchase of a rival fruit when it also comes on special.

Owen (2000) concludes from her studies that we would need to guarantee both internal and external quality to possibly achieve a higher price but we would need to differentiate these products in the supermarket (not by fruit stickers). However to be able to guarantee external and internal quality we need grow *new varieties in the right environment and under the best management techniques* and then *guarantee the quality* using technologies such as NIR, colour sorters etc. In glutted markets this will be become even more important. Currently less than 5-10% of fruit would meet the minimum standards needed to meet consumer expectations and ensure consumer confidence in purchasing the fruit.

2. ***New varieties***

Introducing new varieties may only have a short-term benefit – initially receiving higher prices but reducing prices for a period of five years. Even fruit with 20-30% superior quality characteristics may not attract a higher price. It should also be noted that price/volume relationships are *highly elastic* – prices per tray/kg drop very quickly with increasing volumes placed on the market eg. 80 000 trays of stone fruit per month will saturate the Brisbane market, 120 000 trays of stone fruit per month will saturate the Sydney market, with prices falling from $10 per kg to $3 kg. Compare this with the Hong Kong market where 500 000 trays per month will start to saturate the market.

3. ***Closed loop marketing***

Another questionable strategy is controlling supply of new varieties through closed loop marketing. Australian markets are quickly saturated, for example if 300 000 trays of stone fruit per month is all that is needed to saturate the Australian market, then if we assume seven trays of stone fruit per tree, only 40 000 trees (50 hectares) will be all that's needed to saturate that market. Are the royalties to be collected from such a small number of trees going to pay for the cost of the breeding program/PBR costs? In addition, if plant breeder `A' supplies one group of growers and that gives them a competitive advantage in the market, they themselves, at some time in the future, may be also disadvantaged if plant breeder `B' selects a more superior variety and gives it to another group. Changing varieties is very costly and it would be highly unlikely that any grower would change a new variety in less than 5 years. To be successful, closed loop marketing would need to be conducted on a global basis with an industry licensing new varieties to both northern and southern hemisphere producers and marketing alliances.

4. ***Promotion***

Currently the promotional dollars spent on advertising fruit and vegetable is too small to be effective (<2% of the total advertising dollars spent on food lines) (Dietz, US Centre for Disease Control, 2001; Stanton per comm. 2002). For example, TV advertising up to $400 000 per annum appears to have had no appreciably improvement in stonefruit farm gate prices or consumption rates. Similarly, the consumption of banana per head of population per annum has declined over the past 10 years (ABG figures) in spite of spending $2.5M per annum on promotion. This is *a very important point because most industries prioritise domestic market promotion as their 1st strategy to increase their profits.*

Promoting individual lines also `bumps off' other competing lines or substitutes for a short period and has *no long lasting effects*. Sales probably decline to levels below that before the promotion commenced as was the case for fruit juice in the UK. The practice of discounting may have negative effects on returns to the growers and needs much more careful investigation (Owen, 2000). Of course the marketing consultants will argue that if they didn't implement a promotion campaign, industry would be worse off.

However, if you look at the prices and consumption rates per head of population before and after the introduction of a promotion campaign it shows that the important KPIs (consumption rate per head of population and returns per promotional $) are flat line – **in other words there has been no effect, in actual fact, worse because prices have fallen at the rate of CPI (3% per annum).**

The reason for the lack of response to promotion may be due to several factors including: small size of advertising budgets eg. in USA less than 2.2% of the total budget spent on advertising food products is spent on fruit and vegetables collectively. Fruit also fits into a mundane, non-sexy product category of variable quality and consumer confidence (see Cohen's thesis). Thirdly children identify with high profile sporting and singing stars and none of these are used to promote fruit and vegetables.

5. ***Value adding***

Value adding may be more cheaply done in the developing countries where labour costs are low. Some examples are orange fruit juice and concentrate production in Brazil; these concentrates are exported to USA in large quantities. If it wasn't for the high import tariff on imported fruit juice, the 600 000 acre citrus industry in Florida would be non-viable. In Australia, macadamia are sent to China for cracking due to the cheaper labour rates there.

Why new strategies are urgently needed

If horticultural industries continue to travel done their current path, based on overseas trends, the growers that will survive in the next 5 to 10 years, when the crunch hits, will be those that are the *most efficient* ie high number of marketable trays, excellent quality and lowest costs of production. It is interesting to note that most of *the gains*

in agricultural returns have come about from increases in productivity and not from price (Mullen, 2002).

At some point in the near future (5 to 10 years from now), however, economy of scale will come into play as production costs continue to increase, due mainly to increasing labour costs. Based on overseas data, a grower, or group of growers, will need to have an orchard size of at least 200 000 trees, or more, to significantly reduce his costs of production, due to economy of scale only.

NEW STRATEGIES FOR IMPROVING FARM GATE PRICES AND CONSUMPTION RATES

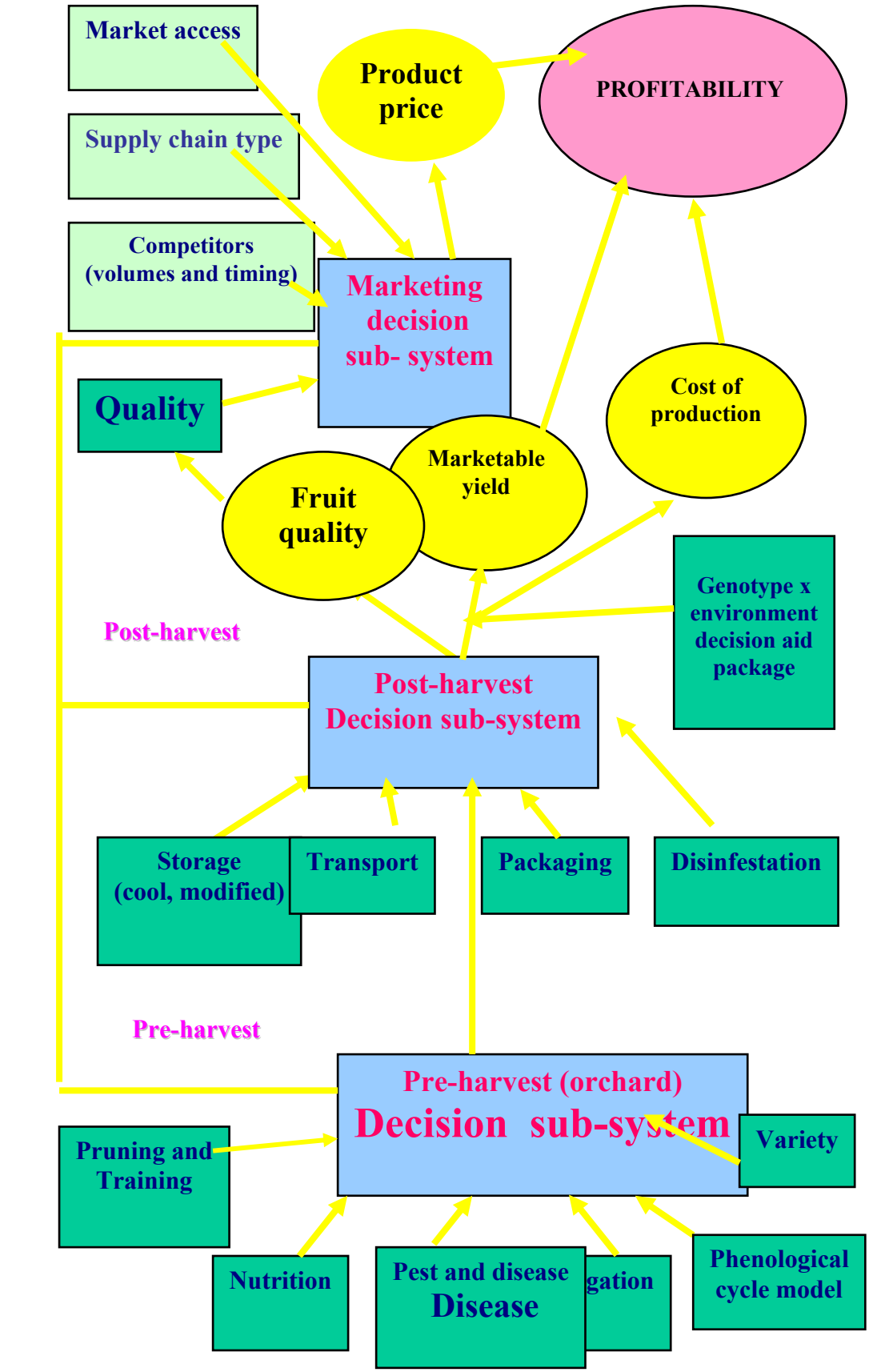
Strategic and structural planning

New strategies can only be developed by using new strategic planing processes. Current strategic planning for most horticultural industries is *seriously flawed*. This is the major problem that needs to be addressed, and urgently, by industry leaders and funding agencies!!. Strategic planning is often undertaken by *inexperienced* consultants, or those with vested interests, in conjunction with farmers and *without the appropriate global information*/intelligence necessary to make complex decisions. Industry/farm planning must be from the outside (global perspective) to the inside, not the reverse as is currently the case. Unfortunately, many farmers lack the time and *visionary skills* needed for strategic planning and focus on *immediate* issues such as pest and diseases issues rather than the *strategic and global* issues, which could ensure long-term viability of their farms.

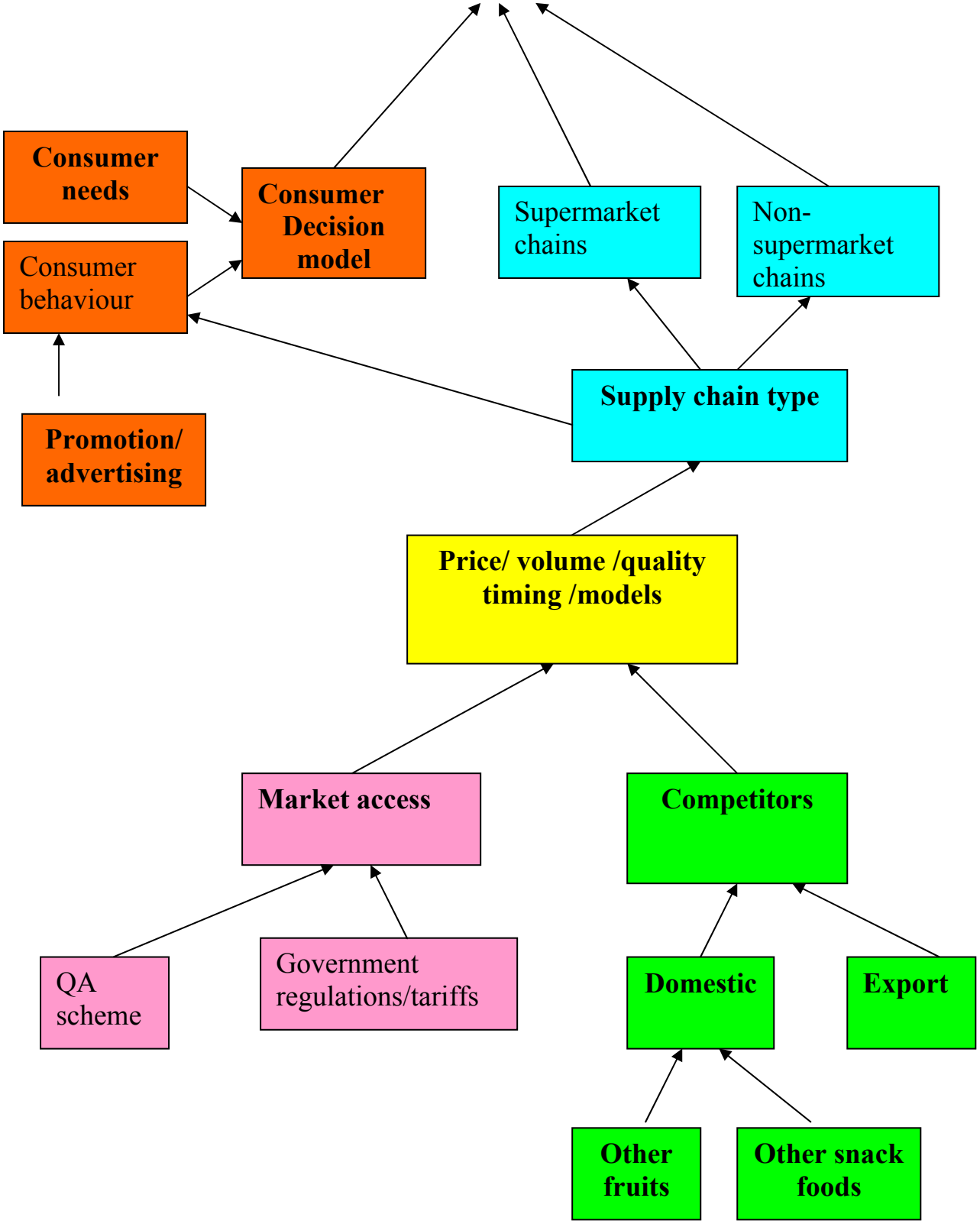
Effective strategic planning would be best made by people with *`big picture', holistic or systems thinking skills*. There are very few of these people involved in horticulture production or marketing systems in Australia. Most scientists have ISTJ personality types (Myer Briggs personality test), with reductionist thinking capabilities. In addition, representatives from all sections of the whole supply chain (consumers, marketeers, researchers, growers) must be present at strategic planning meetings. Whilst the horticultural science conducted in Australia is excellent, the strategic direction where science could be best utilised is often misdirected.

A new approach to strategic planning which encompasses the changes due to globalisation is urgently needed. Our approach, a 6-step process, is briefly outlined below.

STEP 1. The first step is to set a *holistic systems framework* or blueprint, which shows the interrelationships between the three industry sub-systems: orchard, post-harvest and marketing sub systems. Each of these subsystems is interlinked and no one sub-system is more important than the other. In the holistic model, all sub-systems are as equally important. It should be noted that the largest gains in revenues for the horticultural sector have in fact come from increases in *productivity and efficiencies* and not from improvements in price, even though fruit quality has improved significantly over the past decade. Marketing, whilst the final step in the process, is solely dependant on the pre- and post-harvest components.



MARKETING SUB-SYSTEM IN MORE DETAIL



A schematic diagram needs to be drawn to show these relationships. A very simple version of this is presented in Figures 1 and 2. This is *a very important* step because people get onto *`band wagons/fads/buzz words/recent innovations/trends'* and push these as saviours for industries. Unfortunately, these bandwagons/fads/innovations *substitute* for the real goal of profitability/viability. The reason that many

consultants/leaders like `bandwagons' is the difficulty in seeing the `whole picture'; it is easier to `chunk' information and find simple solutions to what are often complex problems. Alternatively, they may have a vested interest in the outcomes.

Since 1972 we have seen about 20-band wagons/trends that have come and gone, or partially gone. The most recent bandwagons/innovations are biotechnology, QA and EMS. Unfortunately, none of these are *saviours* for industry. For example, biotechnology is a tool that will deliver new varieties but this *does not guarantee* that the grower will receive a higher price for the fruit, as there are many factors outside of the control of growers affecting this. In other words we need the systems framework to see exactly where new activities or new technologies fit into the whole picture, particularly more so when operating in a global economy.

STEP 2. A complete economic analyses needs to be conducted for both the production and marketing sub-systems of the whole system. This process is very important to determine and compare grower costs of production, with those of your competitors, whether on the domestic or international scene, as this allows the grower to determine their baseline for setting their profit margin and returns on investment.

Secondly, a comparative analysis is needed on the profit margins for all collaborators in the supply chain and for competing supply chains, both domestic and international. Due to lack of transparency, profit margins for `middlemen' can often only be calculated by process of deduction. This is an important analysis as one of the solutions to reduced returns to growers would be to **direct market** (discussed later).

STEP 3. After conducting a complete economic analysis for an industry the next step would be to set *the key performance indicators (KPIs) and key performance monitors (KPMs) for the industry and the orchard/farm.* Many of the keys KPIs are obvious eg net profits, costs of production etc. Most importantly the variable costs of production need to be carefully assessed for the different operations/activities, as reducing production costs would be a key strategy in remaining viable. Whilst some of these KPIs are obvious (not discussed in this paper), there are others that are very rarely assessed. These include returns on capital invested, returns for advertising dollars etc.

Key performance indicators can also be set for agronomic and physiological processes in the orchard. These include the usual performance indicators such as leaf nutrient standards as they have the greatest impact on marketable yield and quality.

One of the greatest difficulties we have in assessing the potential impact of new technologies is that they are not properly assessed via the key performance indicators. Other indicators are used with the assumption that they are important. For example, the number of articles in women's magazines is *not* a key performance indicator for advertising/promotional dollars; biotechnology is a tool, not a KPI, nor is implementing a QA or EMS system, until there effects on KPIs such as net profits are assessed. Again, many industry leaders substitute technologies/bandwagons for key KPIs such as net profit.

STEP 4. Risk assessment. After determining the key performance indicators it will be necessary to rate the major risks for the industry. If you ask this question of a group of growers, they will mostly tell you that it is `pest and disease incursions'. Again,

holistic thinkers need to guide this process. For most horticultural industries, lack of industry cohesiveness would rate as a much higher risk, as large-scale global marketing will be essential to ensure that a competitive, quality product reaches the market place.

STEP 5. After establishing the holistic systems framework and setting the key performance indicators it is then possible to undertake the **`what if analyses'** with a greater degree of certainty and consensus. `What if' analyses assesses and compares the impact of new technologies and strategies on economic performance. They are often a best guesstimate of expected outcomes. However, with additional data, mathematical or other predictive models could be used to determine potential outcomes with a higher degree of certainty.

STEP 6. Based on `what if ' analyses it is then possible to determine the key strategies that industries need to adopt which will give them the greatest returns for the dollars invested. It also will determine the most appropriate **R, D & E strategies** to implement.

STEP 7. Repeat the above process on a regular basis.

NEW R D & E STRATEGIES

Strategy 1. Collective promotion and education

One of the greatest growth industries for this century will be the `wellness' industry. This industry will be driven by the baby boomers who are now reaching their 50s. Our assessment is that it will be very difficult to increase domestic market consumption due to the competition from other snack foods!!. For example `Uncle Tobys' leads the nutritious snack category, which is valued at $312M (about 36% of the snack food sector) and growing at an estimated 15% per annum. Many of the snack foods that are advertised in the newspapers and TV, contain fruit, but the percentage of fruit component is often less than 5%.

To significantly increase consumption of fruit in Australia, which is currently one of the highest in the world, we suggest that all fruit industries in Australia would need to pool their promotional dollars in a *joint promotional program* to increase consumption of fruit and vegetables by the children, young adults and by the baby boomers. However, even with significant level of funding ($10M annually), it would still be a very small advertising budget compared with large snack food industries such as Coca Cola who spend $150 Million per annum promoting their beverage product in Australia. Most food industries spend between 2 to 3% of the total budgets on advertising and promotion. A comparable amount for the Australian fruit and vegetable industries, which are valued at $5.5 Billion, would be about $137.5 Million.

However, attempts are being made in many developed countries, and in Australia by the National Public Health Partnership, to increase the consumption of fruit and vegetables by about 10%. In the USA, between 1992-97 the National Cancer Institute funded a national program (5 A Day, 3 portions of vegetables and 2 portions of fruit) to research and promote fruit and vegetables in the American diet. Out of a total

budget of about $50M, $10M was allocated to media/communications. It is claimed that the total program increased fruit and vegetable consumption increased by about 10%, but more recent reports suggest that it has little effect. In Australia there are plans to spend $75 M on the program over next 5 years. As in the USA and EU, these programs have largely been unsuccessful in increasing consumption rates, whilst there have been small increases in the number of portions of fruit and vegetables eaten by persons over 55 years of age, the trend with children and young adults has been reverse.

The nutritionist, Rosemary Stanton, at the Snack fruit conference held in Brisbane in 2002 suggests that a `fat tax' be imposed to pay for the promotion campaigns. Obviously these campaigns need to targeted at the young less than 12 years of age (before they are brainwashed), the health professionals and the `baby boomers'.

Several recent studies in the UK and elsewhere (published in Lancelet) have showed that vitamin and mineral supplements had no beneficial effects on health. In contrast, there are numerous studies showing the beneficial effects of fresh fruit on health. These benefits need to be promoted to the public. It should be noted that Australians currently spend $6B annually on vitamin supplements.

Before governments may be willing to invest in promoting fruit and vegetables for to improve health and wellness, the effect of nutritional benefits in **real dollar term** needs to be evaluated eg a study in British Columbia showed that such a promotion would reduce their health care bill by $1B US. The Australian Institute for Health and Welfare estimates the economic cost of poor diet to the Australian health care system to be in the order of $1.5B per year. This increases to $2.2 Billion when indirect costs such as lost productivity are included. *However none of these studies show the beneficial effects of wellness on increased productivity, which could be worth an additional $5-10 Billion. Increased consumption of fruit and vegetables could reduce the medical bill by several billions and improve wellness to a similar degree. This message is not being delivered to politicians.*

Strategy 2. Export

Australia has an excellent opportunity to capture out of season export markets to Asia in particular China. It is estimated that China has about 60 Million wealthy people and this is expected to double in the next 10 years. To be successful on the export markets we need to re-engineer the whole export supply chain. In 1995, consumption rate of fruit in China was 54 kg per capita. Other near eastern neighbours (Taiwan, HK?) 109 kg. In 1995, consumption rate of vegetables was 146 kg per capita. Therefore, considerable room exits to double or treble consumption of fruit and vegetables in Asian countries to raise them to the same level as Australia.

TABLE 3 *Comparative market potential based on an estimated 10% of the population being wealthy*

Country	**Purchasing power ($US)**	**Population total**	**Top 10%**
Australia	18 480	19	1.9
USA	25860	277	27.7
China	2510	1260	126.0
Korea	10540	48	4.8
Indonesia	3690	220	22.0
India	1290	850	85.0

Two issues are critical to the success of increasing exports. Firstly, to achieve economy of scale in export marketing, Australia can only *sustain 3 globally competitive, regional export companies*. These export companies need to be of similar capacity to Capespan International in South African, Carmel in Israel, Dole, Del Monte and Chiquita in Chile. All these companies are exporting over 100M tray equivalents per annum. In Australia, we currently have over 180 companies/growers exporting fruit and most exporting less than 20 000 trays each – far too many to be successful!!!. Our largest exporter is Vitor with only 2 M trays of citrus.

Secondly, these export companies need to be *grower owned* and *employ their own professional marketers* (vertical integration). This eliminates the problem of unprofessional agents and sourcing of poor quality fruit from the market floor for export, which severely damages Australia's, export reputation and results in it being labelled opportunistic. It also significantly reduces transaction and employment costs by eliminating one player in the supply chain (a discussion paper by George and Nissen, 2001) on how to set up these global marketing companies has been prepared)).

Therefore, to be successful with increasing exports, we need to get industry leaders/grower groups for a range of fruit commodities to work together, and market through a *single desk with a single brand.* It also means that we need rapid sea-freight of commodities to Asian destinations.

Getting growers to work co-operatively together is a huge, but the most critical task to improve global competitiveness of Australian horticultural industries. Lack of cohesiveness is due to many factors including: lack of trust and transparency, fractional infighting within many existing grower commodity associations and the tyranny of distance between regions. We suggest that industry leaders, HAL and all State Departments invest expenditure in employing professional facilitators to conduct this process and to ensure cohesiveness of these larger groups.

Also, the formation of *alliances* between Australian and Asian producers, marketeers and R&D agencies will become more increasingly important. Whist increasing imports of fruit into Australia is inevitable, we also can capitalise on increasing

exports into much larger Asian markets/countries through the formation of strategic alliances with partners in these countries.

Selecting export winners

Due to rapid improvements in post-harvest disinfestation methodologies (eg electronic pasteurisation, vapour heat, cold sterilisation etc.), many fruits can be grown and imported into Australia more cheaply than they can be produced here. Only selected fruit industries will remain viable and these more than likely will be export-orientated. Fruits that fall into this category are:

- those which are counter-seasonal to those grown in the northern hemisphere, are the ones which Australia should concentrate on growing and investing R&D. Some fruits, such as banana, will be more susceptible to imports than others as they can be produced all year-round in most Asian and South American countries.
- have short <3months but sufficient storage life to ensure that the commodity can be sea-freighted but also ensure counter-seasonality to northern hemisphere producers. Apples can now be produced and stored all year round in developing countries eg. China.
- are also difficult to disinfest – this will further lessen the risk of being imported.
- those that require a high level of technology to produce eg custard apples, persimmon, blueberries

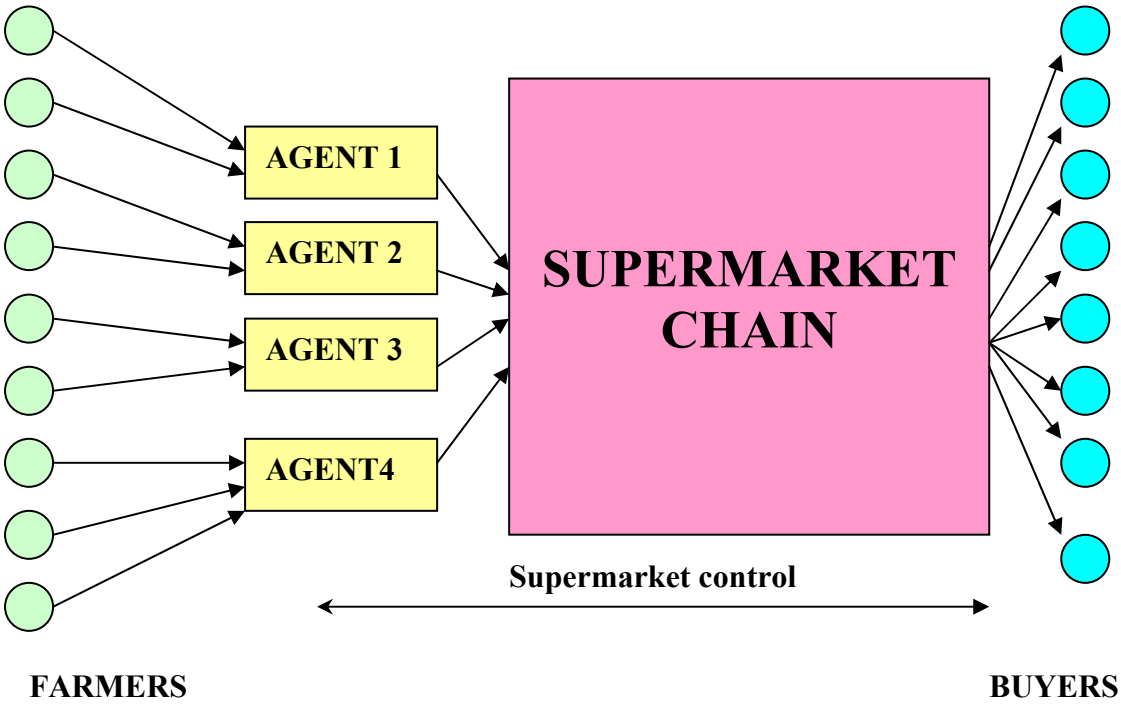
Strategy 3. Setting up global, regionally- based marketing companies

Many marketing consultants regard supply chain management as the panacea to solving many of the marketing issues. Unfortunately the *supply chain is controlled by the supermarkets* and the global marketing and distribution companies or agents *(preferred suppliers)* acting on their behalf. Global clusters and strategic alliances in agrifood industries are examples of corporate convergence which is the becoming the global norm. In 2000, three retailers Carrefour, Ahold and Wal-mart had food and non-food sales of $300B. Nestlé, Philip Morris and Unilever have emerged as the top three food makers. It is predicted that there will be only 4-6 global supermarket chains by 2010 (CEO, Royal Ahold). Unfortunately growers are their own worst enemy, undercutting one another in prices, allowing the supermarkets to play one grower/group off against the other to reduce price.

The only solution to this problem is for growers to market together *(horizontal integration)* so as to control supply. The chances of getting all growers to market together are very slim but a *serious attempt* should be made to make this happen. Vigorous antitrust policy to reduce the power of oligopolies may also address buyer concentration.

Grower survival will depend on strategic alliances with processors, retailers and will centre on food quality, safety and wellness. Small farmers will have greater problems meeting stringent quality and safety requirements and will have higher relative transaction costs within supply chains and greater risk. Most of the compliance costs

will need to be met by the farmer, consequently only well-capitalised farmers will be able to comply, these may not necessarily be the largest.



Strategy 4. Direct marketing – shortening the supply chain

Firstly, to achieve economy of scale in export marketing, Australia can only *sustain three globally competitive, regional export companies*. These export companies need to be of similar capacity to Capespan International in South African, Carmel in Israel, Dole, Del Monte and Chiquita in Chile. If economy of scale in marketing could be achieved through large scale combined group/commodities marketing under a single desk, grower owned company then the company could employ its own professional marketeer(s) who would be payed a base salary plus bonuses based on the number of trays exported and not on a commission basis as is customary with agents.

Horticultural R, D&E priorities

R, D &E is vital to the future success of any industry. The Australian wine industry is an excellent example. The amount of funding spent on R,D&E in agricultural research in Australia as a percentage of GDP (<1.5%) is appalling low and declining. Unless this situation is rectified, Australia will find it increasingly difficult to gain competitive advantage on global markets.

If we look at the above strategies they all require somewhat *different R, D&E priorities depending on the strategic direction* decided on. For example, the export

strategy would place emphasis on post-harvest and transport technologies, and disinfestation technologies. The increasing consumption strategy would place greater emphasis on guaranteeing fruit quality.

Studies that are urgently required

The following studies that have implications for the strategic planning of all fruit industries need to be carried out *urgently:*

- Historical consumption patterns for fruit and vegetables in Australia and for countries, to which Australia exports, particularly Asian countries, need to be evaluated. This will provide the baseline for determining the effects of promotion and impact of some R&D strategies.
- The effects of current promotional programs on the consumption rates per head of population and on price need to be evaluated for a range of fruit industries to determine their effectiveness. If current promotional programs are ineffective these funds can then be directed to programs with greater impact.
- Complete economic analyses of both production and marketing sub-systems for a range of fruit industries needs to undertaken and the different industries benchmarked in terms of KPIs. It appears that some industries such as citrus are performing well in being able to export 35% of their production.
- The effects of quality on price in multi-commodity situations needs to be determined both in consumer focus groups and `within store' to *quantitatively* evaluate the effects of substitutability of different fruits and the impact of supermarket lines of special on price. Perhaps we also need to include in these studies the effects of other snack foods, besides fruits, on purchasing decisions.
- Sensory profiling of different fruit commodities/varieties particularly for different Asian ethnic groups i.e. Chinese, Japanese and Vietnamese. This is particularly important for breeding and selection programs, otherwise we are flying blind!!

A study needs to be conducted on the total number of companies exporting fruit and vegetables from Australia, their export destinations and their export market size.

- A study needs to be conducted on the current sea-freighting channels available to rapidly transport fruit to Asia and the ways to improve them.

Implications And Possible Future Directions For The Australian Custard Apple Industry

- The Australian Custard Apple Industry is in an ideal position to develop high-priced, exotic, niche markets in Asia and Europe.
- Cohesiveness in custard apple marketing will be vital to maximise prices and to coordinate supply.
- The industry should look at controlling new varieties through licensing and production royalty agreements with both southern and northern hemisphere producers to produce high quality fruit all year round to speciality shops and supermarket chains.

- In the short term, the industry may need to form alliances with other commodity groups currently exporting to Asia eg persimmon, blueberry industries, to gain economies of scale in export marketing.
- In the longer term, the custard apple industry will need to look at being a partner in the formation of grower-owned global, export market company covering all fruit and vegetable commodities. This company would be ideally based in Brisbane.
- The industry must look at ways of guaranteeing both external and internal fruit quality and brand only the high quality product.
- Promotion as a strategy to increase consumption needs to be carefully evaluated using key performance indicators eg increase in farm gate price per advertising dollar – it may be better for all industries to pool their resources in promotional and educational activities rather than to compete against one another. However we recognise that custard apples are under promoted and under recognised in Australia and overseas, and will benefit from structured and focused promotion.
- Growers should implement all the new production technologies to maximise productivity and fruit quality. This will ensure they will survive and prosper in the longer term.

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3.3 Calendar for tree manipulation

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Keywords: *Annona* spp., management practices, key performance monitors, rest-breaking chemicals, growth retardants, leaf tipping and stripping.

Abstract

Many new technologies have been or are currently being developed to improve yield and fruit quality of custard apple. These new practices need to be incorporated into a whole management system so as to maximise the synergies between the practices and thus improve yield and fruit quality. They include the use of rest-breaking chemicals, chemical growth retardants, leaf tipping and stripping, humidity control, and correct rates and timing of fertiliser adjusted by leaf nutrient analyses at critical stages in growing cycles. These practices need to be fully monitored and intensity/rates and timing adjusted according to key performance monitors.

New technologies and practices

Preliminary investigations conducted over the past four years have successfully identified a sequence of treatments that will potentially increase fruit set and yield in custard apple by up to 60% with an associated improvement in internal fruit quality.

These techniques will be used in future on the new varieties, Maroochy Gold and KJ Pinks, that have been released for field testing, as the combination of new naturally setting germplasm and new management will ensure consistently high yields and quality.

These techniques will also be **essential** if trees are to be trained and successfully managed on high-density, open Tatura trellis systems, which are now being set up in Queensland and New South Wales. These techniques/practices/technologies are described below and are summarised in Table 3 at the end of this article.

Rest-breaking chemicals

The main cultivars of custard apple grown in subtropical Australia are ‘African Pride’, ‘Hillary White’ and ‘Pink’s Mammoth’. The growth characteristics and phenology of these cultivars are poorly understood. Flowers are produced at the base of newly emerging laterals of moderate vigour (30 to 50 mm base circumference). Fewer flowers are produced on very weak and very strong laterals (Figure 2-1). Cultivars such as Pink’s Mammoth, KJ Pinks and Hillary White cultivars, which have strong apical dominance, produce fewer flowers than less apically dominant cultivars such as ‘African Pride’ (Figure 1).

Several rest-breaking chemicals have been trialed over the past four years. The most effective of these was Dormex (4%) or a combination of Dormex (4%) and Armobreak (2%). However, because Dormex is highly phytotoxic getting it registered for use in custard apple may be difficult.

A new group of rest-breaking chemicals, Waiken, has been trialed recently. It is a mixture of various fatty acid esters. It has a mild rest-breaking effect on custard apple compared with the hydrogen cyanamide (Dormex). However because of its low environmental toxicity and user friendliness, Waiken is more likely to be registered for use, with a trial permit pending. Waiken (4%) proved to be more efficacious when combined with potassium nitrate (5%).

Time of application of rest-breaking chemicals is important. For custard apple, correct timing appears to be about six weeks prior to normal bud break. In southeast Queensland, this would coincide with the 3rd week of August.

Leaf tipping and stripping

Leaf stripping is a useful technique to increase late flowering and fruit set. This technique, if done at the appropriate time during early summer, releases the sub-petiolar buds (buds below the leaf stalks), increasing and in some cases doubling, the number of new season laterals and flowers. Leaf stripping involves removing 5-10 terminal leaves, including the tip (about the last third), depending of shoot length.

In addition, it converts potentially strong vigourous growth into more laterals and many more growing points which helps to dissipate tree vigour.

The timing of leaf stripping appears to be critical. In southeast Queensland we think that the best time to leaf strip is in late November/early December. It takes about 6-8 weeks for the sub-petiolar buds to grow away and for the new flowers to reach anthesis (opening).

Consequently, if leaf stripping is done too late in the season, the temperatures at anthesis may be too low for pollen germination and pollen tube growth to obtain satisfactory fruit set. We intend to investigate faster ways of leaf stripping eg steam applicators.

Fruit quality assessments conducted in 2002 showed that combined use of growth retardant and leaf stripping reduced the severity of internal woodiness by 80%, presumably due to less competition between the developing fruit and leaves (shoots).

Effects of various tipping and leaf stripping treatments on the number of new laterals produced from two trials conducted at Rockhampton and Yeppoon during 2001-2002 is presented below.

Treatments were:
1. Control
2. Shoot tipping (November)
3. Shoot tipping plus leaf stripping (November)
4. Shoot tipping plus leaf Stripping (November) plus shoot tipping (January)
5. Shoot tipping plus leaf stripping (November) plus shoot tipping plus leaf stripping (January)

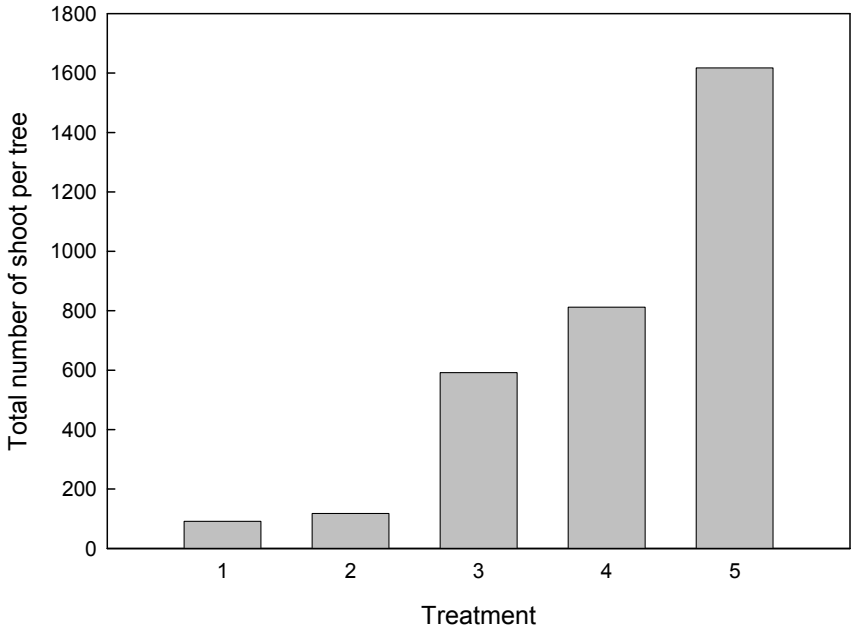
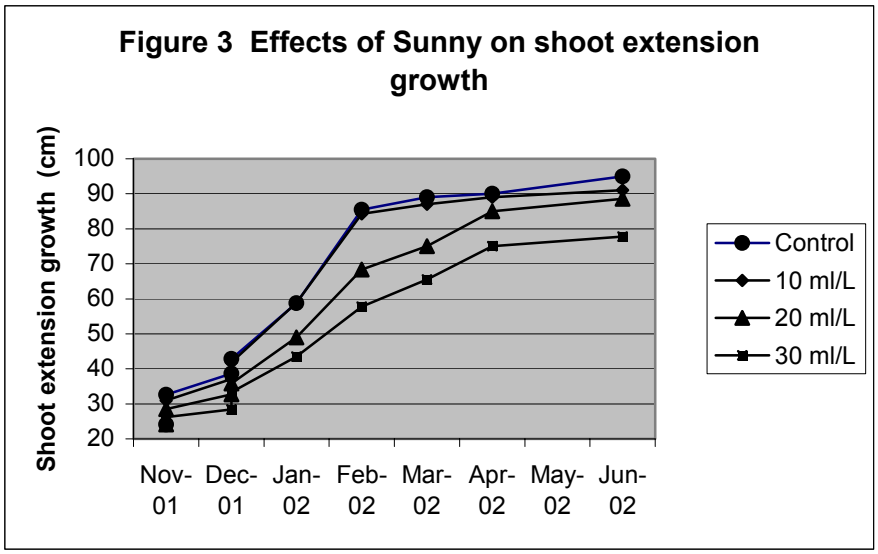


Figure 2. Total number of shoots per tree vs treatments, Rockhampton.

Growth retardants

Excessive vegetative growth has been shown to reduce fruit set and significantly increase the severity of woodiness. Shoot growth greater than 60cm is excessive, so control of growth early in the season, during the first vegetative flush, will be highly beneficial. The growth retardant, uniconazole, Sunny, has been shown to effectively control vegetative growth in custard apple (Figure 3). Each application of the growth retardant Sunny reduced shoot extension growth by about 20%. Two applications about one month apart during the early vegetative flush may be necessary for maximum effectiveness. (**Note Sunny is not registered**).



Humidity control

The ideal humidity range for fruit is between 75-90% RH as this increases stigma receptivity. Late afternoon rain or over-tree irrigation can increase fruit set perhaps by causing condensation of water droplets within the fleshy petals of the flower. We suggest that the overhead irrigation be pulsed on/off at short intervals from about 4.0pm to sunset. However, further investigations are needed to elucidate on the effects of sprinkling for humidity modification. Low rates should not cause waterlogging.

In contrast, light rain or continuous daily sprinkling are detrimental possibly because they dilute the floral scents, which attract pollinators.

Manipulation of insect pollinators

For some custard apple cultivars eg African Pride, fruit set appears to be increased due to the presence of insect pollinators called nitidulid beetles. These are many species, which may be effective in pollinating custard apples. Hanging rotting fruit attractants, in particular pineapple, in the orchards, may increase populations of these beetles in custard apple orchards. Alternatively, a pheromone lure has been developed by the DPI Victoria to attract these insects, as they are a pest in stonefruit orchards in this State.

Soil and leaf nutrient status

Leaf nutrient analysis is commonly used for diagnosing nutrient deficiencies and establishing fertiliser recommendations for tree crops, however sampling needs to be taken into account, the effects of leaf age and position, fruiting, and phenology on leaf nutrient status. The most stable time to leaf sample for most nutrients in custard apple was just prior to harvest. However sampling just after fruit set may be a better indicator of calcium status of the tree as most calcium is taken up during early fruit development. Revised leaf nutrient standards set for 1 month prior to harvest are presented in Table 1.

TABLE 1. *Tentative Australian leaf nutrient standards compared with current leaf standards for custard apple in subtropical Australia*

Nutrient	**Existing standards***	**Tentative Australian Standard****
N (%)	2.5-3.0	2.4-3.2
P (%)	0.16-0.2	0.15-0.21
K (%)	1.0-1.5	1.0-1.50
Ca (%)	0.6-1.0	1.0-1.6
Mg (%)	0.35-0.5	0.3-0.4
Cu ($\mu g\ g^{-1}$)	10-20	10-22
Fe ($\mu g\ g^{-1}$)	40-70	41-66

Nutrient	Existing standards*	Tentative Australian Standard**
B ($\mu g\ g^{-1}$)	15-40	53-107
Zn ($\mu g\ g^{-1}$)	15-30	18-27
Mn ($\mu g\ g^{-1}$)	30-90	59-137

*Sanewski, G.M. (1991)

Calcium

Because of the importance of calcium on fruit quality of custard apple soil pH needs to be maintained at 6.5 to 7.0 and soil calcium concentrations greater than 8 meq/100g. Where pH is measured in 0.01M $CaCl_2$ the reading will be 0.6 to 0.8 lower than for the 1:5 water testing method. Suggested standards for custard apple are presented in Table 2. An organic carbon value less than 2% means your soil organic matter levels are low, while 5% suggests they are high. The use of cover crops, the addition of animal manures, mill mud and compost, mulching, mowing and minimum tillage will increase organic matter levels over time. Higher soil organic levels should improve calcium availability and uptake.

TABLE 2 *Suggested Australian soil nutrient standards for custard apple*

Nutrient	Standards
pH (1:5 water)	6.5-7.0
pH (1:5$CaCl_2$)	5.5-6.0
Organic carbon (Walkley-Black)	Greater than 2.0%
Nitrate nitrogen (1:5 aqueous extract)	Greater than 10 mg/kg
Phosphorus (Colwell)	20-120mg/kg
Potassium (exchangeable)	Greater than 0.5 meq/100g
Calcium (exchangeable)	Greater than 8.0 meq /100 g
Magnesium (exchangeable)	Greater than 1.6 meq/100 g
Sodium (exchangeable)	Less than 1.0 meq/100 g
Chloride (1:5 aqueous)	Less than 50 mg/kg
Conductivity (1:5 aqueous extract)	Less than 1.0 dS/m
Copper (DPTA)	0.3-10 mg/kg
Zinc (DPTA)	2-15 mg/kg
Manganese (DPTA)	4-60 mg/kg
Manganese (water soluble)*	Less than 2.5 mg/kg Greater than 7 mg/kg, toxic
Iron (DPTA)	Greater than 2 mg/kg
Boron (hot calcium chloride)	0.5-1 mg/kg
Calcium:magnesium ratio	3-5:1
Total cation exchange capacity	Greater than 7

Nutrient	Standards
Cation balance (%)	calcium 65-80; magnesium 10-15; potassium 1-5; sodium less than 5

* More reliable test but not commonly used by Australian laboratories

TABLE 3. Calendar of key management practices for custard apple in southeast Queensland. Timing will need to be altered for other growing regions according to stage of growth.

TIME OF YEAR	STAGE OF GROWTH	KEY PRACTICE	KEY MONITORS	KEY EFFECT	COMMENTS
July/August/Sept/Oct	Dormancy and early bud break	Moderate water stress Apply two sprays of copper oxychloride about two weeks apart before bud break (see paper by Don Hutton)	Leaf and stem water potentials, soil moisture potentials measured by tensiometers	Increases floral initiation and flowering	Do not stress trees once fruit start to set as this will reduce final fruit size Spray all leaves left on the tree and on the ground, cleans up carry-over fungal infection
Early August	six weeks prior to bud break	Chemical defoliation	% leaf fall or abscission, should be 100%	Reduces inhibition of apical buds thus increasing lateral growth	Use 25% urea, addition of Ethrel® may improve efficacy if leaves are hard to drop
Late August	one month prior to bud break and after 90% leaf	Apply rest breaking chemical - do not apply closer than one month before bud	No. of new laterals per branch/leader	Increases new lateral growth and consequently number of flowers	The rest-breaking chemical Waiken will receive a trial permit

TIME OF YEAR	STAGE OF GROWTH	KEY PRACTICE	KEY MONITORS	KEY EFFECT	COMMENTS
	fall	break as this may damage the floral buds			for use on custard apple for next season. Do not apply too close to bud break as this will damage the floral buds
Early October	Early bud break	Apply humic acid and mulch	Check soil organic carbon >5% and soil calcium and pH	May increase calcium uptake	May help to reduce internal fruit disorder `woodiness'
Late October/early November	one month after bud break	Experimentally, apply growth retardant when new shoots are 10cm long, two sprays may be needed about one month apart	Shoot extension growth	Slows new seasons growth reducing woodiness and increasing flowering and fruit set	The growth retardant Sunny is highly effective in controlling growth. **Unlikely to be registered before 2005.**
Late November/early December	Peak of first growth flush when new shoots are greater than 60 cm in length	Leaf tipping and stripping Apply fungicides to control leaf and fruit diseases (see Don Hutton's paper)	Only the shoots, which are longer than 60cm have the terminal 5-10 leaves stripped	Used to produce late flowering and fruit set at the optimum time for fruit set.	Takes about 6 – 7 week from stripping to flowering, if done too late temperatures at flowering will be too cold. Use registered products – Benlate or Spin flo; apply only 4 sprays of

TIME OF YEAR	STAGE OF GROWTH	KEY PRACTICE	KEY MONITORS	KEY EFFECT	COMMENTS
					either
November/December/January	Peak flowering months	Apply overhead irrigation in late afternoon – about 4.0pm (needs further investigation)	Relative humidity – 75-95%, ideally about 85%, monitor with RH loggers	Increases fruit set due to improved stigma receptivity	Only low-delivery rates are required to prevent water logging
November/December/January	Peak flowering months	Place pineapple attractants into the orchard about four to six weeks prior to first flowering or alternatively pheromone lures	Nitidulid beetle number per flower	Increases insect pollination of flowers	May only be effective for some varieties eg African Pride
December	two months after bud break	Modify fertiliser rates and timing Apply fungicides to control leaf and fruit diseases	Soil and leaf nutrient analyses	Improves fruit size and quality and reduces internal fruit disorders	Important to check leaf calcium concs. Ideal time to apply fertiliser for fruit development Use registered products – Benlate or Spin flo
February	two months prior to first harvest	Shoot tip pruning	Shoot extension growth – maintain less than 60 – 80 cm	Reduces shading of fruit and prevents excessive growth	Best if done mechanically to reduce costs
February/March	two months prior to first	Liming	Check Soil pH 6.5 – 7.0, Soil calcium >8 meq, CEC	Calcium will reduce woodiness	Apply lime and gypsum prior to wet season to

TIME OF YEAR	STAGE OF GROWTH	KEY PRACTICE	KEY MONITORS	KEY EFFECT	COMMENTS
	harvest	Apply fungicides to control leaf and fruit diseases	Calcium>70%		maximise calcium uptake for spring fruit (6-12 months for an effect) Use registered products – Benlate or Spin flo
February/March	Early harvest	Apply fertiliser Apply fungicides to control leaf and fruit diseases	Leaf nutrient analyses	Improves fruit size and quality	Apply fertiliser if necessary Use registered products – Benlate or Spin flo
April/May/June	Harvest	Apply fungicides to control leaf and fruit diseases	Check fruit quality, in particular for `woodiness', fruit size etc	Improves fruit quality	Use registered products – Benlate or Spin flo

*****Please note that some of the chemicals eg growth retardant Sunny referred to in this article are not yet registered for custard apple in Australia.

Acknowledgements

We wish to thank ACAGA and Horticulture Australia for their financial assistance in supporting the RD and E activities outlined in this paper.

3.4 Preliminary investigations into new clonal propagation techniques of custard apple *(Annona cherimola x Annona squamosa)*, variety *african pride.*

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Introduction

The Australian Custard Apple Industry is predominately based on seedling rootstocks. Genetic variability within seedling rootstock lines affects both the precocity of bearing and productivity of the scion variety.

Many growers within the industry have favourite trees that out preform other trees in their orchards. These trees have exceptional cropping ability and/or fruit quality characteristics. Recovery of these elite scion and rootstocks combinations is vital for continued genetic plant improvement within the Australian custard apple industry. Clonal propagation techniques either for elite scion variety or selected rootstock lines of known performance would eliminate this variability.

Asexual propagation techniques

Tip and stem cuttings

Although a few species of *Annona* can be easily propagated by cuttings, soursop (*A. muricata* L.) (Morton 1976) and sugar apple (*A. squamosa* L.) (Noonan, 1953; Ochse et al., 1961) and most other species have proven difficult to strike using asexual propagation methods such as tip and stem cuttings. In the late 1970's and early 1980's George and Nissen undertook studies of tip and stem propagation of *Annona* hybrids Pink's Mammoth and African Pride. On one occasion a moderate strike rate of 56% cuttings rooting for African Pride was achieved. Average strike rate for Pink's Mammoth was low, with less than 10% cuttings rooting.

Etiolation

Etiolation techniques (producing tissue in the dark) have a beneficial effect on root production of cuttings and a higher success rate than normal tip and stem cuttings achieved. But the extra costs of production using this method made this method uneconomical (George and Nissen 1987).

Marcottage

Marcottage (air layering) has also proven to be unsuccessful with success rates less than 5% of marcots rooted (George and Nissen 1987). In contrast, Neitzel (1982) has reported that marcotting on strongly growing water shoots on cherimoya is possible, although no details on success rate were published.

Tissue Culture

Tissue culture of some *Annona* spp. has not been highly successful to date due to difficulties in obtaining material free of contaminants and problems in initiating rooting. Annonas produce a high quantity of phenolic exudates. These act as a food source for many of the bacteria that contaminate tissue-cultured plants.

Grafting (dormant scion wood)

The main process for propagation of custard apple is grafting. In grafting, clonal scion material is grafted on to non-clonal rootstock material (seedlings). Grafting is normally carried out in the spring with the commencement of sap flow (Everett, 1952; Cann, 1976; Campbell and Phillips, 1983). Success rates vary according to operator experience, scion and rootstock condition with success rates from 75% to100%.

Materials and methods

In the past cuttings have been used as the primary methods for recovery and rapid multiplication of elite cultivars with a low success rate. A review of recent literature revealed several new compounds that may aid in the rooting of cuttings. Chemicals were obtained and applied as either field treatments or as root promoting compounds for the development of a successful cutting technique for custard apples.

Two experiments have been completed to date. Tips cuttings removed from mature grafted field trees of variety of African Pride in November and January. Field and cutting preparation methods and treatments are detailed below.

Field Treatments

In mid-October 2002 and in late November–early December 2002, in-field plant material preparation was undertaken to enable approximately a thousand cuttings to be taken.

Treatments applied were:

- Tip and strip
- Cincturing
- Tip and strip and cincturing
- Field applied sunny (growth regulator)
- Sunny and tip and strip

A description of the McGinnis softwood cutting technique (tip and strip technique)
A technique of taking softwood cutting recently developed by Mr. S.W. McGinnis in conjunction with QHI has developed a new technique for production of softwood peach, nectarine, and plum cuttings ready for field planting within 6 weeks after taking and is being trialed for custard apples. This technique can be used for the rapid multiplication of new germplasm.

Timing

Cuttings can be taken throughout the summer period, except during periods of strong vegetative flushing or in late autumn.

On Tree Preparation

Cuttings are initially prepared on the tree. Bend the shoot tip and cut the off the very soft terminal shoot at the point of bending. Leave two leaves and then strip the next 5-8 sets of leaves along the shoot (about 15-20 cm long). Remove the cutting from tree before the buds from the stripped section of the shoot start to shoot (normally 4-10 days after preparation, depending on temperature). Avoid taking cuttings that produce too many shoots. Place cuttings into iced water on removal from the tree. Tipping and stripping was carried out in October 2002 for Trial 1 and November 2002 for Trial 2.

Cincturing

Branches of approximately 20 to 30 cm in diameter were cinctured at the base using a cincturing tool. This double-bladed tool removes approximately 2-3 mm of bark down to the phloem. Removal of the cambium layer is essential so reserves build in the cinctured branch. Cincturing was carried out in October 2002 for Trial 1 and November 2002 for Trial 2.

Sunny (uniconazole)

Trees were sprayed with Sunny (uniconazole) to inhibit growth. This was carried out once, when average shoot growth on each tree after bud break had reached approximately 20 to 30 cm in length (October 2002). By reducing shoot growth, reserves will build up in the shoots thereby enhancing the ability of softwood cuttings to root. Sunny has preliminary registration for use in avocados as a growth retardant.

Cutting preparation after removal

Cuttings 30 to 40 cm in length are separated from trees and excess leaves and foliage removed. Cuttings are placed in an esky with freezer bricks, wrapped in wet towels to reduce moisture loss for transportation to laboratory for processing, and then cut with a sharp grafting knife through a node at approximately 15-20 cm in length.

Before planting, the base of the cuttings are dipped in chemicals to a depth of 4cm for approximately 30 seconds to promote callus tissue and root development. Cuttings for Trial 1 were removed in mid November and for Trial 2 in mid to late December.

Root Treatments

- Indole–6-Butric Acid (IBA) 2,500 ppm
- Indole–6-Butric Acid (IBA) 5,000 ppm
- Indole–6-Butric Acid (IBA) 10,000 ppm
- Naphthalene Acetic Acid (NAA) 3,000ppm
- Retain (aminoethoxyvinylglycine) (AVG) 1g/L

- Cultar (paclobutrazol) (PP333) 4ml/L
- Sunny (Uniconazole) 4ml/L
- Ascorbic Acid 1,000 ppm

Stem and leaf treatments

Other treatments were applied to the top of the cuttings. Stem and partial leaf, top of the cutting were dipped in chemicals below for 30 seconds.

- 6 benzylaminopurine (BAP) 2,000 ppm
- Gibberellic Acid (GA_3) 1,000 ppm
- KDL

Mist Bed Media

A range of sterile media can be used. A mixture of equal parts perlite and vermiculite or peat: perlite: sand is ideal. The medium must be sterile (steam or methyl bromide) and well drained.

Mist bed Environmental Conditions

Mist irrigation is essential. Mist interval is critical, as over-wet cuttings will succumb to disease. A suggested schedule is 6 seconds on/90 sec off on a hot day, 4 sec on/4 min off on a cool wet day. An indication of over wetting is that the floor below the cutting bench remains wet.

At night, reduce misting perhaps to only 4 times. Bottom heat is desirable. A temperature range of between 28-30°C at the base of the cutting appears to be desirable. Bury cuttings in mix in 10 cm pot. It is also desirable to maintain air temperature at 25°C but higher temperatures are acceptable.

If temperatures in the mist house rise above 35°C, ventilate the house. It is **critical** that cuttings are exposed to near full sunlight as low light also reduces percentage strike. Cuttings must be placed into the potting media by inserting a hole into the media with a pencil. Fertilise cuttings with a very dilute complete foliar mixture.

Disease control and cutting treatment in mist bed

Weekly treatments are applied with a mixture of 3mL/L Agri-Fos-Supa 400+, 0.5g/L Solubor, and 3g/L ammonium nitrate. It is **critical** that the water supply is free of pathogens i.e. use tank water.

Results

Mist bed media

The mist bed media 50% perlite and 50% vermiculite used to strike cuttings taken in mid November was not free draining. This media did not to allow sufficient drainage and maximum air precocity to imitate callus production and rooting of cuttings. Cuttings were removed in mid December from this media and re-potted into a new medium of 60% perlite and 40% course river sand.

Of the 819 cuttings set down in mid November 2002 in the medium of 50% perlite and 50% vermiculite, 66% of the cuttings were not alive upon removal in mid-December 2002. In contrast to the 819 cuttings set down in a new Trial in mid December 2002 in a media of 60% perlite and 40% course river sand, and removed in late May 2003, 11% of the cuttings died.

Carbohydrates

Cutting carbohydrate status may also have an affect on the strike rate success. From previous experiments conducted by George and Nissen (1987), higher carbohydrate reserves provide cuttings with a greater chance initiating roots. Stem cuttings taken in

experiments in August through to October in 1982 and treated with 2,500 ppm of IBA had on average a root strike rate of 9%, while tip cutting achieved on average 23%. Mobilisation of carbohydrates reserves during rapid leaf drop and early bud break may be responsible for such low strike rates during this period. Comparing this to cuttings taken in November 2002, where carbohydrates reserves may be higher, a strike rate of 23% was achieved.

Cuttings taken in December 2002 when vegetative growth rates have slowed, allows for even higher carbohydrate levels within the cutting, and a strike rate of greater than 70% was achieved.

Therefore, rooting increases as vegetative growth is controlled. A rise in carbohydrates levels allows the cutting to live on stored reserves, which facilitates the development of callus tissue and roots. The affects of in field preparations on vegetative growth for Trial 1 (cuttings prepared in mid November) and Trial 2 (cuttings prepared in late December) are shown in Figure 1 below.

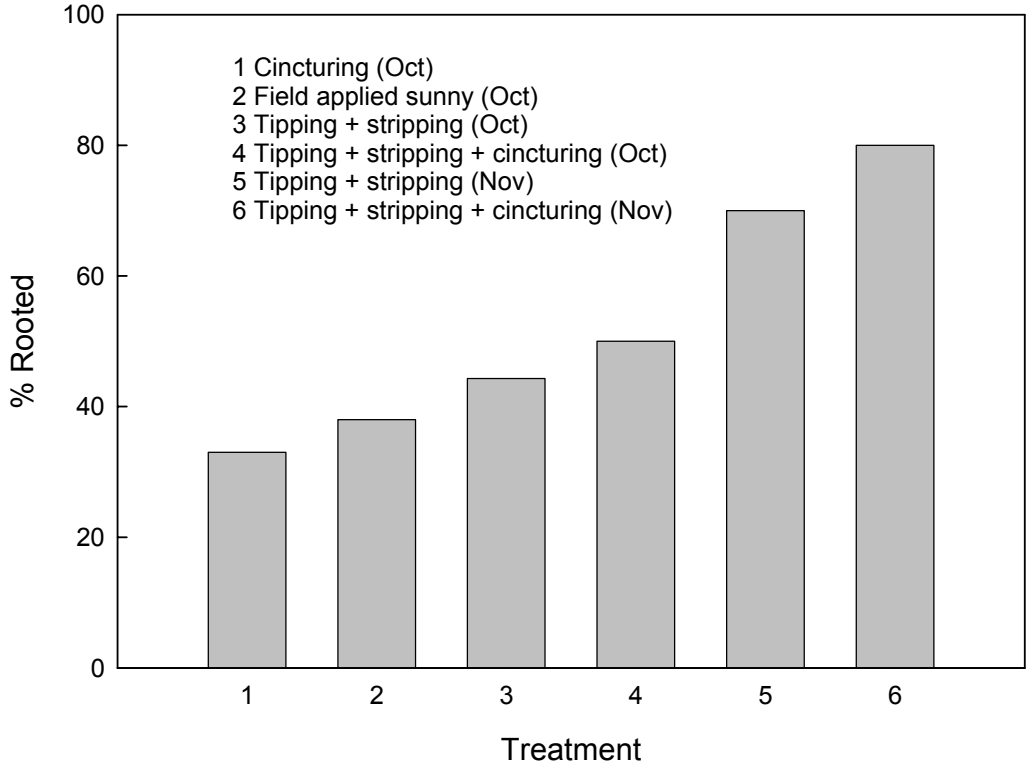

Figure 1. Effects of field treatments on strike rate (rooted cutting) of the variety African Pride. Note that various chemical treatments were used on the cuttings and these are being in commercial in confidence.

Rooting hormone treatments

Increasing the rooting hormone concentration of Indole–6-Butric Acid (IBA) form 2,500 ppm to 5,000 ppm and to 10,000 ppm had very little effect. A maximum of 5% and 3%

difference occurring between all three treatments for both Trials conducted in November and December 2002 to May 2003. Further combination treatments with Naphthalene Acetic Acid (NAA), Cultar (paclobutrazol) (PP333), Sunny (Uniconazole) failed to improve strike rates. Results show, as cuttings are subjected to more chemicals (dipping), lower strike rates were achieved. These treatments used conjunction with IBA lowered the strike rate on average reduced by 3% to 5%.

Retain (aminoethoxyvinylglycine) or AVG is used to stop fruit from ripening early (lengthening their maturation period), giving improvements in fruit quality. Fruit are subject to this material, which inhibits the production of ethylene. Once plant tissue is cut, wound ethylene is produced. The base sections of the cuttings were dipped in Retain to a depth of 40mm for 30 seconds. Retain was used to inhibit this ethylene production and stimulate the healing process.

It was hoped that less phenolic exudates would be produced as a result, thereby providing little or no food for bacteria to utilise and infect cuttings reducing strike rates. But results show that retain had little or no effect on the number of cuttings that rooted. Trial 1 showed that Retain reduces the number of cuttings that rooted by 3% and by 6% in Trial 2.

Stem and leaf hormone treatments

Applying to 6 benzylaminopurine (BAP) to the stem and leaf of the cutting reduced the strike rate by 17%, as did the application of Gibberellic Acid (GA_3), which reduced the strike rate by 13%. KDL had no effect on the percentage of cuttings that rooted. Shoot production was also reduced on cutting subject to these treatments. BAP, GA_3 and KDL all reduce the number of shoots on average by 8% as opposed to untreated cuttings.

Conclusions

The overriding factor in improving the strike rate in the Annona *cherimola* x *Annona squamosa,* variety African Pride is timing (taking of cuttings when carbohydrate reserves are peaking). Field treatment methods such as tipping and stripping and cincturing to improve this carbohydrate status through controlling vegetative growth are highly effective.

The use of a media that provides good drainage and maximises air precocity to imitate callus production and rooting is essential.

Treating cuttings with a rooting hormone such as IBA significantly improves the strike rate. But combination this treatment with other chemical hormones reduces the strike rate. Stem and leaf hormone treatments also reduce the strike rate.

Further studies are needed to determine the optimum timing to take tip cuttings.

Acknowledgments

We are extremely grateful for funding support from ACAGA and HAL. Please note that the chemicals referred to in this article are not yet registered on custard apple in Australia.

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3.5 The bottom line for fruit fly control in 2003.

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Abstract

Although there has been a great deal of research on fruit flies in Australia over many decades, these pests continue to be one of the most widespread and costly problems facing horticultural producers in the country today. For custard apple growers, the presence of fruit flies in production areas necessitates effective field control and the implementation of protocols to meet quarantine market access requirements.

Although there has been relatively little research specifically directed at fruit fly problems in custard apples, there has been significant recent research on new fruit fly control methods, which are directly relevant to this commodity. This paper describes the latest fruit fly control methods, which are available in Australia, and discusses the outcomes of recent research undertaken by the Market Access Team in the Queensland Department of Primary Industries' Agency for Food and Fibre Sciences.

Introduction

It is difficult to determine exactly what fruit flies cost Australia. In a 1998 national review
it was estimated that the total annual expenditure related to fruit fly issues across all states and across all commodities was approximately $500 M. The cost bottom line in 2003 is no doubt even higher.

Although there have been no major exotic fruit fly incursions into Australia since the papaya fruit fly outbreak in 1996, surveillance programs must be constantly maintained for early detection of exotic pest species which could easily enter Australia, particularly from areas to the north of the country. Costly surveillance, incursion management and suppression programs must also be carried out to maintain fruit fly exclusion zones in southern states.

Meanwhile, horticultural producers in endemic fruit fly areas face ongoing costs for field treatments to prevent crop loss due to fruit fly infestation. Furthermore, to meet interstate and export quarantine restrictions, postharvest treatments must also be applied to many commodities at an additional cost to producers. Finally, many potentially lucrative export market access opportunities for fruit fly host commodities are currently not available because appropriate treatments and/or systems for control of fruit flies (and in some cases other insect pests and diseases) have not yet been developed and approved by quarantine authorities in importing countries.

Unfortunately, there are no "silver bullets" around to miraculously solve all of our fruit fly problems. The bottom line for fruit fly control still represents a major cost for producers of fruit fly host commodities including custard apples. However, there have been some significant advances in fruit fly control methods over the last few

years. New products and technologies currently being evaluated under Australian conditions are described below and their possible relevance for custard apple producers discussed.

Cover sprays

While cover spraying with broad-spectrum insecticides such as dimethoate or fenthion has been widely used for fruit fly control in a range of commodities for many years, there is currently a strong move to develop alternative treatments. Consumer and environmental concerns have driven research activity in this area over pesticide usage and residues, problems associated with long withholding periods, which interfere with harvesting, and the fact that broad-spectrum insecticides are detrimental to beneficial insects and are therefore not compatible with Integrated Pest Management (IPM) programs.

Another concern is uncertainty about the long-term availability of the currently used chemicals. Fortunately, unlike many other insect pests, fruit flies have never been shown to develop resistance to insecticides, so this is not generally an issue with chemical control treatments.

Various natural products such as neem oil and natural pyrethrum have been investigated as cover sprays or repellents for fruit fly control but none has proven to be particularly effective. The new generation, microbially produced insecticide, spinosad, which has obtained organic certification in the US, appears to offer the best prospects as a new cover spray treatment for fruit flies. DPI researchers have collaborated with the commercial producers of spinosad to evaluate this new insecticide as a foliar spray against a range of insect pests. The registration and organic certification applications for a spinosad product for a range of caterpillar pests are now in progress in Australia. However, further research is required to determine effective application rates for fruit fly control.

Protein baiting

For many years, bait spraying (ie regular spot applications of protein and insecticide to foliage of host trees) has been used to provide effective fruit fly control in a range of commodities. Baiting is a minimal pesticide treatment, which is compatible with integrated pest management strategies. Because the proteinaceous odours of baits specifically target fruit flies, baits have minimal impact on beneficial insects thereby conserving natural biological control agents and allowing augmentative releases and establishment of mass reared parasitoids and predators for controlling other insect pests. However, all baits to date have required the addition of organophosphate insecticides such as chlorpyrifos, trichlorfon or malathion to the protein products.

Recent bait research

QDPI researchers recently lead a national project to evaluate new generation bait products based on “soft” insecticides which are used in much lower concentrations and have much lower mammalian toxicity than the organophosphate insecticides currently registered for use in baits in Australia. These two new commercial baits include attractant protein sources mixed with either spinosad (Dow AgroSciences) or

fipronil (BASF) as insect toxicants. In large scale field trials carried out by researchers in QDPI and NSW Agriculture in a variety of commercial crops (citrus, pome fruit, custard apples, passionfruit, blueberries), these new baits has been shown to provide the same level of control for Queensland fruit fly as currently used standard bait. The new baits are applied at lower rates, 5-7 L/ha compared to standard baits which are applied at 15-30L/ha, depending on the crop type. Both bait formulations include thickening agents which prolong the effective life of the bait on foliage but current recommendations are that the baits should still be applied on a weekly basis the same as the standard bait. It is hoped that both baits will be registered for use in Australia in the near future.

The new spinosad bait (Naturalure Fruit Fly Bait produced by Dow AgroSciences) recently achieved organic certification in the US and has been used to treat introduced fruit fly outbreaks in organic orchards in California. Registration application for this bait in Australia is now in progress. It is hoped that this product will also be granted organic approval in Australia. If this is achieved, it will represent one of the most significant advances in fruit fly control in Australia for many decades.

Potential for non-foliar bait application

As with all types of protein baits, both of these new baits should be applied in a manner to minimize the possibility of phytotoxicity in treated crops (eg applying to alternate rows and to different sides of the tree each week). Mangoes are particularly sensitive to phytotoxic damage from all protein baits but it is generally not possible in commercial orchards to apply baits to foliage without some contact with fruit. It has been generally accepted in the past that protein baits for fruit fly control will be ineffective if not applied to host tree foliage. However, there is considerable historical evidence from growers that bait applied to other surfaces does provide a level of control. Furthermore, the new thickened baits are likely to be much more effective than standard non-thickened baits on non-foliar surfaces. Hence research is currently being undertaken by QDPI to evaluate the efficacy of non-foliar application of bait. This will involve applying bait to tree trunks, to plywood squares, folded hessian bags, or carpet squares hung in and around host trees. This research could lead to an effective off-crop treatment for commodities which are sensitive to bait phytotoxicity, where residues may be a problem, or in organic production situations.

Physical barriers for fruit fly control

Physical barriers which exclude the adult insect and thereby prevent oviposition into fruit provide non-chemical fruit fly control methods. These are highly suitable for both conventional and organic production on a number of different scales. On the smallest scale, applicable to organic home gardeners, various types of bags can be used to completely enclose individual fruit to protect them from fruit fly and other insect pest damage. On a larger scale, small mesh net fabric can be used to fully enclose individual trees when fruit are susceptible to attack. On a commercial scale, QHI researchers have been working with local netting companies for some years to extend existing net technology to become an insect control method. Netting is already widely used in some horticultural crops for protection from hail, birds, bats, wind and sun. In some areas it is seen as a highly preferred option because it provides non-lethal protection from native fauna.

The extension of netting to provide an insect exclusion barrier became possible with the recent commercial availability of a 2mm mesh net made from long lasting, translucent fibre which minimizes the shading factor. This net excludes fruit flies and a variety of other insect pests such as macadamia nut borer, fruit spotting bug, fruit piercing moth, and yellow peach moth. The net fabric is available in a range of widths and has reinforced edges which allow for gap free seams. Provided this exclusion net is correctly erected and maintained, this technology has the potential to significantly reduce pesticide usage in conventional production, and to provide a practical and appropriate method for organic pest control in a range of crops. Exclusion netting involves a high initial capital cost and it will not be appropriate for all crops, but in some crops where conventional hail/bird/bat netting is already being extensively used (eg stonefruit, pomefruit, kiwifruit, persimmons), it will provide new options for both conventional and organic producers at relatively little extra cost.

DPI exclusion netting trials

Recent trials over two seasons at Maroochy Research Station compared fruit fly infestation in peaches under exclusion netting (with no additional fruit fly treatment) to that in an adjacent block under conventional hail net and treated with Lebaycid cover sprays as per current industry standard practice. Fruit fly trap catches in the area during the trials ranged from 50-350 flies per trap per week. Infestation levels under exclusion netting were zero in both seasons. Infestation level in the chemically treated block was zero in the first year and was 0.25% in the second year. The effects of this small mesh size on environmental conditions and crop parameters under the net have also been studied. Crop management issues were identified and methods to overcome potential problems have been trailed. Further research is required to evaluate the effects of exclusion netting on growth parameters of other crops.

Exclusion netting as a quarantine treatment

Exclusion netting has the advantage that it not only provides highly effective non-chemical field control, but it also has the potential to be used as a quarantine treatment for fruit fly host commodities to overcome market access barriers. Results of the exclusion netting trials have been submitted to the Interstate Plant Health Regulation Working Group to seek approval for exclusion netting as a fruit fly quarantine treatment. If approval is given, the details of a protocol under the Interstate Certification Assurance system will then need to be negotiated with interstate quarantine authorities. The availability of such a treatment would provide significant benefits for all producers who currently rely on dimethoate insecticide postharvest treatments to gain interstate market access for fruit fly host commodities. It is possible that a combination of exclusion netting in the field combined with a physical postharvest treatment (such as heat or cold) could be used to meet fruit fly control requirements of highly lucrative export markets in the future. However, negotiations through Biosecurity Australia with potential importing countries to develop such quarantine protocols can be a lengthy process.

Male Annihilation Technology

Species specific synthetic male attractants (parapheromones) such as cuelure for Queensland fruit fly can be used for both monitoring populations (in traps) or as a supplementary control measure (without traps). If carriers such as cotton wicks or other absorbent material are dosed with cuelure and insecticide and distributed on an area-wide basis (eg 10 devices per ha) the technique is called Male Annihilation Technology (MAT). Small plastic lid MAT devices which protect a cotton wick treated with cuelure and maldison are now commercially available. A new MAT device treated with cuelure and fipronil insecticide has recently been evaluated in Australia and should be available commercially in the near future.

The use of MAT over large areas and for extended periods reduces male populations to such a low level that female mating is disrupted and the breeding pest population is subsequently reduced. However, MAT should be used in conjunction with control methods such as protein baiting which target female flies to ensure crop protection from infestation. This is particularly important because the presence of MAT devices in an orchard can draw male flies away from monitoring traps giving a false indication of pest pressure. Unfortunately there are no effective female attractants known for Queensland fruit fly which would provide a more accurate guide for the timing of control treatments. Various protein products (usually autolysed yeast), which are attractive to females as foliar spot sprays (protein baits), are commercially available but the response of flies to such food type baits in traps is often poor and variable.

Area-wide management in endemic fruit fly areas

A new approach to fruit fly control was recently initiated by the approval of Horticulture Australia funding for a number of pilot programs to implement area-wide management programs in several locations in fruit fly endemic areas in NSW and Queensland. Area-wide control is already practiced in fruit fly exclusion zones in southern states but it has not previously been attempted in regions where fruit flies are known to be present all year round. DPI will lead a three-year area-wide management project in the Central Burnett citrus producing region commencing in July 2003.

The Central Burnett region was previously identified by a national Horticulture Australia review as a highly appropriate area for attempting a pilot program for area wide fruit fly control. Baiting is practiced in almost all of the 2000 ha of citrus orchards, but no control methods have to date been implemented in orchards outside of the citrus season and no coordinated treatments have ever been attempted in town areas.

Recent DPI research has identified untreated back yard fruit trees as breeding “hot spots” for fruit flies, particularly in the summer months. The area-wide program will implement additional MAT treatments in orchards and a combination of MAT, targeted baiting of back yard host trees, and removal of infested fruit in town areas of Gayndah and Mundubbera. The expected benefits of the program will be improved fruit fly control across the entire district, reduced infestation in backyard fruit, and improved market access opportunities based on a district wide approach to

minimising the risk of infestation in commercial fruit crops. The Central Burnett citrus industry is hopeful that an effective area-wide fruit fly control program will assist in gaining entry into lucrative US markets.

Systems approaches to achieve quarantine security

Developing a systems approach to achieve quarantine security for fruit fly host commodities is one of the new directions that is beginning to impact on the bottom line for fruit fly control. Systems approaches involve a number of pest mitigation steps, which cumulatively reduce the risk of fruit fly infestation in the end product to a level that is acceptable to the importing state or country.

To date, there has been fairly limited acceptance of system approach protocols as fruit fly treatments for interstate market access. However, the success of current ICA (Interstate Certification Assurance) protocols such as ICA-28 for citrus from the Central Burnett to Victoria has paved the way for this approach in other commodities. QDPI is currently undertaking research to develop a non-chemical treatment system for avocadoes for interstate trade. Such systems are particularly important for producers in Queensland and northern New South Wales who now rely heavily on chemical postharvest treatments for interstate market access.

Summary- the bottom line for fruit fly control in custard apples in 2003

- No alternative cover spray treatments for fruit fly control are yet available but spinosad may be an option in the near future.
- New, improved, low toxicity bait products are likely to be registered in the near future for a range of crops including custard apples.
- As with current bait products, the new bait formulations should be applied with care to avoid contact with fruit to minimise the possibility of phytotoxicity.
- Non-foliar bait application methods are currently being researched and could be used in custard apples if proven to be effective.
- Male Annihilation Technology is available and can be used to supplement foliar bait treatments but care must be taken in interpreting trap catches.
- Fruit fly exclusion netting fabric and net erection technology is now commercially available and may be appropriate for custard apples in some situations.
- Area -wide fruit fly control programs are now being trailed in some fruit production areas but may not be applicable to custard apple growing areas.
- Systems approaches to developing quarantine protocols are gaining increased acceptance and may be directly applicable to market access issues for custard apples.

Acknowledgement*s*

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3.6 Releasing the mealybug ladybird C*ryptolaemus montrouzieri* in custard apples to control citrus mealybug

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Summary

Trials were done in February-March 2003 to test the effect of releasing adults of the predatory ladybird *Cryptolaemus montrouzieri* for the control of citrus mealybug in custard apple orchards at Glasshouse Mountains in southeast Queensland. Mealybug beetles (adults, larvae and pupae) were counted on 8-10 occasions over two months following releases of 5 or 25 adults in early-mid February.

Releases of 25 beetles per tree gave an effective response in 4 of the 5 releases. Beetle numbers recovered during the first week averaged 0.6-1.7 beetles per fruit and after three weeks, beetle larvae numbers peaked at 13-23 per fruit. One of the two releases of 5 beetles per tree was effective and the other ineffective.

The data suggests that releases of 25 beetles per tree should be made from mid January-mid February on fruit at least 10cm in diameter and showing some sign of mealybug infestation. If the mealybug infestation is skewed (concentrated in one section of a block), releases could be concentrated in the infested area.

It is a good strategy to establish the beetle as early as possible in an orchard in a block (or blocks) with the most advanced fruit and mealybug levels. The beetle can then breed and spread to other blocks. Small releases of 5 beetles per tree may suffice to establish the predator but should be done as early as possible to allow beetle numbers to naturally increase and catch up. Releases are best made in the mornings when conditions are neither wet nor hot and very sunny.

Introduction

Citrus mealybug *Planococcus citri* (Risso) is a serious pest of custard apples infesting the young fruit during December-January and increasing in numbers during late summer-autumn. Heavily infested fruit are covered with mealybugs and the black sooty mould fungus that grows on the honeydew they secrete. The mealybugs can be blown or brushed off at harvest but blackened fruit are laborious to clean (Smith 1991a).

There are about 6 generations of the mealybug per season. The mature females lay some 500 eggs in a loose cottony, mass; these hatch into yellow crawlers which settle in creases in the fruit and pass through three moults before reaching the female adult stage. The male mealybug goes through 4 moults before emerging as a fragile winged adult.

The main natural enemies of the mealybug are the mealybug ladybird *Cryptolaemus montrouzieri* Mulsant, larvae of lacewings like *Oligochrysa lutea* (Walker) and the small parasitic wasps *Leptomastix dactylopii* Howard, *Leptomastidea abnormis* (Girault), *Anagyrus pseudococcii* Girault and *Coccidoxenoides peregrinus* (Timberlake) (Smith 1991b). Larvae of the midge *Diadiplosis koebelei* also feed on the mealybug eggs. The natural enemies can maintain the mealybug at satisfactory levels but they are easily disrupted by chemicals for other pests or by ant activity. The most effective natural enemy is *Cryptolaemus montrouzieri,* but it can be slow in colonizing an orchard and fruit can become heavily infested and blackened before the predator gives control.

Because of this it is thought advantageous to argumentatively boost ladybird numbers by strategic releases of adult beetles in the late spring-summer. Releases were trialed in 2003 in orchards in the Glasshouse Mts area.

Methods

C. montrouzieri adults were mass reared by the 'Bugs for Bugs Insectary' at Mundubbera and a total of about 20 000 week-old beetles consigned to Nambour for release.

Five Glasshouse Mts orchards (all Pinks Mammoth or Hiliary White variety) were used in the study – Thompson, Korczynski, Camilotto, Dann and Seizer.

At Thompson's on 5 February 2003, a mealybug count was done on 600 random fruit in the main block, *C. montrouzieri* (adults, larvae and pupae) recorded and 25 adult beetles released per tree (5000 in total of the block of 200 trees). Beetle (adults, larvae and pupae) counts were then repeated on 7, 10, 13, 17, 19, 24 of February and 5, 10 and 28 March. Mealybug counts were repeated on 17 February and 10 and 28 March. Four counts were also done during the period (of mealybugs and beetles) on a smaller block of 50 trees, 200m away (separated by forest) which received no beetle releases.

At Korczynski's three blocks (block 1 of about 50 trees and blocks 2 and 3 of 100 trees) received beetle releases on 7 February 2003. Blocks 1 and 2 had releases of 25 beetles per tree and block 3, 5 beetles per tree. Mealybugs and/or beetles (larvae, pupae and adults) were again counted at regular intervals on 7, 10, 13, 17, 19 and 24 February and 3, 11 and 21 March.

At Camilotto's a release was made of 25 beetles per tree (total release of 2500 beetles) in a block of about 100 trees on 13 February 2000. Mealybug and/or beetle assessments were made on 13, 14, 17, 19 and 24 February and on 5 and 10 March.

At Dann's a release was made of 25 beetles per tree (again a total release of 5000 beetles) in the block of about 200 trees on 21 February 2003. The conditions were very wet at the time of release. A much smaller release of beetles had been made by the grower a month previously of about 5 beetles per tree. Mealybug and/or beetle assessments were made on 21, 24, 28 February and on 3, 7, 11, 18 and 28 March.

At Seiser's a release of 5 beetles was made in a 25-tree block on 13 February 2003. The trees were large and well foliated but with only 2-3 dozen fruit per tree. Mealybug and/or beetle assessments were made on 11, 13, 17, 19, 21 February and 5 and 10 March.

Results

The results from the 5 orchards (8 blocks) are shown in Figs. 1-7 and summarised in Table 1.

Table 1. Mealybug and beetle levels in eight custard apple blocks at Glasshouse 2003

Grower (No. of beetles released per tree)	**Mealybugs per fruit**			***C. montrouzieri* per fruit**	
	start	**peak no.**	**at harvest**	**adults (peak)**	**larvae (peak)**
Thompson (25)	3.5	3.5	0.3	0.6	17.2
Thompson (0)	2.0	3.5	3.5	0.02	0.02
Korczynski -1 (25) Korczynski –2 (25) Korczynski –3 (5)	18.8 4.1 9.8	20.0 4.2 12.0	0.1 0.5 0.25	0.8 1.7 0.4	22.8 14.2 9.9
Camilotto (25)	19.6	25	0.1	0.85	13.3
Dann (25)	30.0	30.0	1.5	0.05	2.6
Seizer (5)	3.5	14.0	14.0	0.1	0.9

Discussion

Mealybug levels: The most heavily infested blocks at commencement were at Dan's (30 mealybugs per fruit), Camilotto (19.6) and Korczynski (block 1) (18.8).

The earlier small release of about 5 beetles per tree at Dann's had established the ladybird (there were 5 larvae per 10 fruit at the time of the second release) but the resulting beetle level was unsatisfactory.

At Korczynski's and Camilotto's there was little evidence of beetle larvae.

The mealybug infestation at Thompson's main block was heavily skewed towards the southern end and averaged a lower (but threatening) level of 3.5 mealybugs per fruit.

There was a similar level at Seizer's but the shortage of fruit in this block was a significant aberration. The other two Korczynski blocks had 25-50% of the levels in block 1 at Korczynski.

Adult beetle recovery: Adult recoveries were highest for the first 4-5 days, during the first 1 or 2 counts after release but declined after about a week. The releases of 25 beetles per tree had the highest recovery of 1.7 per fruit (Korczynski - block 2), 0.85 (Camilotto), 0.8 (Korczynski – block 1), and 0.6 (Thompson). At Dann's the 25-beetle release had a low recovery, the most likely reason being the very wet conditions during release.

Most of the releases were made in mid-morning under overcast-partly sunny conditions. The releases of five beetles per tree were inconclusive with a poor result at Seizer's, but a reasonable response at Korczynski – block 3 of 0.4. There was a possible leakage of beetles from blocks 1 and 2 to block 3 at Korczynski.

Beetle larval counts: There was a clear response in production of young larvae (13-23 per fruit) in all of the 25 beetle releases (except Dann's) and a good response with the 5-beetle release (at Korczynski – block 3) (10 per fruit).

Conclusions

Timing: All of these releases were made during early-mid February when fruit were 10-15cm in diameter and infested with mealybugs.

At this stage of research it appears that releases should be made where there is evidence of mealybugs. Mealybugs prefer the most advanced fruit (10cm or more in diameter) and this stage is reached from mid January-mid February. Releases on small fruit in December run the risk of failing as beetles fly off to better food sources. Late releases when natural populations are high are redundant and probably not very effective in further reducing the mealybugs (and mould) in time for harvest in March-April.

Numbers: The results to date are based mostly on releases of 25 beetles per tree and these were shown to give a quick effective response. There is the possibility (not yet tested) that releases could be concentrated (if infestations are skewed as at Thompson's) in infested trees, so requiring less beetles per ha.

A release of 5 beetles per tree could be expected to at least establish the beetle in an orchard but effective control will take longer as an extra generation of ladybirds (total of at least 4 weeks) will be necessary to catch up. A release of 5 beetles per tree should possibly be made in early January. It's worth noting that a small release in Dann's block in January established the beetle but levels were still low in mid February.

A further strategy is to make a 25-beetle release in a block with the biggest fruit (usually the first hand pollinated block) with evidence of mealybugs. This would be

in early-mid January and help to establish the beetle in one block of the orchard from which it could spread to other blocks as their fruit size and mealybug numbers increase.

Weather conditions: The best weather conditions and time of day for releasing at this stage appears to be in the morning in conditions not wet and not too hot and sunny. There may be less chance of beetles flying off out of the block if the conditions are slightly overcast.

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3.7 Fungal diseases of custard apples

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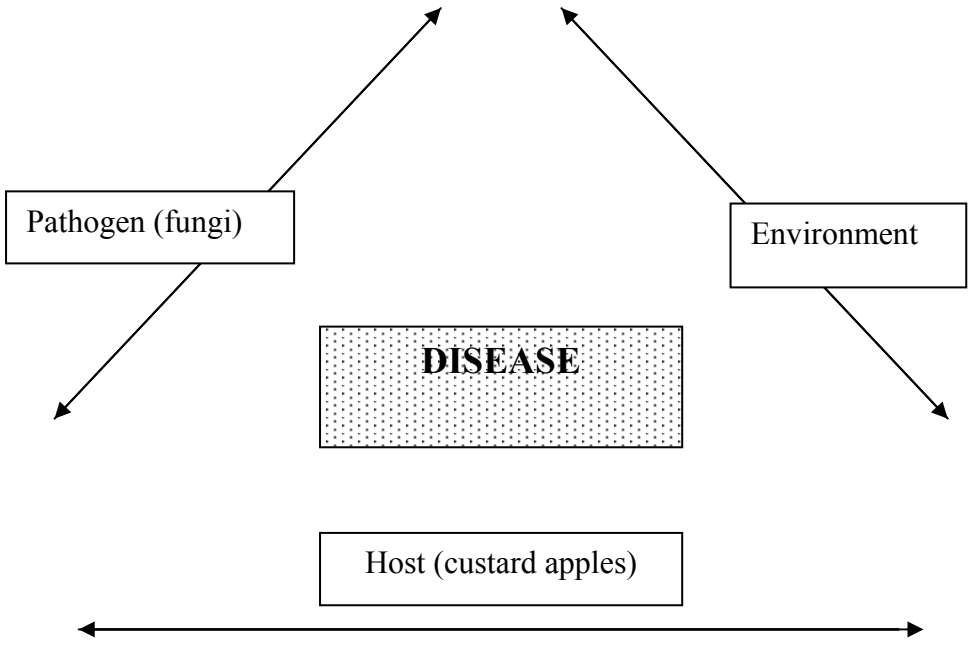
Introduction

In preparing this talk I have tried to bear in mind the conference theme of "Growing our Future – ways and means of improving your bottom line". In doing this I have come to the remarkable conclusion that there are indeed more important issues facing your industry than actually being able to produce sound, blemish free fruit. However I take heart in the realisation that if you don't have blemish free fruit you probably don't have a market either.

In starting, I would like to take a slightly different tack to that requested by the organisers. Rather than considering the question, "What environment do fungi love? & how to keep ahead of them", I will talk about "How to encourage good plant growth and provide the harshest environment possible for disease-causing fungi so that they are NOT ABLE TO SURVIVE".

Custard apples – environment – fungi

I'm sure that you have already heard about the disease triangle. All plant diseases result from the interactions between a host (in this case custard apple), a disease causing pathogen (in this case mostly fungi) and the environment. Basically, disease will not occur unless all three of these factors are present and are in favour of the disease.



The disease triangle is a concept that plant pathologists like to talk about mainly because it gives the impression that this is a very technical subject and gives feelings of self importance. In fact these three cornerstones of plant disease incidence, and hence aspects for consideration for disease control, are quite simple and far from being rocket science. Careful consideration of these points in relation to any crop x disease interaction will usually give useful leads for defeating the fungal foe.

Disease can be managed by:

i. excluding or reducing fungal infecting units (spores)
ii. increasing the hosts resistance to the disease or
iii. modifying the environment so that is unsuitable for the development of disease.

I would like to run through a few examples of how modifications in each of these three areas have already given substantial advances to your industry. The aim of the exercise is to make life as difficult as possible for the fungus. It's not enough merely to squirt it with a chemical. That is just a challenge to the mighty fungus to do one better, and it often does. It does mean directing our attack to any point of the triangle in an attempt to make life unbearable for the potential destroyer.

Table 1 Examples of how modifications to each side of the disease triangle has provided better control of disease in custard apples**.**

Questions to ask	**Changes that have been made or could be considered.**
HOST ☺ Are there other suitable cultivars? ☺ Can the host be changed to resist fungal attack?	- Cherimoya rootstock resulted in less bacterial wilt. - Pinks Mammoth is less susceptible to Pseudocercospora and Cylindrocladium fruit rot diseases than African Pride. - Changing the nature of plant surfaces with the use of highly effective chemicals should be used after all other management options listed above have all been utilised.
ENVIRONMENT ☺ Generally the macro environment cannot be changed. ☺ Can the micro-environment be changed to make life hard for the pathogen?	- Pruning to open the centre of the trees improves light penetration and airflow. This reduces humidity thus minimising pressure due to Pseudocercospora and Pinks disease etc. - Similarly raising the tree skirts also increases air flow and makes life difficult for fungal diseases such as Cylindrocladium diseases and Phytophthora fruit rot. - Choosing a good sunny aspect for a new orchard allows good canopy drying, reduced humidity and less fruit and leaf diseases. - Generous mulching under trees reduces rain splash from contaminated soil and undecomposed plant or fruit debris. This will help reduce Phytophthora and Cylindrocladium diseases. - Provision of neat grass swards between rows reduces movement of wind blown and rain splashed fungal spores from bare soil.
PATHOGEN ☺ Can we exclude the pathogen	- Removal of mummified fruit from trees reduces inoculum of black canker (*Phomopsis*) & diplodia fruit rot (*Lasiodiplodia*). - Removal of prunings takes tonnes of inoculum laden waste from the orchard. If removal is impractical it is useful to facilitate quick breakdown of prunings by chipping and covering them with mulch.

(disease causing organism)? ☺ Can we reduce or eradicate the amount of inoculum of the pathogen?	- Raising the tree skirt minimises splashing *Cylindrocladium* & *Phytophthora* spores from the soil on to the fruit, leaves & limbs. - Ant and mealy bug control minimises spread of *Cylindrocladium* spores into the higher parts of the tree.

Pathogen = disease causing organism.
Inoculum = parts of a fungus capable of causing disease.

Fungicide trials

In my opinion the faithful copper and Benlate/Spin sprays have served the industry well to this point, but with the increase in occurrence of Pseudecercospora fruit rot, caused by *Pseudocercospora annonicola*, the inadequacy of these treatments is becoming obvious. Alternative treatments that have good curative properties to supplement the reasonable protective actions of copper & Spin/Benlate are urgently needed for this disease. Fungicide screening to find a suitable candidate has been an annual component of the current project.

An orchard of cv African Pride was donated to the cause by Nev and Sandy Green of Winston Rd. Palmwoods. In February 2003, each tree in this orchard was assessed for fruit load. Ideally we would have preferred to start spraying before Christmas but the fruit load was insufficient to encourage us to start a trial. We mapped the orchard and assigned treatments to trees. Treatments were applied to a minimum of 20 fruit in the southern sector of each tree, commencing in February 2003. The extremities of the sectors had earlier been marked with coloured tape.

When we assessed the fruit in May it was obvious that one side of the fruit, mostly the side facing into the centre of the tree, was more severely affected by Pseudocercospora fruit spot than the opposite side. We assessed each side of ten treated fruit independently. We also gave a single rating to ten other fruit in the tree that had not been sprayed with our treatments. The rating consisted of a 0 – 10 scale where 0 = nil spots, 1 = trace of disease only; 3 = slight; 5 = moderate disease; 7 = severe spotting; 9 = very severe spotting; 10 = fruit covered in spots.

Data are presented as a Pseudocercospora index, which was obtained by dividing the mean rating on the best side of the fruit, for each tree, by the mean rating for the unsprayed fruit on the same tree.

Results

Exp BH was highly effective in controlling the *Pseudocercospora* disease. Our experience with this product in the previous year was that it had excellent curative properties. See Table 2.

A similar product Exp BF gave comparable control.

The new oil formulation Exp BP gave quite reasonable control, both alone and in combination with fungicide M. Fungicide M was surprisingly effective but did not compare with Exp BH.

The trial also showed that while the standard copper /Spin program was better than untreated, it was less than adequate under the conditions of the trial.

Table 2. Effect of treatment on *Pseudocercospora* index of custard apple cv African Pride.

	Treatment	Schedule	Index	
1	Untreated		5.6	e
2	Standard copper	alternate copper oxychloride 2 g/L & Spin 0.5 g/L at 3 week intervals	4.4	d
3	Standard M	alternate M 2 g/L & Spin 0.5 g/L at 3 week intervals	3.2	c
4	ExpBP	3 weekly 5 ml/L	2.7	abc
5	ExpBP M	3 weekly 5 ml/L & 2 g/L	2.3	a
8	Exp BF M	1 spray Exp BF, M, Spin at 3 weekly intervals. Max 3 Exp BF.	3	bc
9	Exp BH M	1 spray early, followed by M @ 3 week intervals. Revert to Exp BH when a disease event takes place.	2.4	ab
10	Exp BH MS	1 spray Exp BH, M, Spin at 3 weekly intervals. Max 3 Exp BH.	2.5	abc
11	Exp BH HM strategy	1 spray Exp BH early followed at 3 weeks by M; after next disease event apply Exp BH followed at 3 weeks by M, repeat for each disease event. Max 3 Exp BH.	2.1	a
LSD			0.8	
F probability			<< 0.001	

Fungicide M = mancozeb. It is not registered in custard apples and its inclusion in these spray trials should not be taken as a recommendation for its use.

Implications for *Pseudocercospora* spray programs in custard apples

If and when some of these promising chemicals are registered, the custard apple industry will be able to use the standard protectants, copper or Spin, and also have the choice of using an oil or the fungicide M. A highly effective curative fungicide will also be available should *Pseudocercospora* pressure be high. In the meantime appropriate management practices such as those mentioned in Table 1 will help minimise disease pressure. Copper and Spin used separately will give adequate and at times, good control when used in conjunction with good management practices.

Please note: The curative fungicides tested are very prone to the development of resistance. When one is registered it will be essential to use it strictly according to directions, which will include a limit on the number of sprays that can be applied in

any season. It should be used no more than 3 times in a season and should be alternated with a protectant chemical.

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3.8 The custard apple breeding and varietal selection program

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Keywords: *Annona* spp., breeding, varieties, seedlessness, mutation,

Abstract

Considerable recent progress has been made in selecting new types, identifying appropriate parents and gaining an understanding of the inheritance of desirable traits in atemoya. Inter-varietal crosses have been made between the best selections of atemoya and the main commercial cultivars such as KJ Pinks, Maroochy Gold, Palethorpe and Maroochy Yellow. Interspecific crosses have also been made between four different species; *A. cherimola* (cherimoya), *A. squamosa* (sugar apple), *A. reticulata* (Bullock's Heart) and *A. diversifolia* (Ilama). Some 12 000 breeding lines have been field planted since 1998. An alternative approach to conventional breeding using mutation techniques is also being evaluated. Early results indicate that it may be feasible to produce tetraploids by treating juvenile buds or seedlings with gamma radiation. Ten advanced selections are being trialed at six evaluation sites throughout Queensland and northern NSW. Another 15 selections have been made from breeding progeny at the Maroochy Research Station in 2003. The program has successfully developed hybrids with red skin colour and pink internal flesh. Red skin colour may be carried by either a single or double recessive gene. Fruit symmetry, flesh recovery and flavour characteristics of the 2003 crosses are excellent.

Introduction

Breeding and selection in atemoya (*Annona* spp. hybrids) and cherimoya (*Annona cherimola*) has been much neglected. Most atemoya cultivars are hybrids of cherimoya (*Annona cherimola*) and sugar apple (*Annona squamosa*). However, other atemoya cultivars are of unknown genetic origin. Few new cultivars of atemoya and cherimoya have been selected in the past 20 years due to the small population of naturally occurring seedlings, and lack of a breeding programs/strategies for these fruits. In contrast, other subtropical and tropical fruit such as mango have been intensively selected from over several hundred thousand seedlings for more than 100 years.

The main characteristics being selected in atemoya are excellent eating quality, fruit symmetry, smooth skin, chilling tolerance, and low seed number or seedlessness (Table 1). Seedlessness is a desirable characteristic being sought in atemoya and may be achieved through various strategies. The most commonly used approach in other crops is to double of the chromosomes of diploids to produce tetraploids which, in turn are crossed back to a diploids to produce a triploid plant which are often sterile and produce seedless fruit. This technique should also work with atemoya and other *Annona* spp., which are diploids (Thakur and Singh, 1967).

Considering the small size of the current introduction, breeding and selection programs throughout the world considerable progress is now being been made in breeding and selecting new varieties.

More recently, several studies have been conducted to gain an understanding on the genetic diversity and inheritance of desirable traits in atemoya and cherimoya (Ellstrand and Lee, 1987; Rahman *et al*., 1997; Perfectti and Pascual, 1998). This knowledge should lead to the use of genetic markers in breeding programs.

Table 1: Criteria for selection of superior atemoya cultivars

Variable	**Desired type**
Tree morphology	
degree of apical dominance	low
number of fruit bearing laterals	high
Yield capacity	
percentage of flowers set	3-5%
precocity of bearing	2-3 years after planting
tree yield at full maturity	>60 kg
Fruit quality	
Excellent taste	>7 on hedonic scale
Firm texture	>7 on hedonic scale
no of seed per 100 g of flesh	<10
fruit size range	400-600 g, 600-1000g
skin thickness	moderate to resist bruising
skin colour	green, yellow, red, pink
Internal flesh colour	red, pink
fruit symmetry	high
fruit shape	symmetrical
skin type	smooth or mildly tuberculate or impressa
resistance to chilling injury	no russetting
fruit rots (*Diplodia, Pseudocercospera*)	resistant
Post harvest	
storage life	>10 days
storage characteristics	little or no skin discolouration
fruit fly susceptibility	low

Progeny evaluation

Progeny are being evaluated at the Maroochy Research Station for low-seed number, smooth skin, symmetrical shape and high natural fruit set. Approximately 3 000 progeny have been tested to date with another 9 000 progeny to be tested over the next 3 years. A range of parents including various species is being used in the breeding program (Table 2). Out of about 300 different crosses, six parents have produced the most desirable fruit quality characteristics in progeny evaluated to date.

A. reticulata hybrids

Progeny of atemoya x *A. reticulata* and cherimoya x *A. reticulata* crosses produced fruit which were late maturing (spring in Queensland) probably because they have inherited the flowering and fruiting characteristics of *A. reticulata* which flowers in autumn and matures fruit in late spring under subtropical conditions of Australia. Various selections have been made in both Australia and Florida, but these selections have now been discarded due to unacceptable fruit quality.

Progeny have inherited the high levels of internal grittiness and poor flavour characteristics from *A. reticulata*. Further evaluation of the F2 progeny, particularly of crosses with red-pink skin types is being carried out. Attractiveness is a key factor in selling any fruit. Exciting possibilities exist to develop new varieties with external and internal pink-red colour. Crossing of newly introduced red and pink-skinned *Annona reticulata* x *Annona cherimola* selections to red skinned sugar apple and red-skinned atemoya types selected in Australia are currently in progress.

Table 2. Characteristics of selected parents with desirable traits

SPECIES	SELECTION NAME	ORIGIN	DESIRABLE TRAITS
Annona squamosa	red sugar apple	Florida	red skin colour
	Noi	Thailand	large size, light yellow skin colour
	acc.no. 6333	Philippines	seedless
	Lobo	Philippines	big, sweet, few seeds
	Seedless	Cuba/Florida	seedless
	Thai-Lessard, Kampong Mauve	Ex Thailand	violet fragrance, easy peel skin
Annona diversifolia	Imery	Florida	pink skin colour and flesh
	Purple	Florida	purple skin
	'Fairchild,' 'Genova Red,' 'Guillermo,' 'Imery,' and 'Pajapita.'	Florida	white to dark red flesh
Annona reticulata	Camino Real	Guatemala	red skin and flesh,

SPECIES	SELECTION NAME	ORIGIN	DESIRABLE TRAITS
			smooth skin
Annona reticulata	Fairchild purple	Florida	purple skin colour
	Dr Leon	Guatemala	orange skin and flesh
	Young	West Java	sweet type/low grit
	El Remate	Mexico	red skin and flesh
	Canul	Belize	red skin and flesh
Annona cherimola	Citamex	Mexico	orange skin
	Seedless	Peru and Ecuador	reports of seedless or low-seeded types
	Whaley	Ex USA	produced many semi-dwarf seedling progeny compared with other cherimoya varieties eg White, Bays etc
Atemoya/cherimoya x *Annona reticulata* hybrids	75-9, Spain cherimoya x Canul reticulata	Florida	purple skin
	47-18, Gefner atemoya x San Peblo reticulata	Florida	pink skin, late season harvest
	4-5, Priestly atemoya x Fairchild Purple reticulata	Florida	purple/maroon skin, late season harvest
	47-18 X Maroochy Gold, many selections	Ex MHRS,	red and purple flesh, late season harvest
Annona diversifolia X atemoya/cherimoya		Ex MHRS	distinctive flavour characteristics – sherbet, fruit salad
Atemoya cultivars (*Annona squamosa* x *Annona cherimola* hybrids)	Maroochy Yellow	Ex MHRS	very firm flesh and long post-harvest life >2 weeks at ambient, may be useful for increase storage life of custard apple.
	Maroochy Red	Ex MHRS	red skin colour, excellent flavour
	Maroochy Gold	Ex MHRS	tangy flavour characteristics, more acidity than other varieties, chilling

SPECIES	SELECTION NAME	ORIGIN	DESIRABLE TRAITS
			tolerance
	KJ Pinks	bud sport of Pinks Mammoth variety which has very low fruit set	exceptionally high fruit set compared with parent tree, able to set under hot, dry conditions, chilling tolerance
	10 Unnamed selections, various crosses	Ex MHRS	potentially dwarfing characteristics, short internodes and branching structure

Commercial implications

Atemoya production in Australia is based on three cultivars which all exhibit either serious fruit quality defects or are unable to set good crops naturally, without hand pollination. Ten advanced selections have been released from the conventional breeding program to date. Two of these selections appear to have commercial potential. These selections are Maroochy Gold, a Hiliary White x red sugar apple cross, and KJ Pinks, a budsport of Hiliary White. Both selections have excellent flavour and are able to set good crops naturally.

Varietal characteristics

KJ Pinks (Bud sport of Pinks Mammoth)

Advantages

- Very heavy fruit set
- Appears to be adapted to a wide range of climates from semi-tropical to cool subtropical (better fruit set in dry rather than wet conditions)
- Very early bearing
- Fruit are moderate to large size (600-800g)
- 5 seed per 100g of flesh (same as Pinks Mammoth)
- Flavour and ripening characteristics similar to Pinks Mammoth
- Fruit does not appear to russet in cold conditions

Disadvantages

- Some misshapen fruit which may require thinning
- Fruit may soften quickly within four days, and need to be harvested in a short period of time
- Is susceptible to the fungus Pseudocercospora which attacks African Pride

Maroochy Gold (selected from Queensland Horticultural Institute Breeding Program at MHRS)

Advantages

- Tangy flavour compared with Pinks mammoth types
- Seems to self pollinate reasonably well, but still dependent on weather conditions
- Fruit have the capacity to continue to size during the harvest period
- 7 seeds per 100 grams of fruit weight
- Fruit well accepted by panels of Brisbane consumers in taste tests
- Internal woodiness is not common
- Tree vigour similar to African Pride
- Fruit does not appear to russet
- Does not appear to be susceptible to disease
- Does not have great mealybug problem, as fruit skin is reasonably smooth
- Easy to visually determine when fruit are ready to pick
- Fruit will hang on tree

Disadvantages

- Fruit tips may be pointy (4 points at flower end), but not usually a problem
- Pruning probably similar to African Pride
- Liked by birds

Maroochy Palethorpe (selected from Queensland Horticultural Institute Breeding Program at MHRS)

Advantages

- Good eating quality
- Lovely internal flesh texture
- Large fruit with good shape, commonly 600-800 grams in weight
- Fruit have the capacity to continue to size during the harvest period
- Few small fruit or misshapen fruit
- Little sign of chill injury so far
- Pendulous habit of branches, possibly due to large heavy fruit
- Moderate bearer, apparently no problems with self pollination
- Thickish skin, but no or little granular texture near skin
- Fruit appears to stay firm, does not soften quickly when ripe
- 9 seeds per 100 grams of fruit weight
- Later variety, with picking starting in late April in south-east Queensland
- Does not appear to get disease on the fruit skin
- Does not appear to get much russetting on the skin
- Woodiness does not appear to be an issue
- Open tree
- Not vigorous in growth habit, so less pruning required
- May not be so susceptible to mealybug, due to even fruit shape, and fewer bumps
- Easy to determine when fruit are ready to pick, but more work for marketing and transport required

Disadvantages

- May be slow to mature (about 6 years), but could be well suited to top working existing trees, particularly in NSW. In addition it might be possible to use dormancy breaking chemicals to bring trees into earlier production.
- Susceptible to fruit fly, which would need to be controlled through a regular management program
- Some fruit rub between fruit or between fruit and branches, because of pendulous fruit, especially if windy
- Birds like the fruit
- More maturity work to do

Maroochy Yellow (selected from Queensland Horticultural Institute Breeding Program at MHRS)

Advantages

- Flavour is good but does not rate as high as KJ Pinks or Maroochy Gold
- Small to moderate round fruit (around 400-600 grams), no pointed carpels
- Very smooth, yellow skin
- Looks excellent when packed in socks
- Appears to self pollinate reasonably well (no extensive data)
- Has long shelf life of 2 weeks, but tends to ripen unevenly. However may be suited to export marketing. Will probably need to be ethylene ripened if grown in cool subtropical regions.
- May be more suitable to warmer regions eg Yeppoon
- Not much mealybug as fewer bumps and crevices on smooth skin
- Low vigour similar to African Pride

Disadvantages

- More work on deciding stage to pick is required
- Does not ripen evenly, so will require work on ethylene ripening
- Susceptible to anthracnose, which appears over the long fruit ripening period. May be better suited to drier areas eg Yeppoon, Bundaberg etc. No fungicide sprays used on trees to date.
- Fruit skin loses glossy appearance within 5-7 days
- Trees need good light interception to achieve maximum fruit size
- Skin marks easily eg through rub, scratching etc.

Preliminary Recommendations

- Based on limited data, the two best varieties for planting appear to be KJ Pinks and Maroochy Gold. Both varieties have good all round performance.

- The Maroochy Palethorpe variety may be better suited to top-working but needs an effective fruit fly management program.

- Maroochy Yellow may be more suited to the warmer subtropical regions such as Yeppoon and may need to grown on a trellis system to maximise light interception, and fruit size.

- We recommend that growers plant only small numbers of the new QDPI varieties, and assess how the trees perform on individual farms, and in individual areas.

- Negotiations are currently underway to license the new trademarked QDPI varieties to Australian Custard Apple Growers' Association. These varieties will initially be available from selected nursery propagators, who will provide trees only to growers who are licensed by ACAGA to grow these varieties. Please contact ACAGA on 02 6629 5333 for details of access to the QDPI varieties.

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3.9 Fresh-cut custard apples

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Abstract

A fresh-cut custard apple product with acceptable quality and shelf-life has been developed and trials aimed at maximising quality and shelf-life are still in progress. Fruit preparation techniques, pH and buffering capacity variability, product acidification, anti-browning agents and packaging have been investigated and trials to determine the effects of headspace atmosphere composition and storage temperature on product quality and shelf-life are in progress.

Introduction

Recent consumer research indicates that there is a market opportunity for a 'ready-to-eat' minimally processed form of custard apple for domestic and export markets. ACAGA therefore commissioned QDPI to conduct this project to develop a fresh-cut custard apple product. The Commonwealth Regional Assistance Program, ACAGA and QDPI are funding the project. It commenced in March-2002 and is due for completion early in 2004.

The overall objectives of the project are to determine the technical requirements for the manufacture of fresh-cut custard apple, to produce samples of fresh-cut product with known parameters of food safety and to document the technical requirements for commercial manufacture. Before summarising the findings and achievements of the project to date, I'll give you a very brief overview of how conventional low-oxygen modified atmosphere packaging of fruit and vegetables works. I should also mention at this point, in relation to the project findings, that some specific details have been withheld as commercial-in-confidence on the instruction of ACAGA management, pending determination of future directions on commercialisation of the product.

Conventional low-oxygen modified atmosphere packaging of fruit and vegetables

When whole or cut fruit or vegetables are held in sealed packages, product respiration will result in decreased oxygen levels and increased carbon dioxide levels in the headspace of the package. The rate of change in the composition of the headspace atmosphere depends on the respiration rate of the product and the oxygen and carbon dioxide permeability of the packaging material. Decreased oxygen levels and increased carbon dioxide levels slow the processes responsible for physiological degradation of fruit or vegetable cells and also slow down the growth of microorganisms, thereby increasing shelf-life.

However quality can be adversely affected if oxygen levels become too low or carbon dioxide levels become too high. What constitutes 'too low' a level of oxygen or 'too

high' a level of carbon dioxide varies greatly between different products and has to be determined for each product.

In passive modified atmosphere packaging (passive MAP), the package is sealed under air and the modified atmosphere is generated by the respiration of the product. For a particular product held at a particular temperature, the headspace atmosphere composition at any point in time will be determined by the oxygen and carbon dioxide permeability of the packaging material. In active MAP, the package is sealed under a gas mixture, the composition of which is optimal in regard to the quality and shelf-life of the product. In both active and passive MAP, the aim is to achieve optimal headspace atmosphere composition, but this is achieved more rapidly with active MAP. This can have significant beneficial effects on quality and shelf-life.

Fruit preparation and presentation

An investigation of potential peeling, cutting and deseeding techniques has resulted in the following fruit preparation procedure being developed:

Unpeeled fruit are cut into 13mm slices with a bacon slicer fitted with a modified blade. The modified blade has a very light bevel, which reduces slice breakage during slicing. Seeds are removed from each slice with a stainless-steel rod (a small stainless steel spatula, or the handle of a stainless-steel teaspoon have been found to be suitable) and the skin is then removed with a stainless-steel pastry cutter of appropriate diameter. Since slice diameter varies considerably, a set of cutters with a range of diameters is required to minimise flesh wastage. The deseeded peeled slices are manually cut into two to six segments, depending on the size of the slice.

This is a simple procedure involving low capital cost and it would be very suitable for a small-scale regional processing operation. The product has an attractive clean-cut appearance, is almost seed-free and would be suitable for small snack-packs or for larger packs.

Mechanical slicing is important because it ensures a uniform segment thickness, which is essential for uniform product acidification (a critical microbiological safety factor). Mechanical slicing also results in an attractive clean-cut product appearance. Also important in obtaining an attractive clean-cut appearance is slicing the fruit with skin-on and using the pastry cutters to remove the skin from individual slices. The alternative option of manually removing the skin from the fruit prior to slicing gives a much rougher appearance and also results in more breakage during slicing.

pH variability and acidification

Since pH is a critical factor in relation to microbial growth in the product and hence product safety and stability, it is important to determine the effects of such factors as growing location, harvest time, maturity and ripeness level on pH and buffering capacity and the variability in pH and buffering capacity within and between individual fruits in a consignment. It is also important to determine the rate of acid penetration into the centre of segments following dipping in acidic solutions because acidification is necessary to lower pH to a safe level in regard to the potential for

growth of pathogenic bacteria. The following three studies were conducted to obtain this information:

(a) Effect of location, harvest time, maturity and ripeness level on pH and buffering capacity

Fruit was taken from Yeppoon and Alstonville at two harvest times and from the Sunshine Coast at one harvest time. Two stages of maturation were selected from each consignment, based on time for softening to commence. The fruit was then ripened to two stages of ripeness (slightly under-ripe and slightly over-ripe) and flesh pH was measured for each fruit. Fruit segments were then dipped in a citric acid solution for a set time and the pH of the acidified segments was measured in order to assess comparative buffering capacity.

pH was generally higher for Alstonville fruit than for Yeppoon and Sunshine Coast fruit and the pH of Alstonville fruit was generally higher in the September-harvest fruit than in the June-harvest fruit. Buffering capacity was generally higher for Yeppoon fruit than for Sunshine Coast or Alstonville fruit and buffering capacity for Yeppoon fruit was generally higher for the May harvest than for the March harvest. Neither maturity nor ripeness level had any consistent effect on pH or buffering capacity. Taken across all treatments, the pH of individual fruits ranged from 4.5 to 5.5 before dipping and from 3.5 to 4.3 after dipping.

The effects of location and harvest time are not consistent enough to allow accurate prediction of required acid concentration and dipping time to achieve the desired end-product pH. In commercial production, dipping time will have to be determined for each product batch by closely monitoring pH during the dipping process. However it does appear that longer dipping times and/or higher acid concentrations may be needed as the season progresses.

(b) pH variability within and between individual fruits

Flesh pH was measured at various positions within individual fruits from a particular consignment.

Differences in pH within and between individual fruits were found to be small, (range about 0.3) and therefore pH variability for product segments within a process batch will be small. This facilitates the acidification process, since there will be small pH variability in the final product and less sampling required to confirm that the pH of the final product is in the required range.

(c) Acid penetration study

The rate of acid penetration into the centre of segments was determined by dipping segments in citric acid solution, packaging the segments in heat-sealed pouches, holding the product at 3^{o}C and monitoring surface and centre pH over a period of 14 days. Thus the holding time at 3^{o}C required for adequate acid equilibration was established and for microbiological safety it is recommended that in commercial manufacture, the product should be held for at least that period (the period is

commercial-in-confidence) at 2°C to 3°C in a closely-monitored cold room at the factory before being distributed to the market-place.

Anti-browning agents

The effectiveness of various anti-browning agents in regard to maintenance of an attractive product colour and flavour was assessed.

Custard apple segments were dipped in solutions containing citric acid alone and citric acid in combination with one or more of the following anti-browning agents: ascorbic acid, sodium erythorbate, sodium acid pyrophosphate, calcium chloride, sodium chloride and L-cysteine monohydrochloride. Sucrose was also added to the dip solution to minimise osmotic leaching of soluble constituents from the fruit. A range of combinations and concentrations was investigated, and in all cases the pH of individual segments was reduced to a maximum of 4.0 (mean pH about 3.8). Following dipping and draining, the segments were packaged in low-barrier, heat-sealed pouches. The packaged product was stored at 5°C and sensory quality was assessed after various periods of storage.

The best combination and concentration of anti-browning agents was determined, but is commercial-in-confidence at this stage. All of these substances are permitted additives for this product under the joint Australia New Zealand Food Standards Code.

Dipping time varies from batch to batch, depending on the initial pH and buffering capacity of the fruit, but is normally in the range 30 minutes to 60 minutes. Citric acid concentration may have to be varied to some extent during the progress of the season, in order to keep dipping times within a practicable range.

Packaging

Packaging requirements for fresh-cut custard apple have been determined in terms of the required gas barrier properties of the packaging material.

Fruit segments were dipped in an aqueous solution containing the optimum combination and concentration of anti-browning and acidifying agents, as established in the previous trial, and then packaged in heat-sealed high-barrier, medium-barrier, low-barrier and very low-barrier pouches. The packaged product was stored at 5°C and sensory evaluations, microbiological testing and headspace analyses were conducted after various periods of storage.

Best results in this trial were obtained with the high-barrier packaging. The structure and gas permeability of the packaging film is commercial-in-confidence at this stage. With this packaging, acceptable quality was maintained during storage periods up to 4 months.

Commercially, the product could be packaged in either pouches or tubs, with tubs normally being preferred for fresh-cut fruit products because they offer a better appearance, better physical protection for the product and better options in regard to

automation. Irrespective of whether pouches or tubs are used, high-barrier packaging will be required for a long shelf-life product.

Modified atmospheres

A trial is currently in progress, the aim of which is to determine the optimal initial headspace atmosphere composition for active modified atmosphere packaging of fresh-cut custard apple.

Custard apple segments were subjected to the best pre-treatment (acidification and anti-browning agents) and packaging from previous trials. The pouches were heat-sealed under air and under 11 modified atmospheres with different proportions of oxygen, carbon dioxide and nitrogen. The packaged product is being stored at 5^{o}C and sensory evaluations, microbiological testing and headspace gas analyses are being conducted after various periods of storage.

After 9-weeks storage, the quality of product subjected to passive MAP (pouches sealed under air) was comparable to the quality of product subjected to the best of the active MAP treatments (pouches sealed under modified atmospheres). If this trend continues, it will be a fortuitous finding, because packaging equipment is less expensive for passive MAP than for active MAP.

Storage temperature

Another trial is currently in progress, the aim of which is to determine the effect of storage temperature on quality and shelf-life of fresh- cut custard apple.

Custard apple segments were subjected to the best pre-treatment from previous trials and then packaged in high-barrier pouches sealed under air. The packaged product is being stored at the following temperatures:

2^{o}C	Recommended storage temperature
5^{o}C	Upper limit of well-controlled refrigerated storage
10^{o}C and 15^{o}C	Abuse temperatures.

Sensory evaluations, microbiological testing and headspace analyses are being conducted after various periods of storage.

Microbial counts were high in product stored at 15^{o}C after 1 week and were very high after 2 weeks. For product stored at 10^{o}C, microbial counts were in the medium range after 4 weeks storage and sensory quality was acceptable. Product stored at 2^{o}C and 5^{o}C had low microbial counts and good sensory quality after 4 weeks storage. These findings demonstrate the importance of good temperature control from processor to consumer. The product must be held at 5^{o}C or below at all times.

Semi-acidified product

In addition to the studies being conducted with the long shelf-life fully-acidified product (maximum pH 4.0), a semi-acidified short shelf-life product (maximum pH

4.3) has also been investigated. This product may cater for markets preferring a less acidic product, but not requiring a long shelf-life.

Custard apple segments were subjected to the best pre-treatment from previous trials, except that dipping time was reduced to give a maximum pH of 4.3. The product was packaged in low-barrier pouches constructed from two different materials and the pouches were sealed under air. The packaged product was stored at 5^{o}C, 10^{o}C and 15^{o}C for periods up to 3 weeks.

For the better-performing low-barrier packaging material, which can't be specified at this state (commercial-in-confidence), sensory quality and microbial counts were acceptable in product stored at 5^{o}C for up to 2 weeks. However for product stored at 15^{o}C, microbial counts were very high after 1 week and for product stored at 10^{o}C, microbial counts were in the medium range after 1 week and very high after 10 days.

Thus in commercial practice, temperature would have to be well controlled and shelf-life should be limited to 1 week.

Conclusion

A fresh-cut custard apple product with acceptable quality and shelf-life has been developed and trials aimed at maximising quality and shelf-life are still in progress. Following this product development stage, marketing and economic feasibility studies need to be conducted to determine the potential of the product for commercial manufacture. It is important to note that commercial manufacture would have to be conducted in accordance with strict technical guidelines and that any departure from these guidelines could result in an unsafe product. Also good temperature control during storage, transportation and marketing of the product is absolutely essential.

3.10 Pollination, humidity and irrigation

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Introduction

There is no doubt that custard apples and *Annona* spp. in general are susceptible to environmental conditions at flowering, and this problem is exacerbated by plant vigour, and several other factors. It is probably fair to say that there is no other sub-tropical tree crop that is as sensitive to temperature and humidity, than is custard apples (George et al., 1988). This is partly due to the female/male change in flowers, and partly to adaptation in the natural environment in southern Ecuador and northern Peru. In that environment, if it is too dry, fruit will not develop and mature, and if it is too wet, there will be serious disease problems. So flowering is timed to coincide with the onset of storms, when there is the best chance for fruit set and development.

This fits in with observations made by QDPI researchers, who monitored fruit set over the whole custard apple flowering period in southeast Queensland. This work showed that highest fruit set occurred the day after late afternoon showers, where presumably the humidity was increased (George et al., 1989).

Studies in Chile by Saavedra (1977) and in Egypt (Ahmed, 1936) showed an increase in fruit set by spraying open flowers with water. It appears that condensation of water inside the thick fleshy petals is conducive to maintaining high humidity within the flower and for maintaining stigma receptivity and longevity. These observations are further supported by extensive observations in Chile where up to 100 workers are employed to hand-pollinate about 20 hectares of cherimoya var. Concha Lisa and Bronceada. The Chilean farmers store their pollen at 70-80% relative humidity. They indicated that relatively humidity was probably more important than temperature. Best temperatures for pollination in Chile were 18-23 degrees centigrade, and optimum relative humidity for hand pollination is 80%.

It should be noted that humidity and irrigation/rainfall are in our opinion very different. Heavy rainfall during flower opening is not conducive to fruit set and in fact are detrimental due to bursting of pollen grains and dilution of stigma secretions. Heavy rainfall may also reduce nitidulid beetle activity as well. Low humidity (<60% RH) is equally unsatisfactory.

Three different grower experiences are outlined in the following three articles. One grower is from Western Australia, one from northern New South Wales and one from Gin Gin, near Bundaberg. Please note that under tree irrigation, apart from maintaining correct soil conditions, may also increase block or tree humidity, and hence lead to increased fruit set.

We hope to test overhead, low-delivery rate sprinkling on trellised custard apples in the near future. This would raise humidity and simulate the use of an air-blast sprayer, which appears to have produced an excellent result under difficult conditions

at Gin Gin in Queensland. Timing of such techniques would have to be linked to observed floral cycles in each area. From observations made during my recent Churchill Fellowship trip, no one appears to be using a humidity modification as an approach to improve fruit set. Increases in relative humidity appear to be consistent with what we know about custard apple flower biology and behaviour.

Please note that there are new varieties eg KJ Pinks which are less susceptible to relative humidity, and fruit in a much more consistent manner. This means that cropping of custard apple will be much more consistent than in the past, and this is important for maintaining a yearly income for growers. It is also one of the selection criteria for our breeding program. However there are established trees and orchards for which this approach may enhance fruit set.

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3.11 Research on fruitspotting bugs continues

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Alternative insecticides

Endosulfan has been the insecticide most commonly used for fruitspotting bug (*Amblypelta* spp. or FSB for short) control in tropical and subtropical tree fruit crops. It provides adequate control of the pests and tends not to disrupt natural enemies and induce outbreaks of other pests. Most other effective insecticides pose such a risk, but some newer compounds may still be of value if their use strategy is finely tuned to the seasonality of the pest complex. Limited field trials in custard apples over the last two seasons have indicated that a couple of these chemicals could provide acceptable control of FSB, but we have no data yet on their compatibility with the critical natural enemies, especially *Cryptolaemus*.

Netting

Nets of a suitable mesh size (10-12 mm quad), exclude not only vertebrate pests from fruit crops, but also many insect pests, including fruitspotting bugs. For crops such as custard apples, lychees and persimmons, such nets have protected the crops from a range of pests without having a serious impact on the physiology of the trees through reduced light, increased temperature, and reduced air movement. Commercial netting companies continue to refine net types and structures, and opportunities for excluding fruitspotting bugs with will be examined.

Physical barriers on the plant

Particle film (Surround®), and oil sprays (Biopest®), have been investigated to determine if a film of these products sprayed onto the surface of the leaves and fruit, will deter fruitspotting bugs from feeding in avocados. Surround®, applied at what is now known to have been too low a rate, seemed to provide some protection from the bugs, and provides protection for those fruit that might suffer from sunburn. Beneficial effects on avocado fruit quality have also been noted.

Decoy and trap trees

Current research is investigating the possibility of using attractive host trees for monitoring FSB and targeted control. The bugs invade orchards from external breeding areas. In many situations, mainly in larger orchards, hotspots can be identified, and the planting of attractive alternative hosts as decoys or trap trees is an option.

Apart from many crop species, numerous ornamental and native plants are hosts of fruitspotting bugs. Mock orange, *Murraya paniculata*, is a particular favourite of both species of fruitspotting bug, but it is only attractive while it bears fruit. Only the flowering and early fruit set period of some crops would be covered, if *Murraya* were used as a trap tree. It would be of little use in custard apples, with their protracted flowering.

On the other hand, Fuerte avocados are attractive from fruit set in September through to the end of the fruitspotting bug season in April, and could be used in an 'attract and destroy' strategy for custard apples, and especially in avocados.

Semiochemistry

Don't be over-awed by this heading – it is merely an 'all-encompassing' term for studies on insect pheromones, kairomones and host volatiles. I still believe that the answer for the future effective management of FSB will be found in such research.

After 14 years of unfunded research into FSB pheromones, we have recently made some exciting progress. My collaborators, Dr Chris Moore, organic chemist with QDPI at Yeerongpilly, and Dr Jeff Aldrich, Research Leader, Chemicals Affecting Insect Behaviour Laboratory, USDA, Beltsville, USA, have continued to assist with chemical identifications and sensory experiments. In 1999, Chris identified the major component of the *Amblypelta nitida* pheromone, a new compound that required some really high-level expertise and resolve.

In September 2002, I was able to visit Jeff in his laboratory at Beltsville. We connected live female *A. nitida* antennae to an electro-antennogram apparatus to study their response to the male 'pheromone' blend, which Jeff had collected at Maroochy in 1991, and stored in his freezer. The results, which to trained eyes are very exciting, are shown in the figure below. Many of the blips on these graphs look alike, but the important ones – those numbered 1,2 and 3 on Graph A, the corresponding downward peaks on Graph B, and the E in Graph C, which aligns with the 2 in Graph A and the antennal reaction in B, are what excited us.

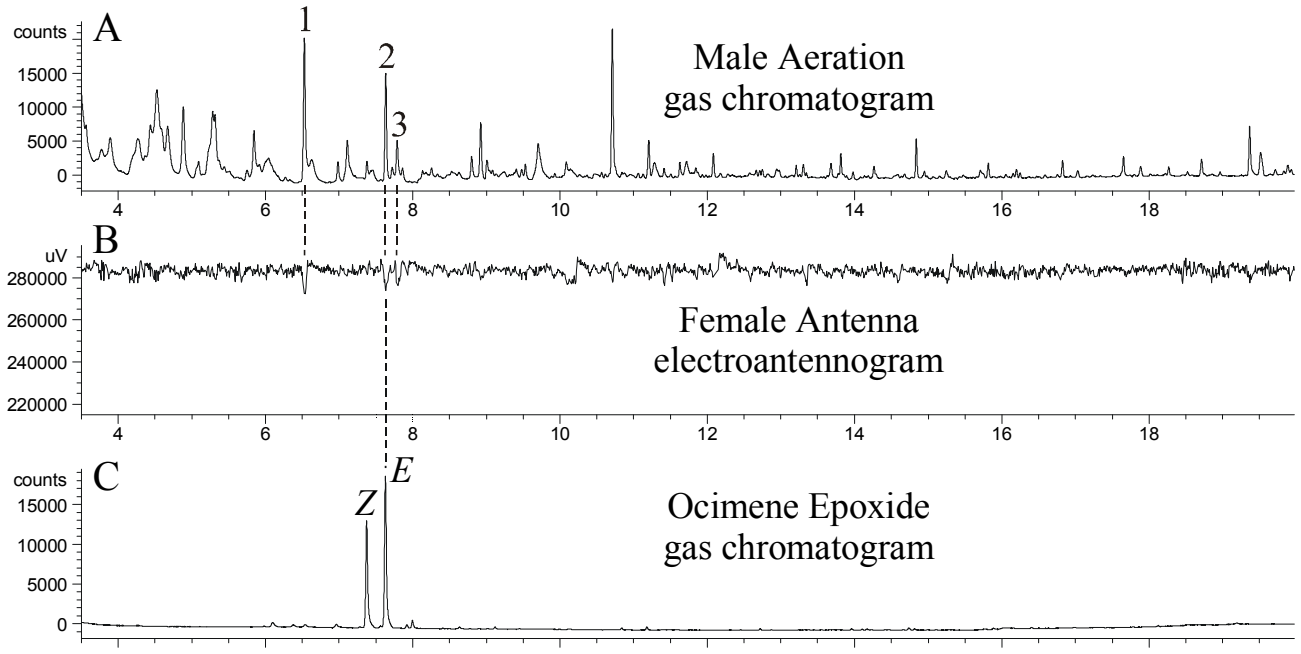

Figure. A. Gas chromatogram of aeration extract of *Amblypelta nitida* males (60m DB-WAXetr; 80°C for 2 minutes to 250°C at 10°C/min, hold 10 minutes). B. Electroantennogram detection using *A. nitida* female antennae. C. Gas chromatogram of a synthetic standard of beta-ocimene epoxides ("myroxyde"; Firmenich, Inc.).

The female antenna electro-antennogram tells us that it is receiving, recognising, and responding to, compounds 1, 2 and 3. These are nonanal, decanal and ocimene epoxide (myroxide). The latter compound is the one identified by Chris, and the Swiss company, Firmenich, now uses it as a component in perfumes. This makes it readily available without our having to synthesise it for experimentation. So we think we are onto something here, although field trials for attractiveness of blends of the three compounds have so far not been successful.

In the next couple of years, we hope to commence studies on the host plant volatiles using some new technology that allows efficient sampling of the headspace of fruit and plants. The theory is that the bugs recognise specific chemicals produced by host plants or the fruit on which they feed, and these lead them to the plant to feed. If we can find a common theme across a range of host plants, we might produce an artificial attractant. This may act alone or in combination with the pheromones. Unfortunately, time and the reluctance of our employer to employ young scientists, may bring a premature end to this research.

3.12 Sunny trial at the centre for tropical horticulture 2003-2004

Trevor Olesen, NSW Department of Primary Industries, Alstonville

An experiment into the use of Sunny to control the vigour of, and promote flowering in, the custard apple cultivar "African Pride" commenced at the Centre for Tropical Horticulture, Alstonville, in spring 2003.

Prior to the trial the trees were pruned from a height of approximately 5m to 3m, and the centre limbs were removed to create an open vase. The trees were then defoliated using first a spray of Ethrel (1000 ppm)/urea(25%) in early October, then a week later Dormex (4%).

Twenty eight trees were blocked into 7 groups of 4, and 4 treatments were randomly allocated within each block. The treatments were:

- control
- sprays of 2% Sunny in mid-November and early December
- sprays of 2% Sunny in mid-November and early December, followed by tipping and partial leaf stripping of branches in mid-January
- sprays of 3% Sunny in mid-November and early December

Yields have not yet been finalized, but the following trends seem to hold. The yields of all trees were disappointing, with an average of only a few kilograms per tree. However, the yields of the trees sprayed with Sunny were higher than those of the controls. There was no obvious benefit in using Sunny at the higher rate.

The trees that were sprayed with 2% Sunny then tipped and stripped produced a much greater number of flowers across the season than the trees that were sprayed with 2% Sunny but not tipped and stripped. However, more flowers have not led to more fruit or greater yields.

At the beginning of harvest the canopies of the trees that were tipped and stripped were considerably smaller than those of all other treatments. Amongst the other treatments there were negligible differences in canopy size.

In conclusion, Sunny increased the yields, possibly through a transient suppression of vegetative growth early in the season that promoted flowering. That the yields were poor may be related to the luxuriant soil on which the trees were grown or the severity of the pruning prior to application.

4.0 TECHNOLOGY TRANSFER

4.1 THIRD AUSTRALIAN CUSTARD APPLE CONFERENCE SELECTED PAPERS

4.1.1 Welcome and introduction

Bruce Sloper
President
Australian Custard Apple Growers Association
747 Adelaide Park Road
Yeppoon Q 4703

Three years have past since our last conference, the theme of which was "Strength in Unity".
From the feedback from growers since then, I get the impression that growers and others involved with our industry they are satisfied with the work undertaken by the management team on their behalf. I have said it many times that I believe we have a dedicated management team who give many voluntary hours to achieve what we do. We also have a very enthusiastic team of managers and researchers who all have a keen interest in the industry's future and improving the bottom line for growers.

The theme of this conference is " GROWING OUR FUTURE TOGETHER". This represents the concern of growers that there have been increases in the cost of production which have impacted on viability of their enterprise. Custard Apples are not an easy crop to grow and there are no quick bucks to be made. We have the challenge ahead to maintain viability and sustainability of our industry. On conclusion of this conference, hopefully you will depart with the optimism I have for our future. Admittedly, times are tough, not only in this industry but most Australian industries. We need to work and cooperate together to overcome the problems and find the solutions.

The demographics of the industry are changing. This is partly because of the realization that the crop is not easy to grow and other impacts. The New tax system introduced since the last conference, food and safety regulations, the impact of Globilisation on export and imports, increasing costs of production, static if not diminishing returns, has seen some changes within our ranks since last conference.

I can remember when Sharyn and I did our initial research into custard apples when making the decision what to plant. The model that was around in those days was that a family unit of Mum, Dad and the kids could quite comfortably make a living from about 620 trees. This is certainly not the case today. Production costs have increased significantly and the return to growers has not kept parity with those increases.

The ACAGA management is aware of these circumstances and the thrust of our endeavours for a more sustainable industry is to develop management systems of existing varieties and develop new varieties that require less input costs and are in demand by consumers.
We know we have a very unique product and there is the demand from those who like nature's sweetest fruit. There is still much work to be done in promoting our product domestically and internationally. Recently we rearranged the application of the

40cent (total marketing and RD &E levy) so that maximum leverage of matching dollars from the Commonwealth Government could be obtained, and that our programs could be fast tracked somewhat.

We have also negotiated a unique licencing arrangement with Queensland Horticulture Institute, propagating nurseries and growers for the licence of new varieties.

The research priority is to have a consistent fresh fruit product whilst running parallel to that work ACAGA continues to develop export markets. A value-added project that could have benefits to growers in the future has been completed from funding sourced outside of industry funds.

During April, May June 2003 Roger Broadley, Patti Stacey and husband Phil, and myself travelled overseas to assess custard apple industries in other countries. Roger had been awarded a Churchill Fellowship to study custard apples and other tropical fruit research and production in Taiwan, Spain, Brazil and Chile. Patti and Phil joined him in Taiwan and I joined him in Brazil and Chile. This will prove to be invaluable in our decision making in the next few years. The information we gathered from both the researchers' and growers' perspective is very interesting and you will be hearing more about this during this conference. There are opportunities for collaboration and possible alliances with these countries.

There are many challenges ahead for growers and for the ACAGA management. Globalization is with us and we must cooperate to maintain our market share. We must firstly cooperate as growers and ACAGA needs to look for alliances and potential international opportunities for market development. It might not be that much longer when we will see imports of either fresh or a value added custard apple product into Australia. I do think that commercial interests in marketing custard apples need to pay close attention to this developing situation. My belief is that we need to be united as growers and as marketers to be in a position to negotiate with the global marketers that are now forming.

ACAGA by its Constitution is responsible for the market "development" of the industry. It no longer has responsibility for "marketing" growers' fruit. To this end over the past years we have facilitated the formation of the 'Jadefruit Custard Apple Marketing Association Inc.' and have licenced that Association with the use of the registered trademark "JADEFRUIT".

Incorporated in the trademark registration is the Logo, which is used by ACAGA.

ACAGA Management has recognised that the use of the logo by ACAGA and the J-CAM Association was inappropriate and more importantly, illegal. We have therefore proceeded with developing a new logo for ACAGA. It is my privilege today to unveil this LOGO.

Before completing, I would like to thank the Commonwealth Government of Australia for their funding support. Without such matching dollar contribution, developing industries such as ours would not have the resources to undertake such research. Also industry thanks the ongoing support from the Queensland

Government, and in particular the Queensland Horticulture Institute. It is appreciated that it is a delicate balance in appropriating budgets, but I give assurance to those in such decision-making positions that the Australian Custard Apple Industry has a sound economic and export future and one that is hopefully nearing fruition.

To all our dedicated researchers, program managers and our extended family of other Horticultural Associations, Agents, Nurseries and Transporters, ACAGA offers our thanks for your professional contributions. Your care is our future.

Finally we bid a very fond farewell to those who have left the industry team over recent years. Your contribution to our industry has been appreciated.

Thank you to all the sponsors of this conference. Without your generous contributions this event would not be possible. I encourage growers to support those who support us.

Today and tomorrow those present will have access to, and hear reports from, all the movers and shakers of our industry. I am very interested in views for the future and problems of the past with regard to our industry and invite you all to express them to any of the management members over these two days.

Enjoy the conference and look to a positive future in the custard apple industry.

4.1.2 Records - a growers experience

Rod Fayle
Macadamia Farmer
Lismore, NSW

My name is Rod Fayle and I own and operate a 2800 tree macadamia orchard at Rosebank in the Lismore area together with my wife Vicki. I will speak about my experience with record keeping in my industry. I hope that you can relate what I have to say about macadamias to the custard apple industry.

When the MacMan project was first under consideration, I was a keen supporter of the concept as I could see the need to improve and better organise my on-farm records. This was not records for records sake, but records to help me with my farming decisions. I could also see the day coming when we would have to keep records, like it or not, for food and environmental safety.

After a bit of a struggle with the early versions of the MacMan program, I have disciplined myself to use the program on a regular basis and am finding the latest version much more user friendly. I am now able to use some of the analytical skills built into the program to extract lots of helpful information tucked away within my records.

Having become a reasonably competent user, the next step for me has been to harvest the collective wisdom of other growers by joining a **Best Practice Group**. I have recently done so and although it is premature to assert the benefits of being in a Best Practice Group, it is clear that the potential is very large.

For an individual Group to work, the members have to be competent MacMan users and have a reasonable amount of information recorded, say two or more years. Members must also be prepared to open their records, their farm management methods and their costs to the members of the group. To do so, group members need to, absolutely and without exception, respect the confidentiality of each other's information.

Having agreed to the ground rules, the MacMan team can then merge the records from the group and use the power of the computer to illustrate differences in various aspects of the farming operations within the group. You can see, for example how much it is costing you to mow your orchard over the year as compared to the group average. You might want to look at harvesting costs, or dehusking and sorting costs. Fertiliser costs can be compared against production. The range of queries and comparisons is limited only by the accuracy and extent of records that have been kept (by all or most members of the group).

The results from our group are only as good as the input information. i.e. how good are your MacMan records? Garbage in = garbage out. I found our initial meeting very helpful in this regard. Clearly some of my records were so far different to the others that I needed to check them. And I certainly found some bloopers! Having the experts on hand was terrific and I can see my own records improving significantly.

Best Practice Groups are not just a bunch of *computer heads* talking to each other through their machines. An equally important aspect has been the discussions arising when looking at the differences in farming costs. Once again, members need to be prepared to *bare their souls, (true confessions of a macadamia grower)* and be comfortable that the detailed personal information will remain within the group. Lots of very practical information is shared and group members can reassess their farming methods with a view to moving towards best practice.

The measure of what constitutes best practice may vary from farm to farm depending on size, topography, location, micro-climate etc. For me, I want to improve my productivity while improving sustainability. By comparing my costs and methods within the group, I hope to make progress in both these areas.

Looking back over my last few years of keeping these records and being a member of a best practice group, what have been the main benefits and issues for me?

- I actually have records. It was not always so. I used to be guilty of the school of thought that *time spent keeping records was time not spent doing something really useful, like working my orchard.*
- The discipline of regularly completing my records, helps me to think more about what I am doing and how I am doing the job at hand. I find this process a useful way of reviewing my knowledge on the many subjects that we all cover on our farms. How much of what fertiliser should I be using at this stage in the crop cycle? What effect on pH? What legislation covers my work? Is the product registered? Is there a withholding period? Is there a more efficient way of doing the job?
- Records help me with my poor memory. There are many jobs that are only done once or twice a year. What tractor speed did I use? What settings on my spreader or sprayer? You can fumble back through your farm diary, madly trying to remember the approximate date, or find the information almost instantly with a computer. I find that very useful.
- Analysing my records is also very revealing. I can quickly relate harvest yield to different parts of my farm with different varieties and/or management practices. Year to year comparisons are instant. Weather records can be overlaid. I look at my reject analysis and relate that to my IPM program and any spraying that has been done. Last season, I used this information to help me make the decision to buy a new sprayer, as I was clearly not getting effective coverage. I have also decided to top work a non-performing variety, following several years of below average performance.
- Self-assessment is very useful, but by joining a Best Practice Group, I have been able to gain far more insight. However, just because something is different, it is not necessarily right or wrong. There may be a perfectly reasonable explanation. But if you find you are spending three times as much as the others on, say fertiliser, you would be foolish not to have a close look at that. One major improvement for me this season has been to change my harvesting philosophy and method. In macadamias, we mostly use finger wheel harvesters to collect the nuts from the ground. Two or more passes are made to try and collect all the nuts on each harvest round. The whole orchard is picked each month over the harvest season (say six months). This year, after comparing harvest costs in our BPG and discussing differences, I changed to single pass, continuous round harvesting. This has been

particularly beneficial during the wet conditions experienced from February to June.

And the negatives:

- Computers don't pick up nuts. It takes time and effort to learn a new program, even if you are reasonably computer literate. If you are not, don't be frightened buy computers, but you have to allocate a reasonable amount of time to be able to use one.
- Records can become *Records for records sake*. The more we keep, the more the various authorities seem to require. While the purpose of the record is to allow you to analyse your costs and make decisions to improve your bottom line, few would argue.

I would be happy to answer any questions?

4.1.3 Financing your farm

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Introduction

Financing a farming operation can present some real challenges, and can be a source of real concern for some people. What type of financing should you have? How much debt is too much? How do you strike a good deal with your bank? When you record a profit, why is that money never in the bank? In an effort to clear some of the fog on this topic, I have set out below some tips and suggestions that may help.

What type of finance is best?

When deciding which type of finance you should use, your first point of reference should be what the funding is to be used for. The type of finance that you have for a farm purchase for example will generally be quite different from the way you finance a tractor purchase or your short term operating and production costs.

The type of finance you choose should generally match the useful life of whatever it is that you are funding. That is, a farm purchase would usually be financed with a long term lending facility, often as a term loan. A tractor purchase should be funded with say a hire purchase, bill of sale or lease with a term of three to five years. An overdraft facility should not be used for something like this. The funding of production costs should be done via some form of short-term facility. This would most commonly be an overdraft, bank bill facility or even a crop credit arrangement. Care should be taken with crop credit that it is not a more expensive financing option than other sources of finance.

Financing Plant & Equipment

When the time comes to invest in new capital equipment, businesses are often faced with a difficult lease or buy decision. More and more businesses are leasing equipment as an alternative to buying however it is not always the best option.

Background

A lease is a contract under which the lessor buys the plant or equipment and leases it to the user over a specified period in return for periodic rental payments. At the end of the lease period, the equipment can either be returned or bought at an agreed price. Some of the benefits of leasing are:

- the lease payments are fully tax deductible;
- the business can conserve its capital and

- the lease can be structured to suit the business.

If the item to be leased can produce a net increase in cash flow, or a net gain in profit, over and above the tax deduction on the rental costs then leasing may be a good option. If it cannot, then other options should be considered. Hire purchase arrangements and bank loans are the most common alternatives to leasing. Each has its own particular tax benefits.

The choice between the three options will generally depend on costs, prevailing interest rates and depreciation allowances. As the costs of each of the alternatives are similar, depreciation often becomes the determining factor. However, the move away from accelerated to effective life depreciation for most assets from 21 September 1999 means that the tax benefits available from depreciation allowances (particularly for long-life assets such as heavy trucks and machinery) have now been significantly reduced. The business also needs to determine whether it is in a position to claim available tax deductions or will be in a tax loss situation.

The impact of GST on the relevant transaction may also have to be taken into account. A business will be able to claim a full input tax credit for any GST in most cases, other than for items, which are input taxed such as borrowing costs.

Leasing

The business obtains a full tax deduction for the lease rental payments. As the bank or finance company providing the lease finance retains ownership of the item, the bank and not the business is able to claim depreciation. At the end of the lease period, the business usually has the first opportunity to buy the item at its residual value (the written down value after depreciation). In some cases, when the business does not buy the item as it fetches less than the residual value on the open market, the business may be liable for the shortfall.

Commercial Hire Purchase Agreement

Hire purchase arrangements involve the business hiring the plant or equipment with an option to purchase later. The finance company retains ownership of the equipment until the business pays it off on a principal plus interest basis. The interest is tax deductible and, as the implied owner of the equipment, the business can also claim depreciation deductions on it. Depending on the nature of the equipment involved, the tax benefits from depreciation in the early years of the agreement may be greater than those achievable by leasing, but this is probably less likely now than under the previous depreciation regime.

It is normally a condition of these agreements that the user, not the finance company, pays registration, insurance and maintenance costs (as for a loan arrangement). Stamp duties and statutory fees would also be payable by the user.

Loans

If a business takes out a loan to purchase plant or equipment, the interest on the loan is tax deductible. As the business takes title to the equipment, the business can also claim a tax deduction for depreciation over the item's effective life.

A bank or other financial institution may not provide loan finance unless the business puts up security for the loan, which in the case of many farms involves taking out or extending the mortgage on the farm.

Consider the options

Before making any lease or buy decisions, analyze all options to determine both the tax benefits through tax deductions and depreciation and also the net cost of the alternative financing options to the business and their respective impact on profits.

Rates and charges

With any type of financing for your business it is important to know its cost. With debt finance this is made up of interest and other charges. These costs should be known so that they can be properly managed.

The other type of funding or source of capital is equity funding. That is, capital invested in the business by the owners. This too has a cost. In order to assess the viability and performance of any business it is important to know the overall cost of capital invested in that business. If the combined cost of debt and equity funding in a farming enterprise is say 12%, and the business is recording a return of say 5%, then in real terms you are going backwards.

Many people don't consider the cost of equity, and only look at debt. In that case your return only has to clear the cost of borrowing money at say 8%. Depending on seasons and commodity prices this can still be a big enough challenge. In the words of one of my clients 'if I look too closely at returns then I wouldn't be farming'.

How much debt should you have?

This is the perennial question. How much debt is too much? How much debt is too little? With farming enterprises the level of debt that should be taken on, is governed by serviceability rather than looking at debt as a percentage of assets.

We all know that farming is a business that requires a high level of capital invested but often yields only a modest return. It is therefore not appropriate to say that we have say $2M invested here, so a debt of $800,000 or $900,000 should be no problem. This may or may not be the case. The level of debt that is appropriate is governed by the returns being generated and therefore what level of repayments can be sustained.

The returns being generated will vary from farming enterprise to farming enterprise. It is a product of management ability as much as it is the seasonal conditions or commodity prices. Two properties of similar size, soil types and geographic area may in fact be able to support different levels of debt because of differing abilities of the managers. The right level of debt to have is therefore and individual assessment.

Applying for finance

When looking to apply for a loan there are a few do's and don'ts that will help you get the best outcome with your bank.

DO'S

- Prepare a good business plan that includes, among other things, an assessment of risk, projected cash flow and profit and loss financial statements, work out three possible scenarios (good, bad & likely), and explain how the funds are to be used.
- Have information available that illustrates the good relationship that you have with the bank.
- Invite the bank representative to your farm to present the proposal, and plan out how the meeting will run.
- Don't be afraid to negotiate with the bank on interest rates, terms and conditions etc.
- Examine your loan documents carefully.
- Execute the documents
- Use the funds according to your business plan.
- If changes occur in your business, be sure to let the bank know. This may even involve renegotiating your loan conditions.
- Make sure that you comply with debt servicing conditions, monitoring conditions and covenants.

DON'TS

- Submit a half-baked application with key information missing.
- Attempt to make frequent changes to lending conditions without prior approval.
- Use funds for purposes other than those stipulated in your loan application.
- Disregard credit covenants or principal objectives of your business plan.
- Fail to comply with monitoring requirements requested by the bank.
- Give unacceptable excuses for your under performance.

MANAGING DEBT

Having applied for and received a loan it is important that all debt is managed properly. Be sure that you meet all servicing and reporting requirements of your loan. If circumstances change it is important to keep your bank informed and where necessary renegotiate the loan conditions. This can be because of either favorable or unfavorable changes.

If in some areas, drought conditions persist through winter, it may be that loan conditions will have to be changed to extend the term of the loan or possibly redraw the facility to give additional funding for carry on finance. On the other hand, if you

are ahead on repayments and the value of your farm has increased, then it may be possible to negotiate a better deal than you currently have. It is a question of monitoring your own performance and gauging when you need to make any necessary changes.

One successful farmer that I have spoken to told me that he likened managing debt to managing another paddock. With neglect weeds grow and it under performs. With good management the results can be spectacular.

WHY IS MY PROFIT NEVER IN THE BANK?

Positive cash flow is not the same as recording a profit and it is important for any business manager to understand this fact. Profit measures performance over time with income and expenses being recognized when they are incurred. Expenditure is offset against income to give a measurement of performance.

Cash flow is the movement of cash in and out of the business. Some transactions for example are treated quite differently when calculating profit than from a cash flow perspective. When calculating profit or loss we claim depreciation on capital equipment and only the interest component of your loan repayments. From a cash flow perspective, the total amount paid for an item of capital equipment will come out of your cash balance at the time of purchase. When making loan repayments, the payment is usually made up of both a principal and an interest component. This again means that there will be a fundamental difference between the impact on your profit and loss statement, verses your cash flow statement from these two transactions.

As I have already stated profit or loss is a measure of a business's economic performance over a given period. For a farming business to be economically viable and sustainable it must record profits. This will often not be possible in every year, but it needs to be achieved in the majority of years. Even though profit is used to determine the amount of income tax that you pay, profit is not a dirty word.

Income tax, whether we like it or not, is an expense of doing business. You therefore should be looking to trade profitably and still minimize the amount of income tax that you pay. Good managers generally try and minimize the amount that they have to outlay for repairs and maintenance or veterinary expenses, but it would be less than prudent management to cut them out all together. The same approach should be taken to income tax.

While generating profits is critical to any business, cash flow management is absolutely essential. Timing of cash inflows and outflows is the basis of cash flow management. That is, making sure that there is sufficient funds available to make those essential payments such as wages, suppliers payments and loan repayments. There is an old saying in business that says that while profits are essential, cash is king.

4.1.4 Custard apples - horticulture Australia report

Wayne Prowse
Marketing Manager
Horticulture Australia

Horticulture Australia is a company established under corporations' law in 2001 to provide marketing and R&D services to Australia's horticultural industries. It had its genesis in the two previous statutory corporations (AHC and HRDC) and is now owned by 28 industry bodies including ACAGA.

The logic behind Horticulture Australia is simple. By bringing together resources of thousands of individual producers, marketing and R&D programs that can benefit the wider industry can be more effectively implemented than to rely on market forces. Without an equitable "all of industry" investment, benefits to "non contributors" provide a disincentive for the progressive few to invest. In addition Horticulture Australia provides a mechanism to manage levies collected by Levies Revenue Service (a division of AFFA) and utilize the government $ for $ matching of R&D projects. Importantly the funds for each participating industry is kept separate to ensure that monies collected from the Custard Apple industry are spent on Custard Apple related projects.

To put in perspective, Australia's horticultural industry is valued at approx $5.5billion.

Horticulture Australia currently invests approx $62million (1.1% of gross value) into R&D and marketing projects and programs that benefit horticultural industries. Of this, R&D levies are $10.5m, Voluntary Contributions are $15.4m and Government funds are $25.9m to give a total $52million invested in R&D programs. On marketing, Horticulture Australia invests some $8.2million from levies and $2.3m other contributions, which is a total $10.5million. Government does not provide funding for marketing projects.

The key program areas that Horticulture Australia is focused include consumer research, product safety and quality, increasing demand for products in domestic and export markets, access to new markets, effective supply chain and an efficient sustainable production base. These areas are common to most industries and consistent with the Custard Apple strategic plan.

It is no coincidence that these program areas can be broken into the four basics of a marketing mix: **product quality, pricing, place and promotion**. From the whole of horticulture to the specific program for the Custard Apple industry these basics do not change.

Many of the R&D projects are focused on improving **product quality**, from plant breeding and variety improvement, on farm activities such as understanding soil nutrition and water management through to post harvest research and supply chain management. Horticulture Australia's "Retail Development Program" is an example of the way in which we can influence retail produce managers to manage fruit better in store and also identify problems before selling unsatisfactory produce to

consumers. Consumers also need to be reminded and even educated on how to handle our fruit correctly.

Whilst we are unable to control the final **price,** most, if not all programs, are focused on the ultimate goal of improving grower returns. Some projects aim to reduce the existing cost of production, others aim to create a commercial opportunity to influence the price paid through either a better quality product and / or increased demand.

Getting the right product to the **right place** at the right time is the domain of the market system. Once again, supply chain projects have assisted horticultural industries to improve efficiencies in distribution and maintain better quality through to the consumer. Perhaps the key area that Horticulture Australia is assisting is in opening up access to new markets. For example: Summerfruit to Taiwan; Citrus to USA; and Apples to India.

Before discussing promotion it is important to understand that promotion cannot be effective unless the above marketing basics are in place. Promoting poor quality fruit may lead to a worse outcome than no promotion. Similarly promotion when no product is available is a waste.

The main aim for all **promotion** programs is to increase consumer demand. By increasing consumer demand, the market will clear more quickly and reduce incidence of over supply. Reduced over supply will mean better fruit from having less aged stock in the market. And importantly there is less need to cut prices to clear stock, which means higher average prices for all. We all know that prices usually increase when supplies are short. An increased demand should have the same impact on prices at higher supply levels.

There are four key elements of the promotion mix that we use:

Public Relations – by establishing good relationships with the food media and supplying credible information we can influence the amount of editorial / publicity in the media (magazines, radio, TV and even internet sites). Horticulture Australia regularly takes food writers on field trips to orchards to meet with growers in addition to regular press texts, fact sheets and individual follow up. The Custard Apple PR program has been most effective (see PR report).

Whilst PR influences editorial, we have no control over what is said and when. Magazine advertising, in the form of advertorials is a good way to get a message to consumers at the right time and place. For example we can target specific magazines in the Health or Baby Care sectors for related massages. Then there are the popular "foodie" magazines such as Australian Good Taste and Super Food Ideas. These reach shoppers at supermarkets, are dedicated to food and provide an environment to advertise when readers are receptive to messages about food products. We sometimes use newspapers for tactical advertising when a rapid response time is critical.

Point of Sale, usually in the form of recipe leaflets and posters create the last opportunity to remind consumers about our products whilst they are at the point of buying. An attractive recipe leaflet may just mean the difference between a shopper

buying a custard apple and walking past. Linking the POS messages to other advertising serves to reinforce the reminder.

With its strong visual and audio cues, TV is still recognized as the strongest and most effective adverting medium. It is also one of the most efficient cost-wise in terms of reaching consumers. Whilst this does not suit all industries due to the initial costs, Horticulture Australia is now using TV advertising effectively for Apples, Summerfruit, Macadamias and Avocados. Each product has a unique campaign to suit its needs, such as product attributes, target market, timing, image, and of course budget The results are measured by market data and show either increased sales or increased prices relative to sales levels of previous years.

Other speakers at this conference are discussing the specific programs that Horticulture Australia invests for the Custard Apple industry. Importantly Horticulture Australia invests industry funds to create opportunities for individual enterprises to implement commercially. We encourage marketers to be effective, understanding, and using the outcomes to ensure that the investments deliver value to industry members and make a real difference.

4.1.5 Benchmarking – compare, analyse, decide

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Abstract

The custard apple industry should consider a benchmarking project in order to establish business performance parameters and work towards a more progressive, professional, business-focused industry. The concept of benchmarking is to compare how a group of growers are performing against a particular measure and to establish how the average performance can be raised to the higher end of the range.

The benchmarking process is a lot more than a simple comparison, however. It is important to realise that for benchmarking anything, you need a fairly rigorous process and that anything less than full cooperation from participants is unacceptable. The process includes four main steps – collect data, compare data, analyse results and decide on changes to be made.

Introduction

Is benchmarking an invasion of privacy or a genuine business improvement tool? This question is easily arrived at for anyone trying to describe benchmarking to a group of growers, trying to gain cooperation of growers to participate in a benchmarking project and trying to explain a set of results to a group of growers. The issue of confidentiality in a key one to consider at any stage of the discussion and is a cause of great anxiety among many would-be participants.

So, how do we describe benchmarking and why should we be nervous about participation in benchmarking? What's in it for us? The crux of benchmarking is 'to compare' how we are performing for a particular measure against how one or more others are performing against the same measure. The benchmark as such is the performance of something at a particular place and time, such as the known performance of a tractor and sprayer combination that we already use. We then compare that performance against a paddock test in a magazine, against a demonstration at a field day backed up with manufacturer's information or against what a neighbour tells us his or her tractor and sprayer capability and performance is. Going to a field day is one giant benchmarking event.

We can benchmark just about anything we can measure and we are doing it almost constantly. We can benchmark the performance of our marketing programs, a research project, our land-use or indeed the performance of this conference. Benchmarking is the key ingredient of continuous improvement. Its ability to assist improvement is almost always tied to the degree of objectivity we use and the accuracy of the base information that we crunch. Which of the tractor and sprayer comparisons in the previous paragraph would we most rely on?

For the purposes of this presentation, the focus is on benchmarking the performance of our businesses. How viable are we and what are the main positive and negative contributors to that viability? We'll have a look at some examples later and look at the key factors that we can measure.

The benchmarking process is a lot more than a simple comparison, however, and this process has the potential of getting growers very edgy. It is important to realise that for benchmarking anything, you need a fairly rigorous process and that anything less than full cooperation from participants is unacceptable. If you are going to benchmark something as complex as business performance, you have to participate all or nothing.

The process includes four main steps – collect data, compare data, analyse results and decide on changes to be made.

Discussion

Step 1: Collecting data

The benchmarking process starts with collecting data, or information. This can be a major obstacle in itself due to simple availability in the first place, ensuring the information is in a format that can be compared between participants and that we have someone to collect the data. The quality, quantity and availability of data required are significant reasons why some growers make the conscious decision not to participate.

For benchmarking business performance, we require some fairly sensitive data. If we want to get down to any of the profit comparisons we are obviously going to need cost and income information. To calculate these comparisons per hectare, per tonne, per megalitre or per household, we need another layer of information. If we are growing a number of crops and we wish to identify the contribution of each of those crops to the end result, we need to be able to break up our costs and income on the basis of those individual crops.

This is no mean feat for many farm businesses. The GST and an increasing use of farm accounting packages makes this easier for many than it used to be but it still requires considerable time input if you are to get a meaningful output.

The main source of information for many business benchmarking programs is the statements prepared annually for the Australian Taxation Office. The advantage with this approach is that the information is in a generally consistent format between accountants and covers the entire cost and income elements of the business. The down side is that it is not available for at least 12 months so the comparisons are often on the season before the current one. For this reason, more basic benchmarking of just production costs, for example, can be carried out soon after the completion of harvest. This is a compromise that can be conducted instead of or in addition to a more total business benchmarking project.

The final issue in collecting data is 'who does it?' There are many options here. Some benchmarking models allow the individuals to input their own data on-line. Others use independent individuals to meet with the grower on an appointment basis to move the numbers from the growers' spread sheet or written tables to the data base. People

used for this purpose include accountants, farm record keepers and Department of Agriculture staff. The key is to ensure that you select a person or people with the credibility, capability and confidentiality to do the job.

Step 2: Compare the data

The second part of the process is the comparison between data. Basically, this relates to which measures you wish to compare and the extent of the benchmarking. This is a fundamental that must be fully agreed with the consultant prior to commencement and may be the reason you choose or not choose a particular consultant.

Not all benchmarking packages are the same. Some are more complex than others. Some lead to different outputs. Without suggesting one is better than the other, business financial performance benchmarking seems to be in two camps – the gross margin camp and the farm operating surplus camp. Gross margin analysis is quite popular because it is reasonably well understood by finance professionals and many amateurs. Farm operating surplus is less mainstream but quite user-friendly and regarded as more likely to lead to business improvement.

There are a number of variations of both themes that mean that these options need to be thoroughly researched and understood before you decide which way to go. The benchmarking road is littered with fatal projects and very unhappy growers because of poor decisions made by R&D committees. Fortunately there are successes to report also.

The final point to consider before embarking on a benchmarking comparison is what else to compare. Businesses are more than just financial and it is possible to benchmark lifestyle and environmental issues. Lifestyle comparisons include hours worked and holidays taken. Environmental benchmarks often relate to production units, income and profit generated per megalitre of irrigation applied, energy consumption, nutrient loss, etc.

Step 3: Data analysis

The third part of the process is analysis. This happens on an industry basis with the averages of the combined comparisons, often broken down into quartiles, and on an individual basis. A good consultant who can interpret the results on this basis is critical.

The analysis is often presented in a printed report that has a section tailored for the individual's own information and a general section with overall findings and analysis. This is where relationships between operating costs, variable costs, debt, plant and equipment, depreciation, off-farm income, total income, etc are made and the overall health of individual businesses and the industry as a whole are scrutinised. Presentation skills are important, both in person and in the report, to ensure growers can readily understand the results. Some consultants consider that growers have the same level of financial literacy as they do.

Step 4: Decision time

Having participated up to this stage and received a lot of information and analysis does not mean the end of the process. The purpose of benchmarking is to have the evidence with which to make objective decisions rather than relying on gut-feeling alone. The final step, then, is to draw up a plan or just an action list of one or two items to start making improvements. The beauty of benchmarking is that you can factor in possible scenarios and see what the results are likely to be. This helps with prioritising what changes to make and knowing which changes will lead to the best results. This part of the process can be undertaken by the grower alone, with the benchmarking consultant or in conjunction with a private or government farm consultant. Either way, the process is somewhat futile and the effort wasted unless individuals use the information provided back to them.

An example

The citrus industry participated in a benchmarking project in 1997/98 and has continued in a small way since. In the first two years of the project, businesses generally performed well when most of the seven key indicators were in the high performance range. There were examples of successful businesses that did not have all their results in the high performance bracket but they compensated for a low or medium indicator (eg irrigated area per family) with higher performance in another indicator (eg low costs, low debt or high income).

Performance indicator	Unit	Performance		
		Low	Medium	High
Income (price x yield)	$/ha	< 5,500	5,500 – 6,500	> 6,500
Property size – ha irrigation per family	ha	< 25	25 – 35	> 35
Operating costs as % farm income	%	> 70	70 – 50	< 50
Labour as % farm income	%	> 35	35 – 25	< 25
Debt as a ratio of farm income	ratio	> 1	1 – 0.3	< 0.3
Machinery value / farm income	ratio	> 0.6	0.6 – 0.3	< 0.3
Non-farm income	$	< 5,000	5,000 – 20,000	> 20,000
Disposable income per family (after orchard depreciation)	$	< 30,000	30,000 – 60,000	>60,000
Net worth per family	$	< 400,000	400,000 - 800,000	> 800,000

Recommendations

There are few, if any, more-powerful decision making tools than a well-run benchmarking project. To see growers making decisions based on evidence with or without gut feeling rather than on gut feeling alone is to really see progress in action. The Australian Custard Apple Growers Association Inc has the opportunity to learn from others and develop a program to lift the performance and professionalism of the collective industry.

Recommendations from here include:

1. Contact other grower associations and seek their thoughts and opinions of the value of the concept, their own experiences and any evidence of improvement or otherwise.
2. Contact Horticulture Australia Ltd for reports of any funded benchmarking project to again ascertain the success or otherwise of the concept.
3. Contact providers of benchmarking services to provide information on the services they provide, referees, costs, experience, etc.
4. Develop a proposal for HAL funding.
5. Conduct a project for 12 months, evaluate, improve and continue.

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4.1.6 Custard apple marketing program 2003-04

Rogaya Alkaff
Marketing Coordinator
Horticulture Australia

From a marketing perspective, the issues facing the Australian custard apple industry are two-pronged:

1. The Consumer – research has shown that most consumers have both heard of and recognize custard apples, but lack the knowledge and confidence to purchase them. Some consumers however, still believe they are a vegetable when they see them in store.

2. The Retailer – An increasing number of retailers are stocking custard apples, however many are not sure of how to handle and/or store them. The quality of the product suffers. This also means that they do not have sufficient product knowledge to pass to their customers.

Horticulture Australia's (HAL) marketing program for custard apples is aimed at tackling these two issues. And in doing so, we are addressing Goal 2 of industry's Strategic Plan to increase consumer confidence and satisfaction with Australian custard apples.

This is done via a combination of three integrated communication tools carrying the same messages.

1. PUBLIC RELATIONS

One of the tools we used to tackle the consumer confidence issue was public relations.

The 2002-03 PR campaign developed for the Australian custard apple industry had 4 principle objectives:

1. To create awareness of Australian custard apples, including its season, varieties and availability;
2. To communicate Australian custard apples' nutritional qualities and its multitude of uses;
3. To stimulate media interest in Australian custard apples and hence gain maximum media coverage aimed at consumers; and
4. To subsequently raise awareness and increase consumer demand for the fruit.

The campaign targeted the mass media including 'foodie' magazines such as *Australian Table*; lifestyle magazines, such as *Australian House and Garden*; health-based media such as *Australian Slimming*; newspapers including the *Daily Telegraph*, *Herald Sun* and *Courier Mail*; major suburban and regional newspapers including *The Manly Daily* and *Sunshine Coast Daily*; and food and lifestyle TV programs such as *Fresh TV*, *Good Morning Australia* and *The Today Show*.

The campaign also targeted non-media audiences, such as chefs, food stylists and the general public.

HAL employed the services of a specialized PR agency based in Sydney called Beyond The Square (BTS). BTS is briefed by HAL on the issues facing the industry, the objectives of the campaign, and given all the relevant information needed to successfully implement the campaign.

A 'media kit' was then developed and distributed to the target media outlets. BTS followed up with personal contact. This follow up is crucial in order to build a relationship with the media on behalf of the custard apple industry.

HAL and BTS liaised with the media to provide product for recipe development and photography, to arrange interviews and spokespeople, and even to organize orchards for TV production crews to film in.

The 2002-03 PR campaign for custard apples was undertaken in two distinct stages in order to coincide with both the growing season and the financial year.

Stage 1 covered the second half of last year's season and ran from July through to September 2002. Media Kits and fruit samples were sent out to target the short-lead media, i.e. daily and weekly publications, and the lifestyle TV programs.

Stage 2 covered the first half of this current season and continued through until June. Activities started as early as January to reach the longer lead media, such as the glossy magazines.

The 2002-03 PR program for custard apples achieved fantastic media coverage aimed directly at grocery buyers. Custard apples are lucky in that they are seen by the media as new and exciting, and therefore a 'newsworthy' product to write about.

Some examples of the publicity custard apples received in the media include:

MAGAZINES

• Slimming Magazine	March 2003	2 x pull-out recipe cards
• Australian Family Circle	March 2003	"In Season" news piece
• New Vegetarian & Natural Health	April 2003	2- page feature
• Slimming Magazine	May 2003	"In Season" news piece
• Australian Table	May 2003	"In Season" news piece
• That's Life	July 2003	Health benefits article
• Woman's Day	July 2003	"In Season" news mention

NEWSPAPERS

• Sydney Morning Herald	June 2002	Recipe feature
• Courier Mail	July 2002	Mention
• Sunshine Coast Daily	August 2002	Recipe feature

• Illawarra Mercury	August 2002	Recipe feature
• Central Coast Daily	March 2003	Recipe feature
• Manly Daily	March 2003	½-page feature
• Sydney Morning Herald	May 2003	1-page feature
• Canberra Times	May 2003	Winter fruit feature
• Daily Telegraph	May 2003	Market news
• Hornsby Advocate	June 2003	Feature

TV

• Fresh TV (Ch 9)	September 2002	Recipe feature
• Good Morning Australia	September 2002	Recipe feature
• Fresh TV (Ch 9)	October 2002	Recipe feature
• Fresh TV (Ch 9)	May 2003	Recipe feature
• Totally Wild (Ch 10)	July 2003	Orchard feature (Starring Paul Thorne!)

OTHER MASS MEDIA

• www.dietclub.com.au	Recipes and general product news
• www.ninemsn.com.au/aww/freshTV	Recipes featured on TV show (still accessible today)

ANOTHER PR EXERCISE – THE "CHECKOUT CHALLENGE" – WAS UNDERTAKEN AT THE SYDNEY ROYAL EASTER SHOW.

The aim of the all the above PR activities is to educate the consumer on the fruit and thus in turn create a stronger demand resulting in better sales.

2. POINT-OF-SALE PROMOTIONS

Another tool employed by HAL to communicate the same key messages was point-of-sale material.

This involved the development of two new recipes, the production of new photography and the design of two bright and eye-catching information cards to be displayed at the point of purchase retail stores. The development of POS material was very important as, unlike editorial gained from PR, it gave us complete control over the message content.

The leaflets contain information on nutrition, availability, varieties, ripening and how to eat, as well as a delicious recipe idea and pictures of the product itself. The industry website was also prominently printed on the front of both leaflets.

25,000 leaflets of each design were printed and distributed to retail stores through the Fresh Produce Retail Service team and also to the major markets via their promotions departments. The remaining leaflets were distributed the same way again this season and at the "Checkout Challenge".

3. FRESH PRODUCE RETAIL SERVICE

HAL manages a team of 7 retail development professionals who regularly visit approximately 600 stores across 5 states. The stores include the major retail chains and independent outlets. The team forms the basis of a flexible service, which is then tailored to suit the specific needs of the custard apple industry.
The key focus of the program is to better educate retailers on the correct handling, storage, availability and usage of custard apples. It also encourages stores to stock the fruit by giving them sufficient product knowledge and support.

The produce managers are given 'Fresh Produce Tips' containing industry's key communication messages to distribute to their staff. Point-of-sale material is also distributed directly to the independent stores by the FPRS team.

A great benefit of the service is the establishment of a closer relationship between industry and retail. The two-way communication channel provides valuable feedback to the custard apple industry.

Data collected and recorded on the 'Product Watch' Sheets include pricing, percentage of stores stocking custard apples, the type of display (loose or tray), the quality and ripeness of fruit on display, and whether the fruit is stored in a refrigerated area.

The custard apple retail program is undertaken in cycles. This year the cycles have been at the beginning and middle of the season:

- March 2003 4 weeks in store
- July 2003 4 weeks in store

To help gain a thorough understanding of the product, the RDO's received training from Patti Stacey March 2002 prior to the first ever cycle.

The outcome of this program is a better informed, and more confident retail sector with an increased number of stores stocking custard apples. This added confidence in product knowledge, including better storage and handling practices, is ultimately transferred to the consumer via better shopping and eating experiences.

LOOKING TOWARD THE FUTURE

HAL will continue to communicate the key messages until they are firmly established in the minds of the consumer.

The 2003-04 PR campaign is already underway and four new recipes have been developed for distribution to the media.

In addition to the promotions undertaken in 2002-03, HAL will also be coordinating 2 additional activities.

1. An 'advertorial' will be run in *Australian Good Taste* magazine to coincide with the start of the 2004 season.

2. The Australian custard apple industry will have a presence on the **AUSTRALIA*fresh*** stand at HOFEX in Hong Kong next year to encourage export market development.

Summary

As you can see the marketing program has aimed to meet consumer expectations based on information gathered from the R&D program and other industry activities – to make sure the consumer receives a favorable taste experience every time they buy a custard apple.

In order to do this, our promotions target consumer awareness and education, as well as retail education and handling.

As levy payers your direct benefit is from the return on investment that you reap as a result of these programs.

4.1.7 Is netting and trellising an option for growing custard apples?

Phil Stacey, Custard Apple Grower
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Introduction

Patti and I grow two hectares of African Pride custard apples on the Alstonville Plateau in northern New South Wales, with trees varying from 23 years old to 1 year old.

Constraints to custard apple production

The greatest constraints we find to growing the crop are:

- Excessive vigor causing unmanageable trees that are hard to keep small
- High labour costs in pruning
- Poor fruit set
- Poor internal quality
- Inconsistent fruit set causing increase in vegetative growth and poor returns
- Fruitspotting bug damage causing heartache.

Management of excessive growth and inconsistent fruit set requires:

- Dwarfing rootstocks
- Increase in early fruit set with defoliation, pruning and increasing humidity if dry.
- Open Tatura trellis to slow the growth
- Total exclusion netting to ?increase humidity and ?reduce light and so reduce growth

Fruitspotting bug

Management of fruitspotting bug may require netting with either total exclusion net or perhaps 16mm net.

Possible benefits of total exclusion netting

- Keeps out all pests – fruitspotting bug, fruit fly, yellow peach moth, possums, rats, birds, wallabies.
- Increases humidity so possible increase in early fruit set, and perhaps earlier fruit.
- If dry, overhead misters are easily installed.
- Reduced light will possibly reduce vegetative growth (this has been shown in lowchill stonefruit total exclusion netting trials).
- Added wind protection so reducing damage to trees and fruit.
- Possibly reduce cold and frost in winter.

Possible problems with total exclusion netting

- Increased fungal diseases (friendly fungi made be a possibility).
- High maintenance on structure if not installed correctly.

Possible benefits to growing custard apples on Open Tatura Trellis

- Reduces vigor, as trees are grown at an angle.
- Pruning more manageable so reduction in labour costs.
- Easier picking as all fruit is reachable from the ground.
- Cleaner fruit , with reduced rubbing due to pruning technique.

We estimate we loose up to 20% of our crop alone to fruit spotting bug, not to mention the losses by birds, bats and possums, and in a dry year our crop can be reduced by half.

A worst-case scenario is 50% loss.

1. On plantings of 6m x 4.5m vase trees, there are 370 trees of African Pride to the hectare with a potential on producing 3700 trays @$14net per tray = $51,800 net return in a good year. 20% loss = $10,360 loss. 50% loss = $25,900 loss.
2. A Higher valued crop like KJ Pinks and Maroochy Gold, @$20net per tray = $75,000 net return. A 20% loss = $15,000 loss. 50% loss = $37,500 loss
3. Denser plantings of higher value trees on open Tetura at 1100 trees hectare, 5 trays per tree (could be more) producing 5,500 trays @$20 = $110,000 net return. A 20% loss = $22,000 loss. 50% loss = $55,000 loss.

Cost of trellis and netting

Cost of building trellis and netting systems will vary depending on terrain, materials used and cost of labour. The estimated minimum cost of netting (from NetPro) with total exclusion netting is $66,000 per ha.

Taking the estimated lost $ on 20% loss factor in scenario 2, it would take 4 to 5 years of full production to recoup the cost of the total exclusion netting. If losses were greater than this, it would take fewer years to cover the costs. In scenario 3, the cost of the trellising would have to be added (about $15,000 per ha) but cost recovery should be sooner due to greater production. It should take about 3 to 4 years to achieve full production.

4.1.8 Quarantine issues with overseas market access

Irradiation as a potential treatment to open markets

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Abstract

There is an internationally agreed process for developing market access for plant products within the Sanitary and Phytosanitary agreement of the World Trade Organisation. Quarantine issues vary from market to market depending on the pests, potential host plants, host environments, likelihood of the pest establishing and the plant health and trade implications of any establishment. Custard apples are a host of pests of quarantine concern such as fruit flies, and treatments that meet the standards of the importing country are required. Irradiation is effective against insect pests, relatively non-damaging to custard apples and is therefore a potential plant quarantine treatment for custard apples. Presently working on access to two new export markets and an alternative treatment to a third export market.

4.1.9 Report on my Churchill Fellowship trip to Taiwan, Spain, Brazil and Chile

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INTRODUCTION

With excellent support from the custard apple industry, I was fortunate enough to be awarded a Churchill Fellowship to travel to Taiwan, Spain, Brazil and Chile. Hong Kong was also an important part of the itinerary, but SARS put a stop to that. A slightly longer time was spent in Taiwan, and in the end, this worked out well, as Taiwan had 5000 hectares of *Annona* spp. in production. This was equally divided between sugar apple and atemoya (custard apple), and proved to be a complete shock, as only five years previously; I was given a figure of about 150 hectares of atemoya for the whole of Taiwan. A feature of their industry is the rapid development and change in major crops, usually in a cycle of about 10 years.

On part of my travels, the President and Secretary of ACAGA accompanied me. This worked well, I believe, for two reasons.

Firstly it is important for industry to develop personal contacts and make evaluations for itself. Secondly, it gives a different perspective on industries in other countries – one person cannot take in everything, and may miss something important. Different people bring with them different experiences, and different areas of expertise.

TRAVEL

Approximately 40-5000 kilometres on three continents were covered in about eight weeks, making it a fairly intensive and arduous trip, and made more difficult because travel was conducted in four countries where English is not the first language. However I must say that the cooperation I received, often from people that I had not met previously was outstanding.

I did not feel that anything was held back, although it is possible that we missed a few things. So I would like to extend my appreciation to the people (too numerous to mention here) who were so helpful to me when I visited their countries. They made my trip both technically successful and enjoyable. I am sure we will see international linkages developed further with reciprocal visits.

I must admit however that the best part of my trip was returning to Australia. We are indeed the lucky country, as some countries are heavily populated, very smoggy and polluted. Ask the ACAGA president about Santiago!!!!

REPORT

I have completed the custard apple section of my Churchill Fellowship report on Spain, Taiwan, Brazil and Chile. The report comprises about 60 pages, and will be published separately. Growers will be advised of the details. At the present time, I have had no time to sort through and include some of the 600 or so digital photographs.

In addition, because of time constraints in getting these proceedings together, printed, and bound prior to the Conference, I do not have time to prepare a comprehensive report. Much of what I have to say will be covered in my Conference Powerpoint presentation.

ACKNOWLEDGMENTS

I thank the ACAGA Management Committee for their ongoing support. The industry should be proud of their contributions, and I hope growers can acknowledge their efforts, often at some personal expense.

I thank the Churchill Fellowship Trust, which allowed me to develop a global view of what is happening with custard apples.

I would also like to thank the Minister and QDPI management for supporting my Fellowship.

Finally I would like to thank my wife and family for allowing me the opportunity to travel on behalf of the Australian Custard Apple Industry.

4.1.10 A study tour to Taiwan

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INTRODUCTION

The initial study tour was to cover both Hong Kong and Taiwan, but due to the SARS outbreak, the Hong Kong segment of the tour was cancelled and the visit to Taiwan extended from 10 days to 14 days. The tour was conducted in conjunction with Roger Broadley's Churchill Fellowship World Tour, which covered Taiwan, Spain, Brazil and Chile.

The purpose of the tour was to:
- Investigate the local Taiwan custard apple industry
- Investigate the whole market chain of custard apples in Taiwan
- Investigate market access into Taiwan for Australian Custard Apples,
- Identify potential importers for Australian Custard Apples

PRE TOUR PREPARATION

Contacts were made with horticultural representatives in various universities in Taiwan and the Agricultural Office of Taiwan. Through one of those contacts, a 10-day tour itinerary was organised.

Through the Queensland Government Trade and Investment Office in Taiwan, contacts with fruit importers were arranged.

TOUR ITINERARY

17th April – flew from Brisbane to Sydney to Taiwan, arriving 6pm.
18th April – confirmed bookings and arranged interviews with 4 fruit importers.
19th April – visited Taipei wholesale market and local wet markets.
20th April – familiarisation tour of Taipei
21st April – travelled from Taipei to Taichung with Professor Chen, Professor of Pomology from the National Pintung University. Visited Taiwan Agricultural Research Institute (TARI) in Taichung.
22nd April – escorted by Professor Shih, senior horticulturist with TARI, and visited atemoya-growing district in Shintze and a Tourist Farm in Fengyuan.
23rd April – visited the Chai-Yi University, toured the fruit growing areas and drove to Pintung.
24th April - with Professor Yen, toured the Pintung fruit growing district and the Fengshan Tropical Horticulture Experimental Station.
25th April - visited the Taiwan Banana Research Institute at Fengshan and a fruit wine facility. Drove to Kaoshiung
26th April – Familiarisation of Kaoshiung, caught train to Taitung on the east coast.

27th April – with Mr Lin, district horticulturist with the Taitung District Agricultural Improvement Station, visited atemoya and sugar apple growing farms, central packing sheds and value adding processing factory.
28th April – visited the Taitung Farmers Association and the Taitung District Agriculture Improvement Station. Flew from Taitung to Taipei.
29th April – with Professor Lin from the National Taiwan University, visited 3 fruit importers in and around Taipei. Visited Costco Warehouse.
30th April – visit to Julia Hsu at the Queensland Government Trade and Investment Office in Taiwan
1st May – Interviewed a fruit importer and R n R. Flew from Taipei to Sydney to Brisbane arriving 11am 2nd April.

INFORMATION GAINED

General knowledge on Taiwan

The population in Taiwan is 22,500,000 people, predominantly ethnic Chinese, living in an area smaller than Tasmania. They are a democracy with a free enterprise system. The climate is sub-tropical in the north and tropical in the south. Average rainfall is 3,000mm per year, falling mainly in the monsoon period of April to September.
Fruit consumption is claimed to be the highest in the world at 130kg per person per year. The term "custard apple" is not widely known in Taiwan. The sugar apple is referred to as "sze-ya" or "budda's head"(similar appearance) and the atemoya as "fong sze-ya" or "pineapple budda's head"(due to not being as sweet). Along with durian, the custard apple is a prized fruit eaten by the majority of the population.

Evaluation of custard apple growing in Taiwan

Prior to our arrival in Taiwan, it was believed there were 140ha of custard apples grown in Taiwan. In fact there are 5000ha of custard apples grown, 50% sugar apple and 50% atemoya varieties. At present, 95% of this production is in the Taitung district on the east coast and 5% in the Taichung district on the west coast. There are 4,500 custard apple growers.

The season starts in July and runs till March with their peak production being September to January. The atemoya varieties are similar to the African Pride variety grown in Australia but not as sweet. Due to the high prices received for the fruit in the past, there has been as increase in production and prices have dropped dramatically in the last 2 years. There has been no export up until now but growers are looking for export markets.

GROWING TECHNIQUES

Sugar apples have been grown in Taiwan for many years, mainly in the Taitung district on the east coast. These trees are grown from seed, and due to the seed consistency, are not grafted. The original fruit is generally small and seedy. Over the years, better varieties that are larger with fewer seeds have been developed.

Growers have developed atemoya varieties in the last 5 years, so 50% of the sugar apples have been partially top worked to atemoya - hedging their bets. When there is

a glut of sugar apple, they let the atemoya dominate and visa versa. Some growers are propagating their trees by grafting atemoya on a strong sugar apple seedling.

We found Taiwan's farmers to be very efficient in their farming techniques, getting maximum production out of every square inch of land. Land costs in the vicinity of A$170,000 to A$350,000 ha. The average size of a farm is one hectare with approx. 250 trees to the ha. with some producing 30t to the ha. The soil is very rocky and poor quality. The tree size is kept small by using dwarfing sugar apple rootstock and severe pruning techniques. All farmers interviewed stressed the importance of getting the branches to droop. The atemoya trees were more vigorous and different techniques were used to keep the branches down – tying high branches down to lower branches, weighting down tall branches with rocks hanging off ropes tied to branches, choosing more droopy varieties.

One grower on the west coast, considered to be one of the best growers, obtained very high production off his atemoya trees (Florida selection). The climate was similar to the Yeppoon district and he obtained double cropping (with the larger set maturing late) the following way:

- Trees were planted on 3.5 by 3.5 metre spacing.
- 700 trees per hectare.
- Early fruit maturing in July (late summer) produces poor quality fruit and a lot of stem end splitting – this fruit only returned A$17.50 7kg tray.
- Later fruit maturing in October (mid autumn) produced better fruit and returned A$29 tray.
- Trees are pruned severely in March/April (Spring).
- In May, laterals are tipped when 13 to 14 leaves.
- In June/July (mid summer), the 5th and 6th leaves are stripped, flowers hand pollinated and end of lateral cut off after fruit is set. This fruit is harvested in October to March.

On the east coast, similar pruning techniques are used but they claim 3 harvests – 1st harvest June on the outside of the trees, 2nd harvest August on the inside of the trees and 3rd harvest January after a second pruning in August.

All fruit is hand pollinated. When fruit is the size of a golf ball, a polystyrene sock and white paper bag is placed over the fruit to protect it from insect stings. Their number one pest is Oriental Fruit Fly. The only control methods taken are fruit fly traps and bagging of the fruit. No insecticide cover sprays are used for fruit fly as the government has banned systemic insecticides. Few orchards use machinery but those that do, use very small, locally manufactured special purpose machines.

To fit in with the attitude of waste not want not, all below standard fruit is processed into ice blocks, ice cream and wine in a factory owed by the growers.

1. Market chain of fruit distribution in Taiwan.

In the Taitung district, the local Farmers Association has encouraged growers to form marketing groups of 5 to 9 growers all in close proximity to each other. All members

of the group pack together, requiring no hired help and ensuring uniform packing. A single lane weight grader is used – fruit is cleaned by using compressed air, placed on grader by hand and sized into 5 sizes on a sloped table. Fruit is packed, in the sock it was grown in, into a polystyrene liner, which is placed in a single layer tray or double layer carton.

No brand name is used but the pack house is recognised by its registered number and district. The fruit is not cooled at any time. Sugar apples blacken if kept in temperatures below 15 degrees. Once packed, fruit is transported immediately to the central markets in Taipei or Kaoshiung in small covered trucks, arriving in the early hours and sold that day. The shelf life of sugar apples handled this way is three days and atemoya five days.

Marketing is done either by the individual group or through a single desk marketing system set up by the Farmers Association. In the Taitung district, 40% of farmers market by this single desk system. There are 3 systems of selling – direct to the customer, traditional wholesale market and the auction system. With the auction system, the Farmers Association sets a price range they want to sell at. The buyers inspect the fruit. If supply is high, the price starts low and builds up. If the supply is low, the price starts high and then comes down. Prices received by the farmers for custard apples vary from A$3kg to A$8kg depending on variety and time of year.

Fruit sells for between A$5 and A$15kg.

2. Market potential for Australian Custard Apples in Taiwan.

The custard apple is a highly prised and valued fruit in Taiwan, with most of the population of 22,500,000 familiar with the fruit.

The brix level of the Taiwan custard apple is 19 to 23 – the Australian varieties have brix readings as high as 35. The Pinks Mammoth variety is a superior product to the Taiwan varieties – larger, sweeter and less seed.

The window of opportunity for Australian fruit is April to July, which co-insides with the Australian season peak production.

3. Market access for Australian Custard Apples into Taiwan.

At present, due to Queensland fruit fly, there is a quarantine restriction on Australian Custard Apples into Taiwan. Access is permitted under fumigation treatment but this treatment destroys the fruit. There is a market access application with Biosecurity Australia for market access into Taiwan under irradiation.

Talks between Biosecurity and BAPHIQ are scheduled to take place in July 2003, where various forms of quarantine treatments including irradiation, will be discussed. If irradiation is accepted as a quarantine treatment, we feel there is a very ready market for Australian custard apples in the Taiwan off-season. An import duty of 30% exists. Direct flights from Australia to Taiwan are limited, but as the irradiation process is more accepted, more products will use this technique, there will be more fruit entering Taiwan and therefore more flights made available.

4. Potential Fruit Importers.

Four large fruit importers were interviewed and the potential for them importing Australian Custard Apples was discussed. All 4 had no hesitation in saying there is very good potential and they were very interested. We stressed the importance of the cool chain. There are cool rooms available for storage but most felt the fruit would sell fast enough without the need for cool storage. It was important that the fruit arrived in time for sale the day of arrival. Packaging and price was discussed.

ACTION PLAN

1. Technology Transfer

At the 3rd National Custard Apple Conference in July 2003, we are presenting a paper on our findings and recommendations. During the field trip, which includes our farm, demonstrations will be given on bagging and pruning techniques learnt.

An article will be written for the custard apple newsletter and posted on the custard apple web page along with photographs.

2. Access to dwarfing rootstock

One of the District horticulturists has agreed to send over seed from the new variety of sugar apple they have. This is to be tested as possible future dwarfing rootstock by Alan George at Maroochy Research Station as part of his research work with custard apples.

3. Trials of learned pruning techniques

It is hoped a pruning technique to develop fruit later in the season will be trialed next season on several farms in the northern coastal districts.

4. Trials of growing fruit in socks and bags

A sample of the bags used for bagging fruit was bought back and will be trialed on our farm to test the effect they have on fruit that is growing during the colder weather.

5. Market access to Taiwan

A report will be sent to Biosecurity Australia on our findings in the hope that it will speed up access into Taiwan.

6. Assistance to growers to export fruit when market access is available.

Once access is available, the contacts made and maintained of fruit importers will assist growers and exporters in Australia to market fruit in Taiwan,

7. Future possible revisit during the Taiwan harvest season with a study tour of growers.

We believe that a future study tour with a group of Australian growers, during the Taiwan growing season, would be a very worthwhile project.

SUMMARY AND CONCLUSION

This 14-day study tour to Taiwan visiting custard apple growing areas, meeting Taiwan custard apple growers and marketeers and making contact with importers, has been most successful and worthwhile.

Taiwan has proved to be the largest producer in the world of annona, and far from learning from our expertise, they taught us a great deal about efficiencies in farming, marketing and value adding. We feel that the information we can convey to the Australian Custard Apple farmer certainly fits in with our conference theme of "Ways and Means of Improving Your Bottom Line". When Taiwan accepts irradiation as a quarantine measure, export of Australian Custard Apples to Taiwan is sure to be a success.

Acknowledgments

We would like to acknowledge and thank Horticulture Australia and the Australian Custard Apple growers Association Inc for their financial assistance that made this study tour possible.

Our deepest thanks go to Roger Broadley who, with his excellent communication abilities, has developed strong links with his overseas counterparts that enabled such a great itinerary and trip in Taiwan.

We also would like to thank Professor Yen of the National Pintung University for his time and energy in making this trip so successful.

4.1.11 The Brazil and Chile experience

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Introduction

This study tour was planned in conjunction Mr. Roger Broadley's (QDPI) Churchill Fellowship world study tour of Taiwan, Spain, Brazil and Chile. Mr. Broadley started his tour in Taiwan where two other growers joined him to assess Taiwan's custard apple industry. Similarly, I joined Mr. Broadley in Brazil and continued the tour through districts of Brazil and Chile looking at the South American custard apple industry from a research and grower perspective.

The aim of the project was:
- To gather production and processing intelligence in both countries
- To view tree management systems
- To view packing processes
- To assess the level of value adding being undertaken
- To evaluate marketing trends and future directions regarding marketing
- To establish a network of contacts for future collaboration
- To improve decision making for the Australia industry based on the results and information gathered

BRAZIL AND HORTICULTURE

Brazil has abundant water, fertile soil and a varied climate and a natural advantage for producing tropical and temperate climate fruits. Brazil is the third largest fruit producer in the world, and has been posting one the highest growth rates in international fruit production. Fruit production is of significant importance to the country as it exploits natural advantages of the country and is placed high as priority by the Brazilian government.

The government has been active in promoting the country's fruit particularly abroad in the USA, Canada, England, France, Germany and many other European countries. Brazil faces similar, and in cases, more stringent barriers than Australia, for exports. Brazil is host to the fruit fly and other pests, and also has to agree to unassociated environmental issues before export. This pressure is mainly coming from Europe. Fruit production in Brazil is one of the most labour intensive industries. The country has very cheap labour and plenty of it compared with Australia. The population of the country is approximately 200 million people.

AREA OF Annona spp. AND PRODUCTION

The Annona industry was centred on the Sao Paulo State, which was the main area, visited. The north-eastern State of Bahia could not be visited because of time constraints although information supplied suggested that the atemoya industry and horticulture generally was expanding in that area.
From data supplied and from Mr Broadley's calculations, it would indicate that the total area of production of Annona to be approximately 1000 hectares which produces approx. 4440 tonnes of fruit. The main package for fresh fruit is into a 3.7kg carton. These figures are a little rubbery, as the newer plantings in the Bahia State are not yet in production and the exact area planted was difficult to establish. This may be worth follow-up in the future.

Peak production for sugar apple is from February to March. Other varieties are dependent on location but normally harvest occurs from April –July.

MARKET DEVELOPMENT

Brazil has recently established phytosanitary agreements with China, South Africa and Chile and is negotiating many other countries and in particular is trying for the one agreement with the European Union.

Annual production of fruit is estimated to be 43 million tons with a value of approximately $AU2 billion.

NATIONAL INDUSTRY STRUCTURES

The Government supports and funds Research Institutions, Universities and individual growers and groups of growers. There does not appear to be any national industry structure similar to that in Australia. There was much interest when details of the Australian structure and funding mechanisms were discussed.

VALUE ADDING

Brazil has a developing industry in value adding tropical fruits. Annona species cherimoya and graviola are used in yoghurts and drinks. Annona species value adding is only on a small scale. The graviola drink and a Cherimoya ice cream were available commercially. The graviola drink is commonly sold through cafes.

Pulp is packaged into 100mL packages and frozen. One package is used per drink. It is a very refreshing and tantalizing drink. The cherimoya ice cream was sold through a franchised ice-cream retail outlet. The product was based on a milk product as opposed to the graviola drink that was water based. The flavour of the fruit in the ice-cream product was not that noticeable.

Tasting sessions were conducted on a variety of other recipes, mainly preserves and jams, at a private residence and were very palatable. These products were not in any commercial production. The offer has been made to share recipes with the ACAGA web page to educate consumers how to use custard apples.

There was no other opportunity in Brazil to observe value adding of Annona species. As production increases in Brazil I have no doubt that this area of production will be exploited.

Visit to Research Station

Ventro APTA Frutus, Jundiai.

Dr Ivan Jose A. Ribeiro (Director), Dr Celso Pommer, Mr Takanoli Tokanaga. These gentlemen very kindly hosted Mr Broadley and myself during our visit to the research station. Mr Takanoli was the Annona spp specialist and we visited the trial plantings of various types at the research station. I formed the opinion that the Australian industry is advancing well in terms of the breeding program in comparison. The fact that the Director and Mr Takanoli were retiring soon didn't augur well for industry in the Sao Paulo State. As mentioned before, there didn't appear to be much collaboration between institutions. Mr Broadley and myself gave a presentation on the Australian industry to staff and growers.

VARIETIES

The main varieties grown in Sao Paulo were Thompson, Gefner and sugar Apple. These varieties were stated as not requiring hand pollination in the Sao Paulo area.
Rootstock varieties in Brazil have been selected for their pest and disease tolerance. Arrangements have been made to import samples for trial in Australia.

ORCHARD MANAGEMENT – ORCHARD VISITS

We visited a number of orchards in the Turvolandia district where mainly Thompson variety was grown. Fruit were bagged using newspaper wrapped and stapled into position. This didn't appear to be successful for a number of reasons. It provided a great residence for mealy bug and as the paper disintegrated the ink from the print and paper residue created problems. Brazil has similar pests and diseases as Australia.

Another orchard visited in the Paraisopoulis district was an orchard of about 56000 trees planted on an area of 20 hectares. The huge number of trees was a result of the growers inter-planting and changing from vase to centre leader and trellis system. This grower has some difficult decisions in the near future to decide which system and which trees to retain.

He has also been trying to grow organically which is not proving successful. Overhead irrigation has created problems. This grower has managed to get contracts with a major retailer and he takes great care in presenting only quality fruit. He has been developing an ethylene absorbing packaging in an attempt to improve shelf life.
With all orchards visited to this point vigour has been a major problem.

VISIT TO LONDRINA

This trip was organised so that we could visit and view the Nakanishi method of trellis. Professor Nakanishi is a pioneer is developing trellis systems for *Annona* spp. He owns and operates an orchard near Londrina, which was about 400 km from Sao Paulo City. Regrettably we did not get to his orchard because of weather but did some 4x4 driving in a 2x4 vehicle getting to other growers in the district using a similar system. Professor Nakanishi was very knowledgeable and Mr Broadley will present more technical detail at the conference on this method.

VISIT TO DOMESTIC WHOLESALE MARKETS—SAO PAULO CITY

Sao Paulo City has a population of 20 million people. One can imagine the area, activity and confusion in a wholesale market supplying a population of this size. Wooden boxes are still heavily used and there is very little palletisation or mechanical lifting or transporting with forklifts within the markets.

Nearly all is done by hand and shifted using a manpowered two-wheeled trolley, which can carry enormous loads. Frequents traffic jams occur in the crowded sheds. Not much refrigeration as most probably everything is sold quickly.

THE FUTURE IN BRAZIL AND COOPERATION BETWEEN AUSTRALIA AND BRAZIL

The Brazilian industry seems not to be expanding in the area that we visited. Comments resound about being a difficult crop to grow; being so labour intensive and costly to grow compared with other fruits. The Brazilian industry was keen to have available any Australia research. There may be some opportunity for collaboration on rootstock materials as we all a have a common vigour problem. The centre leader and the Nakanishi trellis system needs further investigation.

Brazil appears to be targeting Europe, Britain and USA as export markets, which, with the exception of the USA, the Australian custard apple industry is not investigating at this time.

CHILE AND HORTICULTURE

We visited Chile from the 26th May-9th June 2003 and visited the main growing areas and the major Research and teaching establishments. Presentations were given to Universities, Research Establishments and growers groups.

Chile is divided into 13 Regions from it northern to its southern boundaries. Population is approx. 15-16 million people. Chile has a market-oriented economy, which is evident from its high level of foreign trade. There was a severe drought in 1999, which affected agricultural production.

GDP composes 8% agriculture, 38% industry and 54% Services. There is significant poverty in the country and 22% of the population exist below the poverty line. This has an impact on viability of fruit production as theft of fruit is common and the

protection of the crop is a necessity. Electric fences (voltage questionable), broken glass topped security fences around the orchards and armed guards (with real bullets up to 12 months ago) are common practices. A more economical practice has developed in the use of prickly acacia as a perimeter hedge. This plant is a noxious weed in Australia, but its dense long and piercing thorns are a very effective and economical deterrent to thieves.

Climate

Chile lies between geographic coordinates 30 degrees South and 71 Degrees West. The climate varies from temperate with desert areas in the north to Mediterranean in the Central regions, to cool and damp in the south. Terrain is low coastal mountains, fertile central valley and rugged snow capped Andes mountains in the east. Elevation ranges from 0metres to 6,880metres.

In the northern growing areas we visited around La Serena, a very low annual rainfall of only 90 millimetres is recorded per annum, compared with the area around Quillota, which receives 400mm. However, there is plenty of available irrigation water sourced from the melting snows of the Andes.

National Horticultural Structures

From the comments made at the various meetings with Research and Universities visited there was envious comment made of the Australia industry structure, as there appeared to be little cooperation between the regions in both research and production. We did meet with the President of the Annona Association of Chile in La Serena who was very interested in learning more about the Australian Custard Apple Growers Association structure and methods of funding.

The Annona Industry

The size of the industry in Chile appears to be diminishing with cherimoya being replaced with avocados. Production areas for cherimoya were quoted as being approximately 1100 hectares and reducing, compared with avocado area of 22000 hectares increasing.

Main varieties grown are cherimoya Concha Lisa and Bronceada. These are easily distinguishable from each other as Concha Lisa has a smooth skin and Bronceada has many more raised carpels. Concha Lisa tends to be for export because it does not damage as easy whereas Bronceada is sold more on the domestic market.

An important and significant observation was the vigour of the rootstocks used. This compares similarly with Australian rootstocks, which are also vigorous. Various management techniques have been developed for the control of this vigour. Cherimoya varieties are common rootstock particularly Concha Lisa.

Bending and twisting the vigorous growth appeared to slow the vigour. Other management systems such as central leader, trellis and vase are in use. It appears that the central leader method is more manageable and gives higher yields per hectare. This would be also the case if planted similarly in Australia however Chile is in the

very enviable position of not having many pests and diseases as Australia. However this could change with more tourists crossing borders with Argentina. The dense planting on similar spacing in Australia would cause major problems.

Determining maturity and when to pick fruit is as much of a problem in Chile as it is in Australia. There is research being undertaken to develop a colour spectrometer or colorimeter to determine from viewing through the apparatus whether a fruit is ready for harvest. The plan is to have it affordable for each picker to have one. The device would need to be calibrated for varying light densities inside and outside the tree canopy. The unit is still under development and most probably is still a couple of years from production.

Pollination

Nearly all pollination is done by hand either using a brush or a puffer. A sample of the puffer was given to me. This will be featured in a future article in the Custard Apple Newsletter and also displayed at the industry conference.

Labour costs are approximately 8-9 times less in Chile compared with Australia. Regular comment from growers was that the Annona industry was becoming very expensive and that the fruit was a very difficult crop to grow. A similar comment was said in Brazil. From the experience of the varieties in Australia we also would concur with the comment.

There is a pollination specialist in Chile who has developed the techniques and process for collecting and applying pollen. She was extremely helpful and has given details of her work that will be published separately in the Custard Apple Newsletter. A complicated recording system of flowers pollinated by workers in the field exists.

Workers average 180-200 flowers per tree and are paid on the fruit actually set. Pollination occurs between 0730 and 12.00 midday. Relative humidity is about 50-60%. Extreme care is taken with the storage of the pollen. Relative humidity is maintained at around 80-90% in the farm storage room.

Workers are issued with enough pollen to do one hours work, when they then dump the old pollen and replenish with new pollen.

Value Adding

Research was continuing into a semi processed product and drink products. Several products were taste tested. The University at Quillota had done most of the research although we did meet a grower in the north who had seriously attempted producing and marketing a pulp product.

Although the product was acceptable the cost of production was not competitive with other fruit products. This grower was a citrus and cherimoya specialist and did not have enough cherimoya pulp product available to either command market attention or price.

The University were more confident of their products although were realistic with its future considering the reducing size of the industry. We tried a cherimoya pulp added to white wine in the proportion of 300grams per litre of wine. Cheap wine was said to be OK. As Cherimoya does not have similar brix levels to Australian atemoya, sugar was added to taste.

A liqueur product was also tasted and was very palatable and similar in clarity but sweeter to the Australian mango liqueur I have tested.

A frozen pulp product was also viewed. This product needed to be processed within two hours from skin off to freezing to avoid browning. It has been keep successfully frozen stored without any detioriation of the product for 8 months.

There could be medicinal values of cherimoya/atemoya yet to be investigated.

Export Markets

Chile has a Free Trade Agreement with the USA, and is working toward an agreement with the European Union. Exports occur to the USA and Japan. Air transport space is a problem as products such salmon (much higher value) and avocado command higher space and importance because of the relative values.

Interesting to note the USA market prefers cherimoya fruit of size 300-400 grams.

It is interesting also to note that the Chileans market through any one of three companies who deal in cherimoya exports. One is a grower cooperative and all companies compete in the USA markets. Cherimoya is a lesser export product in comparison with citrus and avocado. The marketing companies do the export development and tradename recognition. Packaging and quality standards are specified and any downgraded fruit is sold locally.

One important function of all companies marketing operation is that if a problem occurs with a shipment of fruit, the loss is not solely borne by the growers. All other marketing members and the Company share the loss of any shipment. This is determined at the end of the season.

The Future in Chile and Cooperation between Australia and Chile

The Annona industry in Chile is reducing in size due to the better returns and less production costs of other fruits. There are a number of significant growers who are aware of the costs but recognize the high value of the fruit. These growers are content to ride out the current wave and continue to improve on production costs.

Potential for future collaboration and cooperation are seen to be in areas of:

- integrated pest management, particularly with mealy bugs
- varietal and rootstock research
- marketing and global supply networks
- value adding

- maturity determination
- industry structures and the interface with Government
- licensing arrangements that will benefit growers, expand industry and research, improve the sustainability and viability of the Australian & Chilean industries into the future in a global environment.

Conclusion

The aim of this project was to gather production and processing intelligence in Brazil and Chile through discussions with key personnel, visits to producing farms and packing and processing facilities.

The opportunity to join with Mr Roger Broadley was highly beneficial.
Information collected by myself as a grower and administrator of the industry and Mr Broadley as a researcher, will benefit Australian growers in production practices and assists with future decision making and viability of the industry.

The project also provided the opportunity to meet with and develop a network of potential collaborators for the future.

Sincere gratitude is expressed to Horticulture Australia Ltd and the Commonwealth Government of Australia for their support and assistance with this research project. I am confident that the results of the trip will have a broad impact in the future.

Schedule 1 ---- Study Tour Itinerary

Date of visit	Place	Institution/Organisation to be visited and purpose
17th –26th May	Brazil	Several researchers including Dr Celso Pommer, Mr Takanoli Tokanaga (Annona spp. specialist) at Centro APTA Frutas, Jundiai, Dr Leon Bonaventura and Dr Nakanishi– discuss technical issues (especially trellis systems) associated with growing atemoya, visit atemoya and sugar apple farms, atemoya nurseries, and view/collect germplasm
26th May – 9th June	Chile	Universidad Catolica DeValpairaiso Dr Ricardo Cautin Morales, Professor Pedro Underraga, Dr Monica Castro and other staff of Escuela Agronomica- study cherimoya production in the lower Aconcagua Valley, Guallarauco agro-industrial product and cherimoya processing, packing and marketing, Dr Antonio Ibacache, study all aspects of cherimoya production in Elqui Valley, La Serena, Chilean Fruit Company (itinerary being developed in Chile)
9-11th June		Return from Santiago to Brisbane

4.1.12 The fresh produce market – function and failure?

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Abstract

The domestic market chain is heavily weighted against the commercial interests of growers. Consumers have a ceiling on the prices they will pay for fresh produce, and supermarkets, accordingly, use their considerable buying power to push down prices to protect their profit margin and market share. Growers suffer most economic damage from this downward price pressure. The wholesale system uses a method of trade that is legally questionable, denies transparency of transactions, and directs all risk to growers. The chain offers too much scope for abuse of market power and process, and too little protection for the most vulnerable in the chain. The only means of redress is a Code of Conduct that is manifestly ineffective; it must be reformed.

Introduction

The custard apple industry has, by its internal organisation, marketing arrangements and niche market, been able to insulate itself from many of the shortfalls of its market chain. It should understand these shortfalls and continue to work around them. At the same time it should appreciate that it would be more profitable if its market environment were reformed.

Why am I here today, and what's my authority to speak on market chain performance? In part it's because as Chair of the NSW Farmers' Horticulture Section I have been for three years at the receiving end of a barrage of grower complaints about chain shortfalls and demands that they be corrected. However, a more reliable vantage point from which to observe chain function has been afforded by my over two years on the Horticulture Market Chain Committee.

The Committee was established in 2001 by the then NSW Agriculture Minister to examine the operations of the fresh produce market chain. Its chaired by a senior officer of NSW Agriculture and has representatives from Coles, Woolworths, the Australian Retailers' Association, the NSW Chamber of Fruit and Vegetable Industries; the citrus, apple/pear, stonefruit, vegetable and banana industries and the NSW Farmers' Association. I represent the last.

I won't pretend the Committee has thrown light on all the shadowy places in the market chain. Nevertheless, after two years of inquiry it is inevitable that some aspects of chain function must become clearer, and it is with this improved clarity that I speak today.

My charge today is that the domestic fresh produce market chain is failing to provide growers – the principal risk takers – with a fair return for their work and capital investment.

Two converging forces are squeezing the horticultural industry. Pushing from below are production costs that have risen by at least 34% in the past decade – some even say they have doubled in that time. From above, we have factors that combine to keep our prices largely static. For many industries, prices remain at those they received in 1993. Indeed, many growers tell me that their prices today are below the 1993 level. Long-term profitability under these circumstances is impossible.

There is then something badly wrong with our market chain. But where does the fault rest: with the growers' practices and performance, with the operations of other parties in the market chain, or both?

The Market Chain Committee has accepted that growers can do more to work more profitably in the market chain. Of course we are not powerless – you have shown this.

Indeed you are a model industry. You have embraced collaborative marketing – and developed a premium supply line marketed under one brand that is trusted by market buyers. Your two industry segments have monopolies of supply between February and October. You work hard to improve industry quality and to educate retailers and consumers. Your supply is roughly in harmony with domestic demand; and you seek out export opportunities. All this adds up to good supply management – and to the amplification of your supply performance.

However, at the end of the day this performance is despite the market chain, not because of it. There are a number of systemic chain failings that even the most adroit industry can't avoid. It's to these I now turn.

Supermarkets

Let me start with the supermarkets because – as purchasers of some 50% to 70% of our produce depending on what definition of market share you employ - they are exceptionally powerful in setting the prices we receive.

Australia's retail market is one of the most concentrated in the world being dominated by two players: Coles and Woolworths. This allows them the opportunity to use their power in the market for their commercial advantage. While that power may be exercised in a range of ways, my focus today is purely on the degree to which the supermarkets can influence price.

The supermarkets make no secret they use their buying power to secure their fresh produce at the lowest possible price. They have acknowledged this quite freely to the Market Chain Committee and have agreed that it be recognised in a Committee statement. But we can't be surprised at this: it's a rational and predictable commercial response by any business.

That said, the supermarkets offer four factors that contribute to the low returns to growers. They relate to: (i) volume of supply, (ii) consumer price expectations, (iii) supermarket profit margins, and (iv) the relative weakness of suppliers.

First, ***supply volume*** – our contribution to our misfortune. The quantity of a produce line on the market at a given time is a critical factor in determining the price supermarkets need to pay for that line. It's basic economics. Market price reflects the interplay of supply and demand - when there are shortages, price rises; when there is surplus, price falls. Sadly, the horticultural industry seems to be in a constant state of surplus.

The industry is a prolific producer - in the last decade increasing production by a startling 142% in contrast to 40% for agriculture as a whole. But we don't have the markets for this scale of increase. Only about 15% to 20% of our production is exported, and the average per capita consumption of fruit and vegetables over the past decade has grown very slowly. So it's no surprise the supermarkets purchase on markets replete with produce. This gives them an awesome ability to be price setters, especially for lines that are perishable.

So you can see why it's important that the custard apple industry continues to keep supply in balance with demand. You are a "non-glamour" industry and consequently have not attracted the volume of growers that typically flood into an industry that is perceived to be doing well. I strongly urge you to continue to keep your profile low.

The second factor is the ***inelasticity of consumer price expectations***. The supermarkets say they have no option but to keep the retail price of fresh produce within known consumer price tolerances. They cite a price 'ceiling' on all produce lines which if exceeded will deter volume sales in their stores and endanger their share of the finite fresh produce market. Market research by grower industry bodies and findings by the University of Sydney's Department of Agricultural Economics have confirmed the existence of this 'ceiling'.

The third factor impacting on the pricing practices of supermarkets is that they must ***protect their profit margin***. Coles and Woolworths assert that they need an annual average gross profit of 35% on their total fresh produce sales. Achieving this gross return over a year's trading means that at different times in that year, and for different produce lines, the margin may exceed 35%. Equally at other times (typically when supply is low), it may be less. This explains why on occasions the difference between the retail price of produce and the price paid to growers can seem excessive, thereby giving rise to claims of profiteering.

However, the supermarkets insist that an annual average 35% gross margin translates ***into a modest net profit of around 4%***. The difference comes from the costs of their labour, transport, advertising, store operations and wastage. For example wastage accounts for about 6% of their stock value.

The net profit figure of 4% was claimed by the supermarkets to the *Joint Parliamentary Select Committee on the Retailing Sector* and was not challenged in the Committee's proceedings. The figures are consistent with those provided by the Australian Tax Office on retail profit margins, and in supermarket company reports.

You may not like the conclusion, but we simply can't show a case that supermarkets are profiteering. Of course, they might be, but the Market Chain Committee must

complete a study of price increases along the chain to know by how much the respective chain parties profit.

The final factor is the relative weakness of suppliers in the market chain causing them to bear the principal burden of keeping the retail price of fresh produce low. The downward pressure on price flows back from retailers through wholesalers to suppliers, the only "link" without price power. Accordingly, as the point of least resistance, we become price takers in a miserly price delivery process.

So we have it – a concentrated market with the dominant players protecting their profit margin and market share by using their buying power and the over-abundance of fresh produce to impose downward price pressure that does the most economic damage to those at the bottom of the chain.

Wholesale Markets

Let me turn now to the wholesale "link" in the market chain.

The Committee's review is limited to the merchants represented by the NSW Chamber. Accordingly, any observations I make now arising from my Committee experience can only be related to the Sydney Market. You may see some relevance elsewhere, but I must leave it to you to make your own judgement about this.

But before I say anything unkind about this sector, it's only fair that I make two introductory statements.

The first is that the central markets are critical to grower commerce, and their role and future must be protected if we are not to become dangerously dependent on supermarkets. It's in our interest that the merchants continue to be profitable. However, they must retain the trust and support of growers - an outcome that requires they be modern places of commerce.

The second introductory statement is that my criticism of the central market system mustn't be interpreted as an attack on the individuals who operate within it. This is certainly not my intention.

Indeed, I accept that the majority of merchants are honest people who deal fairly with their growers. I know that there are many wholesale businesses built up over generations enjoying fine reputations, and that we all have merchants whom we trust and with whom we have long-standing and happy relationships. My focus is on practices and processes, not people.

And it's proper given the commercial impact that the central market has on our profitability that we look critically at those practices and processes. And in this regard we must be mindful that the gap between the retail price of our produce and the price we receive reflects two profit mark ups – retail and wholesale. The respective contribution of each is yet to be determined.

Until that task is further completed I must be circumspect about what I say. Nevertheless, there has been enough revealed by the Committee to confirm what most

growers have long felt: the operations of the central market system are inconsistent with contemporary commerce and need major reform.

Four main deficiencies in the system have been identified.

The first deficiency is that it offers too much scope for profiteering. Merchants may, if they wish, retain whatever they want from a sale without having to account for their deduction. The NSW Chamber admits that merchants use "discretion" when determining what they will pay a grower. This ranges from "averaging" out consignment prices to otherwise deciding what they will pay according to their own definition of entitlement. To be blunt, the system is wide open to abuse by those inclined so to act.

When we question the fairness of such a system, the Chamber tells us that if we don't like it, we can change our merchants until we find one who gives us better prices. But how reasonable is this? All work in the same way and presumably with the same commercial imperatives and opportunities. We deal with a homogenised system, not transparent commercial relationships whose practices and margins are open to objective comparison.

It's reasonable to expect some accountability of the wholesalers' operations. Enormous sums of our money are involved and we are entitled to more than the comforting assurance that the wholesalers can be trusted. Most probably can be, but can you imagine any other business these days operating on such a naïve basis

The second – and indeed critical - deficiency relates to the legality of their method of trade.

The NSW Chamber says their members operate as neither agents nor wholesalers, but as a "hybrid" of the two. This hybridised method is in fact a design that gives merchants the optimum commercial advantage. Further, it allows them to escape the specific legal requirements that attach under Australian commercial and contract law to agent and wholesale operations.

A number of sources, including the ACCC, have questioned whether this hybrid interpretation is legally sustainable. If it's not, we have been the victims of a profound misrepresentation – perhaps even misleading conduct under the *Trade Practices Act*. The opinions are that merchants should trade -and trade explicitly - as either an agent or a wholesaler and accept the legal obligations of both – obligations that provide greater transparency of transactions and other commercial protections for growers.

The third deficiency is a consequence of the second: all risk is carried by growers. Let me illustrate this with three examples.

> Example 1: the NSW Chamber argues that suppliers retain ownership of their produce until the merchant's ybuyer yaccepts delivery, thereby distancing merchants from all risk – and responsibility – in the passage of produce through the chain. This is fine if the merchant tradyyes as an agent; definitely not if he trades as a wholesaler.

> Example 2: merchants refuse to be bound to any price before on-selling the produce. This frees them from the proper professional responsibility to both assess price movements and accept the consequences of market failure. Growers carry the sole risk for price fluctuations. Again, fine if the merchant is an agent; not fine if he trades as a wholesaler.
>
> Example 3: merchants are determined to conduct their commerce informally, that is without formal agreements about the conduct of their transactions with growers. Such informality favours the merchants, as formal agreements would provide clarity about respective responsibilities, make merchants more accountable, and be used as the basis for more effective disputes resolution. Informality allows the merchants maximum freedom to interpret their responsibilities as they wish. We must be the only industry of our size to enter into substantial commercial relationships without a contract of some type.

Normally in the commercial world those who carry the most risk take the greatest profit. The opposite is true in our market system. It would be vastly different if our commerce were conducted under the legal principles attached to agent and wholesaler relationships.

The final problem with the market system – in regard to both the wholesale and retail sectors - is that there is no independent and effective means of making the system accountable for the probity of its operations**.**

Our only recourse is to the Retail Grocery Industry Ombudsman - and I stress here that the incumbent, Bob Gaussen, is an excellent officer doing his best to resolve disputes - but his powers under the voluntary *Retail Grocery Industry Code of Conduct* are demonstrably inadequate, as is the Code itself. His role is to mediate, not investigate. He needs 'substantive merit' before accepting an application. He may not impose a solution on the applicant or respondent, can't protect against commercial retaliation, and, more amazingly, any certificate he issues must remain confidential. Thus he can't investigate, expose or order redress.

To put the case at its bluntest: the current system allows merchants, if they are so inclined, to pay their growers any price they wish and without need to account for their transaction or to fear exposure or sanction. It also allows them to transfer all commercial risk to growers by a method of trade that facilitates inequity of advantage.

Conclusion

Market chain dysfunction is a major factor in the rapidly declining profitability of the horticultural industry. This doesn't mean we are powerless. You have shown by your innovation, adaptability and organisation, that an industry can cope well despite the systemic disadvantage it faces. This is a lesson that is being slowly learnt in the horticultural industry, and I am confident we will see a rapid uptake of measures by growers that enhance their supply power.

But we must do more. Even the best performing industry will do better in a market chain that is accountable, in which the legal obligations of the parties with whom it trades are clearly known, and the risks of its commerce are shared equitably. These are simply the hallmarks of modern business, and we have every right to expect that the market system shows the same adaptability that we have had to show. No business system can expect to remain immutable in a dynamic commercial environment.

For this reason, there is now a determined campaign, initiated by the NSW Farmers' Association, to reform the *Retail Grocery Industry Code of Conduct*. All state and national farmer organisations have joined the campaign and will be lobbying for Code changes that better protect the commercial interests of farmers.

For your part, all that I ask now is that the custard apple industry continues to do what it has been doing: that is, to work as a disciplined, cohesive body - exploiting your niche market and brand recognition; ensuring manageable supply volumes; marketing professionally; and maintaining high quality standards.

You might do something else also: you should recognise, appreciate and value what you have achieved. While you are at it, you might also give a silent vote of thanks to those of your industry leaders who have contributed to that achievement.

4.1.13 Macman – a farm recording system model for horticultural industries

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Abstract

MacMan is a farm recording system to enable growers to satisfy the food safety and quality assurance requirements of their customers. It also enables growers to compare and analyse their results and identify where they can improve their orchard profitability.

The MacMan farm recording system has resulted from the team of software programmers and extension staff working with growers and key industry personnel to develop a system to meet the range of growers within the Australian macadamia industry. MacMan enables macadamia growers to keep all the important management records for their farming enterprise. Growers can also produce more than 70 styles of reports designed to suit their needs.

The development of MacMan is a model for other farm management systems designed to meet the needs of Australian horticultural industries.

MacMan best practice groups are now being formed in major regional production areas. This enables growers to compare their results and share and discuss ideas and experiences with other growers. Ninety percent of participating growers responding to a recent survey have already decided to make changes to their management practices as a result of these meetings.

Introduction

Record management is becoming increasingly important for Australian horticultural producers. Growers continue to be asked for more evidence that they have satisfied the food safety and quality requirements of their customers. Record keeping can be very onerous and time consuming if not organised well.

Good record management can also be used to improve your business. It enables you to compare and analyse costs and results. This information can then be used to improve the productivity and efficiency of your business.

MacMan is a simple yet powerful recording and reporting system designed with the Australian macadamia industry to monitor and improve nut quality and orchard profitability. It is designed to give macadamia growers a quick and easy way to keep important farm records and produce a wide range of useful reports. It also provides a recording system to satisfy customer's food safety and quality assurance requirements.

MacMan consists of:

- A simple, standardised computer based and paper based recording system, and
- A comparative analysis system that enables growers to analyse results within their own farms and to confidentially compare their results with other growers and industry standards.

MacMan development

The development of the MacMan farm recording system began in 1997. The Australian Macadamia Society recognised the need for on-farm quality management and approached the Queensland Department of Primary Industries to work with them to build a system to enable growers to record key food safety and quality management information. At the same time, growers could use this information to identify where they could improve their efficiency and productivity.

Since then, the MacMan team of software programmers and extension staff within DPI and NSW Agriculture has worked closely with focus groups of key growers, consultants and processors and AMS staff to develop a farm recording system to meet the needs of the range of growers within the Australian macadamia industry. Since the first release of the software in 1999, the program has regularly been updated as the focus groups identified further needs within the industry.

There are now 246 macadamia businesses with the latest version of the MacMan farm recording software.

What can you record in MacMan?

MacMan enables you keep all the important management records for your macadamia farming enterprise. These includes details about your:

- Farms, blocks and plantings. A planting is the lowest level of recording in MacMan. Plantings enable you to record jobs or harvest yields in part of a block if you wish.
- Employees.
- Contacts. This includes customers and suppliers of goods and services.
- Machinery
- Pests and diseases. MacMan also provides you with information about major Australian macadamia pests and diseases, including life cycles, habits and damage, host plants and distribution, monitoring methods, biological and cultural controls, and pictures of the pests and diseases and damage caused.
- Chemicals such as fertilisers and pesticides. MacMan also enables you to keep a chemical stock inventory linked to your job records.
- Storage vessels, such as silos or bins.
- Water sources, such as creeks, dams and bores.
- All the jobs performed on a macadamia farm. This also includes all the labour, contract, machinery and chemical costs involved in the jobs. You can also create your own job categories if you wish.

- Employee time sheet records.
- Variable costs. Although MacMan is an agronomic recording program, it also has a simple financial recording system that is very useful in calculating costs of production.
- Harvest yields.
- Post-harvest handling.
- Factory results.
- Monitoring for pests and diseases, leaf and soil analyses, and water quality.
- Weather information, such as rainfall, temperature and relative humidity.
- The timing of important growth cycle information such as flowering, leaf flushing, mature nut drop and premature nut fall.

Reports

One of the features of the MacMan farm recording software is the ability to produce a wide range of reports. There are currently more than 70 styles of reports in MacMan to suit growers' needs. These include both tabular and graphic reports. The graphic reports include a number of highly visual trend, bar and pie charts that enable you to see and compare important information at a glance.

The reports can also be exported to a number of common file formats, including Adobe Acrobat Portable Document Format (.pdf), Microsoft Excel (.xls) and Rich Text Format (.rtf). This is particularly useful if you wish to send the reports by electronic mail.

Some of the reports in MacMan include:
Delivery report. Many processors require a delivery report to accompany each consignment concerning key food safety and nut quality issues. MacMan provides the traceability back to the orchard to enable the delivery report to be produced.
Cost of production report. MacMan can calculate your costs of production for a particular farm, block or planting and for a particular time frame.
Weather, pests and spray overlay chart. This report provides you with a picture of what is happening in your orchard with regard to pest and disease management. It enables you to overlay your weather data (rainfall, temperature and relative humidity) with your pest monitoring results and your spray events.
Leaf and soil analysis monitoring charts. This enables you to graph and compare results of different nutrients and locations. Further work is also planned to overlay this information with yield and quality results and fertiliser applications.

An example of the weather, pests and spray overlay chart is shown below.

Best practice groups

The Australian Macadamia Society and the MacMan team are now forming best practice groups with interested growers in all major macadamia growing areas. The groups enable growers to compare their results from data recorded in MacMan. The growers can then analyse the results and identify where they can improve their productivity and efficiency.

At this stage, four best practice groups in regional areas have met at the end of the 2002 season and the start of the 2003 season. An evaluation was recently conducted of the best practice groups to help provide direction for future expansion.

Ninety percent of the growers have decided to make changes to their farm management practices as a result of the meetings. This included changes in their:

- Fertiliser program
- Dehusking and sorting operations
- Harvest management
- Under tree soil surface and weed management
- Orchard establishment, and/or
- Pest and disease management

Some growers have also reported major cost savings they have been able to make to their operations, as a direct result of their participation in the best practice groups.

This reinforces the principal that farmers learn best by sharing and discussing ideas and experiences with other farmers. The respondents stated that the best thing about the meetings was the exposure to different approaches to management and the consequences of these approaches. They appreciated the open and frank discussion and the willingness of all concerned to share their information. Nearly all respondents want to continue participating in best practice groups for as long as possible.

Training and support

One of the strengths of the MacMan program is the training and support provided to Australian growers. Each Australian macadamia grower is entitled to attend training sessions that are held regularly in all major Australian growing regions.

A telephone and electronic mail support service is also provided free-of charge. A limited amount of on-site support is also provided to enable growers to effectively use the MacMan software. This is particularly for growers participating in best practice groups.

The picture below shows Russell Parker from the MacMan providing training to growers in Gympie.

MacMan-net discussion group

Over 130 macadamia growers are now subscribed to the MacMan-net discussion group. This is a forum where growers can share information about MacMan or farm management in general through electronic mail. Recent discussions have involved topics such as the management of biennial bearing in macadamias and the use of Ethrel to promote uniform nut drop.

Farm diary

Not every grower wishes to use a computer to keep farm records. The MacMan diary is designed to enable users who prefer to use a paper based system to keep the same records as the MacMan software. The two systems are complementary to enable growers who do not use a computer for farm recording at this stage to switch easily from the diary to the software when they are ready. Many growers may also prefer that their staff record information by hand and have one person enter it in a computer on a regular basis.

Implications for the Australian custard apple industry

The development of the MacMan farm recording software is a model for other horticultural industries. It demonstrates how extension staff and software programmers can work closely with growers and other key industry personnel to design a system to meet the needs of that industry.

Food safety and quality has become a key issue for Australian horticultural producers. Growers will increasingly need to provide information to their customers to assure them about their farm practices. Farm recording systems such as MacMan that are tailored to meet the needs of industry enable this information to be easily managed.

Most Australian horticultural producers are also facing decreasing margins between costs and returns. They need to continue to identify ways to improve their productivity and efficiency to ensure their survival. Growers can use farm recording systems such as MacMan to compare and analyse results within their own farms and with other growers and against industry standards. The MacMan best practice groups have demonstrated that growers can use this information to share ideas and experiences to make improvements in their farming operations.

4.2 AUSTRALIAN SOCIETY OF HORTICULTURAL SCIENCE CONFERENCE – COOLUM

4.2.1 Breeding and selecting new varieties and rootstocks of custard apple (*Annona* spp. hybrids) in subtropical Australia

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Keywords: fruit quality, species, progeny, inter-specific, mutation

Abstract

Considerable recent progress has been made in selecting new types, identifying appropriate parents and gaining an understanding of the inheritance of desirable traits in custard apple. Inter-varietal crosses have been made between the best selections of custard apple and the main commercial cultivars such as KJ Pinks, Maroochy Gold, Palethorpe and Maroochy Yellow. Inter-specific crosses have also been made between four different species, *Annona cherimola* (cherimoya), *A. squamosa* (sugar apple), *A. reticulata* (Bullock's Heart) and *A. diversifolia* (Ilama). Some 15 000 breeding lines have been field planted since 1998. Alternative approaches to conventional breeding are also being evaluated. Early results indicate that it may be feasible to induce mutation with gamma radiation. Fifteen advanced selections from the breeding program are being trialed at six evaluation sites throughout Queensland and northern NSW. The program has successfully developed hybrids with red skin colour and pink internal flesh. Red skin colour may be carried by either a single or double recessive gene. Fruit symmetry, flesh recovery and flavour characteristics of some crosses are excellent. Rootstocks with potential dwarfing characteristics such as shortened internodes and short, bushy stature have also been selected out of seedling progeny. These selections are in the process of being clonally propagated for future field-testing with a range of new scion varieties.

Introduction

Most custard apple cultivars are hybrids of cherimoya (*Annona cherimola*) and sugar apple (*Annona squamosa*). However, other custard apple cultivars are of unknown genetic origin. Few new cultivars of custard apple and cherimoya have been selected in the past 20 years due to the small population of naturally occurring seedlings, and lack of a breeding programs/strategies for these fruits. In contrast, other subtropical and tropical fruit such as mango have been intensively selected from over several hundred thousand seedlings for more than 100 years. In 1998, an intensive breeding program for custard apple was initiated at the Maroochy Research Station, Nambour, Queensland (George et al., 2002). A range of breeding strategies has been used in this program including conventional polyline crossing, evaluation of colchicine to induce autotetraploids and induction of mutations using gamma radiation (George et al., 2002; Hamill, 2003). This program is now releasing potential new varieties to industry for further testing.

Materials and methods

Multiple breeding strategies are being used to improve fruit quality characteristics of custard apple in Australia. These have been previously described by George et al. (2002). An update on the breeding strategies used is presented below.

Polyline custard apple crosses

About 300 polyline custard apple crosses have been made between the best selections of custard apple (KJ Pinks, Hiliary White, Martin, Maroochy Gold, Maroochy Red, Palethorpe, R11-T3; R11-T4; R11-T6; Ruby Queen, Bullocks Heart). Whilst the majority of these cultivars and selections are hybrids between cherimoya (*Annona cherimola*) and sugar apple (*Annona squamosa*), others are of unknown genetic origin. No genetic fingerprinting studies have been conducted to identify their exact origin.

Inter-specific and inter-generic crosses

Inter-specific crosses have also been made between four different species; *Annona cherimola* (cherimoya), *A. squamosa* (sugar apple), *A. reticulata* (Bullock's Heart), *A. diversifolia* (Ilama) and custard apple. Inter-generic crosses have also been made between *Rollinia deliciosa* and custard apple. To date, none of the progeny of these crosses has produced commercial cultivars but red skin colour of selected *Annona reticulata* and *Annona squamosa* has been transferred to the progeny.

GAMMA IRRADIATION TO INDUCE RANDOM MUTATIONAL CHANGE IN SEEDLINGS

Because bud tissue has an extremely low bud/graft success rate after gamma radiation treatment, we selected seeds because of their ready availability. The variety selected was the custard apple cv. Hillary White. A dose response curve was established before selecting the treatment dose rate (Figure 1). In total, over 5 000 seed were exposed to a range of doses of gamma irradiation from Cobalt 60.

Selection of dwarfing rootstock progeny

Rootstocks with potential dwarfing characteristics such as shortened internodes and short, bushy stature have also been selected out of seedling progeny.

Progeny evaluation

About 15 000 breeding line progeny have been planted at the Maroochy Research Station at Nambour, Queensland since 1998. Progeny are being evaluated for low-seed number, smooth skin, symmetrical shape, flavour, texture and high natural fruit set (George et al., 2002).

Advanced selections

Ten advanced custard apple selections have been made to date and these are being tested in a wide range of subtropical environments in Queensland and northern New South Wales.

Results and discussion

Polyline crosses

Since the start of the breeding program in 1998, 15 advanced selections have been made from breeding progeny at the Maroochy Research Statio**.** Progeny of custard apple x *A. reticulata* and cherimoya x *A. reticulata* crosses produced fruit which were late maturing (spring in Queensland) probably because they have inherited the flowering and fruiting characteristics of *A. reticulata* which flowers in autumn and matures fruit in late spring under subtropical conditions of Australia. Progeny have inherited the high levels of internal grittiness from *A. reticulata*. Further evaluation of the F2 progeny, particularly of crosses with red-pink skin types is being carried out. Attractiveness is a key factor in selling any fruit. Exciting possibilities exist to develop new varieties with external and internal pink-red colour and excellent flavour.

Gamma irradiation of seed and colchicine application to mature buds

Fresh seed extracted early in the growing season showed that above 80 Gray exposure to gamma irradiation, the germination rate began to fall (Figure 1). Up until 80 Gray the germination rate wasn't significantly affected compared to the control germination rate of 27%, which is quite low. The treated seedlings are still in the process of field-testing. Previous studies showed that colchicine treatments applied to buds on mature trees were ineffective in inducing auto-tetraploids (Hamill, 2003).

Dwarfing rootstocks

Fifteen potentially dwarfing rootstock progeny have been selected. Clonal propagation techniques, using softwood cuttings (George et al., 2003) are being developed to quickly multiply up this germplasm. The best scion varieties will then be field tested on these clonal dwarf rootstocks.

NEW VARIETIES

Commercial custard apple production in Australia is currently based on three cultivars, African Pride, Pink's Mammoth and Hillary White, which all exhibit either fruit quality defects or are unable to set good crops naturally, without hand pollination. Fifteen advanced selections have been released from the conventional breeding program to date. Two of these selections appear to have commercial potential. The first selection is Maroochy Gold, a Hillary White x red sugar apple (*A. squamosa*) cross. This selection has excellent flavour. The second selection is KJ Pinks, a budsport of Pink's Mammoth, which was selected by a commercial farmer near Nambour. Natural fruit set of the KJ Pinks variety was found to average 41% during the 2003 season, compared with its parent, Pink's Mammoth, which was less than 3% (R.J. Nissen pers. commun., 2003) (Table 1).

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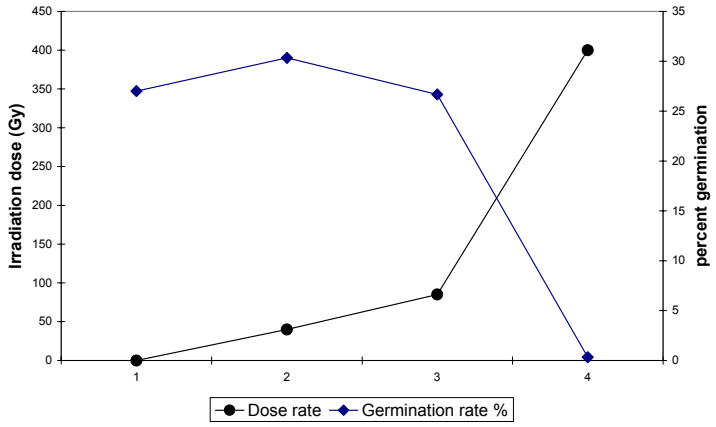
Figures

Fig. 1 Dose response on fresh seed



Tables

Table 1. Characteristics of some of the major varieties of custard apple grown in Queensland.

Variety	Productivity rating[1]	Average fruit weight (g)	No of seed per 100g flesh	Brix (°)	Texture rating[2]	Flavour rating[2]	Shelf life (days)
KJ Pinks	10	500-800	5	22	6	7	5
African pride	7	500-700	10	24	6	7	6
Maroochy Gold	6	600-800	5	22	7	8	6
Maroochy Yellow	6	400-600	5	25	7	7	7
Maroochy Smoothie	6	400-600	5	28	8	8	10
Palethorpe	4	600-800	9	19	7	7	8
Hillary White	3	500-700	5	22	6	7	5
Pinks Mammoth	1	700-900	5	22	6	7	5

[1] Based on natural fruit set without assistance from hand pollination
[2] Hedonic scale, 1=dislike intensely, 9=like intensely

4.2.2 Can Australian horticulture survive and meet the global challenge?

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Key words: fruit, vegetables, trends, markets, exports

Abstract

Globalisation is having a major impact on performance of Australian horticulture. Australia is highly vulnerable to cheap imports of many fresh and processed fruit and vegetable commodities. New and emerging crops will become increasingly important. Particularly threatened will be commodities that can be produced and/or stored all year round eg bananas, apple, and pineapple. New post-harvest storage and disinfestation techniques will exacerbate the problem. Imports from Asia and many other developing countries such as China, Chile and Brazil are cheaper because of their low costs of production. For example, labour costs in rural regions of China are about A$2 per day, leading to low costs of producing a tray of fruit e.g.A$3 per tray for stonefruit in China. Lower farm gates prices for Australian farmers are also being driven by consolidation in major Australian retail supermarket chains due to increasing pressure from international competitors such as Aldi. Farm share of the retail price has dropped from about 30% in the 1980s to less than 15-20% in 2003. Due to increasing costs of production, and falling or static returns, Australian farms are being forced to amalgamate to achieve economies of scale and to improve their efficiency of production. For example the number of potato farmers in the Fassifern Valley of Queensland has fallen from 480 to 50 in the past five years, while production has not changed. This trend is well documented in the USA. Whilst globalisation poses a major threat, Australia also has opportunities to increase exports of counter-seasonal commodities such as low chill stonefruit, lychee, custard apple and sweet persimmon to Asia, where populations are becoming increasingly urbanised, and disposable incomes are increasing rapidly. Australian industries must become more competitive to access these markets. We suggest that this can be achieved through the formation of larger export clusters and companies, standardized packaging and QA systems, and an internationally recognised brand name e.g. Oz Brand. We discuss new strategies to improve the survival and competitiveness of Australian fruit and vegetable industries.

WORLD SCENE – THE KEY GLOBAL DRIVERS

Globalisation is having a major impact on world horticultural production and distribution of fruit and vegetables throughout the world. The key drivers are: government deregulation which, when combined with improved disinfestation, is leading to freer trade; fewer but larger international global distribution and supply companies and supermarket chains (Hendrickson, 2001); and the emergence of China as a large producer and exporter and importer of fruit (FAOSTAT, 2003). In terms of production, we are starting to see consolidation in the number of farms producing fruit

and vegetables in western countries (Johnson, 2002). In both the USA and EU about 25% of horticultural producers account for 75% of total fruit and vegetable production (Ikerd, 2002). Patenting and licensing of varieties and new technologies to selected growers will further drive this consolidation. In contrast, consolidation that is taking place in the supply chain is being driven by supermarket chains who demand continuity of supply of safe, high quality product from northern and southern hemispheres. The chains will deal with fewer suppliers and pay the lowest price to remain competitive.

Blank (2003) suggests that horticultural industries in developed countries must make serious changes to ensure a successful future. He reports that the returns on horticultural investments are less then 1% (on average 0.4%) compared with 9.0% for food processing, 10.6% for retail, and 16% for food service. Ikerd (2002) suggests that in the global economy, small farms will be replaced by large farms, which in turn will be controlled by giant multi-national corporations. Under globalisation, small independent farms quite simply will not have access to markets for internationally traded commodities (Ikerd, 2002).

In the USA, over the past decade, farmers share of the retail price paid for fruit and vegetables has declined (Carman et al. 2004). In 2000, the farmer received an average 16% of the retail costs of fresh fruit, 19% for fresh vegetables and 17% for processed fruit and vegetables (US Bureau of Labour, 2000). This has occurred in spite of a 15-20% improvement in fruit and vegetable quality over the past decade. Consequently, prices have remained static, so in effect farm income has declined.

AUSTRALIAN SCENE – THE KEY DRIVERS

The Australian production scene is driven by: oversupply, high labour costs compared with competitors eg Asia, Chile etc. (George et al., 2003), increasing costs of production (mainly wages), decreasing returns (prices static, not keeping up with inflation), uncoordinated marketing by many small growers, variable fruit quality and little or no control of product after it leaves the farm gate, particularly if product are sold via merchants or agents. Imports from Asia and many other developing countries such as China, Chile and Brazil are cheaper because of their low costs of production. For example, labour costs in rural regions of China are about A$2 per day, leading to low costs of producing a tray of fruit e.g. A$3 per tray for stonefruit in China. Despite these negatives, Australia has excellent opportunities to increase exports to Asia and Europe.

In summary, the Australian drivers are similar to the American drivers. Like their American counterparts, Australian fruit and vegetable growers are caught in a cost/price squeeze with costs of production increasing over the past 10 years, but prices have remained relatively static, consequently in real terms have fallen (Spencer, 2004). Therefore, Australian farms are being forced to amalgamate to achieve economies of scale and to improve their efficiency of production. For example the number of potato farmers in the Fassifern Valley of Queensland has fallen from 480 to 50 in the past five years, while production has not changed.

In addition, expansion of horticultural production in Australia for domestic markets only will be small because consumption rates for Australian-produced fresh fruit and

vegetables in Australia has been relatively static for the past five years (ABS, 2000; ABARE, 2003). It should be noted that apparent increases in total consumption rates for fruit (all sources) in recent years, has been due mainly to imported (about 600 000 tonnes annually) processed orange juice concentrate, which equates to about 30kg per capita (ABS, 2000). Even if we could increase overall domestic market consumption by 10%, this may have only minor impact, due to the small size of the Australian market, on individual grower returns (George and Nissen, 2001, unpublished data).

WHY CURRENT STRATEGIES MAY NOT BE SUCCESSFUL

The Australian consumer is faced with a overwhelming variety of food products; in 1960s there were about 600 food lines on shop shelves, today there are over 12 000, and growing (Stanton, pers. com. Snack Fruit Conference, Brisbane, 2002). Consumers are demanding faster, more convenient food lines that are easy to prepare. Most marketers suggest that the price paid by consumers for fruit and vegetables and consumption per capita will increase, provided quality meets the consumers' needs. However, fruit quality and price are often poorly related (Owen, et al., 2000). Finding out what the consumer wants and producing a product to meets that specification does not automatically guarantee that the farmer will receive a higher price. Two other factors are important: consumer behaviour and supermarket pricing strategy. Owen et al. (2000) suggests that the price that buyers are willing to pay for high quality fruit and vegetables may be low because the buyer is often conditioned to buy good quality fruit at low prices when the supermarkets run their specials. Many fruits eg apple, pear, banana, peach, plum etc can also easily substitute for one another so that when prices are high for one their purchase is delayed until they come on special, and an alternative fruit type is purchased. The practice of price discounting confuses the buyer and serves only to delay the purchase of a rival fruit when it also comes on special. Price/volume relationships for fruit and vegetables are also highly inelastic with prices dropping very quickly when increasing volumes are placed on the market (George and Nissen, 2001, unpublished data).

Currently the promotional dollars spent on advertising fruit and vegetable is too small to be effective with <2% of the total advertising dollars spent on food lines (Cohen, 2002; Stanton per comm. 2002). For example, the Australian banana industry used to spend about $2.5M per annum on promotion but key performance indicators (KPIs) of consumption rates per capita (ABARE, 2003) and farm gate prices (Spencer, 2004) indicate little or no impact from the promotions. This is a very important point because most Australian industries prioritise domestic market promotion as their first strategy to increase their profits. Promoting individual lines displaces other competing lines or substitutes for a short period and has no long lasting effects. Fruit also fits into a mundane, non-sexy product category, of variable quality and consumer confidence (Owen, et al., 2000), which makes them difficult to promote compared with other 'snack foods'. In 2004, there were about 30 fresh fruit snack lines compared with 1 700 processed snack foods in the average supermarket (Stanton, per com., 2004).

WHY NEW STRATEGIES ARE URGENTLY NEEDED

For future survival, Australian farmers will need to become more efficient and reduce their production costs. Most of the gains in agricultural returns have come about from increases in productivity and not from increases in price (Mullen, 2002). However, in the near future, economy of scale will come into play as production costs will continue to spiral due to increasing labour costs. To achieve economies of scale, a farmer of staple fruit lines will need to have an orchard size of at least 200 000 trees, or more, to significantly reduce production costs, due to economy of scale only.

STRATEGIC AND STRUCTURAL PLANNING

New strategies can only be developed by using new strategic planing processes. Current strategic planning for most horticultural industries is seriously flawed. This is the major problem that needs to be addressed by industry leaders. Strategic planning is often undertaken without the appropriate global information/intelligence necessary to make complex decisions. A new approach to strategic planning which encompasses the changes due to globalisation is urgently needed. A 6-step process has been described by George et al. (2003), and will not be presented in this paper. Based on detailed analyses of the effects of globalisation, we suggest that strategies presented below might be employed to ensure a sustainable future for Australian horticultural industries.

NEW STRATEGIES TO EXPAND AUSTRALIAN HORTICULTURE

Strategy 1. Collective promotion and education

The potential to expand production of fruit and vegetables in Australia, based on domestic consumption alone, will be difficult due to lower population growth rates (<1.1% per annum, ABS, 1998), static fresh fruit and vegetable consumption rates (ABS, 2000) and competition from other processed snack foods. To significantly increase consumption of fruit in Australia, which already is currently one of the highest in the world, we suggest that all fruit and vegetable industries in Australia would need to pool their promotional dollars. These programs should be aimed at young children and teenagers and the "baby boomers". Despite significant TV advertising, through 5-A-day campaigns to promote consumption of fruit and vegetables in most western countries, there is little statistical evidence to show that these campaigns are working. More recently, there has been a shift to implementing educational programs in schools to alter eating behaviours of young children (Buzby et al., 2004), and these programs appear to be having greater success than TV advertising.

Strategy 2. Export.

Australia has an excellent opportunity to capture counter-seasonal export markets to Asia, in particular China. In 1995, consumption rate of fruit and vegetables in China was 54 and 146 kg per capita, respectively. Therefore, considerable room exists to double or treble consumption of fruit and vegetables in Asian countries to raise them to the same level as Australia. According to the Chinese Academy of Social Sciences (China View, 2004), China now has over 200 million middle class people with this

number expected to double in the next 10 years. This group will have sufficient income to purchase high quality fruit and vegetable imports from Australia and other western countries. However, to be competitive in export markets we will need to re-engineer the whole export supply chain (see strategies 4 and 5).

Strategy 3. Selecting export winners

Due to rapid improvements in post-harvest disinfestation methodologies (eg electronic pasteurisation, vapour heat, cold sterilisation etc.), many fruits can be grown and imported into Australia much more cheaply than they can be produced here. Particularly threatened will be processed or semi-processed commodities and fresh fruit and vegetable lines that can be produced and/or stored all year round eg fruits such as bananas, apple, and pineapple and vegetables such as potatoes, carrots and garlic. Only selected fruit and vegetable industries will remain viable and these will have to be export-orientated. Fruits and vegetables falling into this category have the following characteristics:

- are counter-seasonal to those grown in the northern hemisphere. These are the ones which Australia should concentrate on growing and investing R, D&E. Some fruits, such as banana, will be more susceptible to imports than others as they can be produced all year-round in some Asian and South American countries.
- have short (<3months) but sufficient storage life to ensure that the commodity can be sea-freighted but also ensure counter-seasonality to northern hemisphere producers. Apples can now be produced and stored all year round in developing countries eg. China.
- are difficult to disinfest – this will further lessen the risk of being imported.
- require a high level of technology to produce eg persimmon, blueberries

Strategy 4. Setting up global, regionally based marketing companies

To achieve economy of scale in marketing, farmers must market their produce together (horizontal integration) so as to control supply and to develop an internationally recognised brand name e.g. Oz Brand. In addition, farmers will need to form strategic alliances with processors and retailers and focus their activities to supply safe, quality assured, high quality product.

Based on current Australian production levels, Australia can probably only sustain three globally competitive, regional marketing companies. These export companies need to be of similar capacity to Capespan International in South Africa, Carmel in Israel, Dole, Del Monte and Chiquita in Chile. All these companies are exporting and distributing worldwide over 100M tray equivalents per annum. In Australia, we currently have over 180 companies/farmers exporting fruit with most exporting less than 20 000 trays. This is far too many to be successful.

Ideally, these global marketing companies should be farmer-owned and employ their own professional marketers (vertical integration). This eliminates the problem of unprofessional merchants/agents and sourcing of poor quality fruit from the market floor for export, which severely damages Australia's export reputation and results in it

being labelled opportunistic. These global companies need to market through a single desk with a single brand.

Australian horticultural farmers have been reluctant to market co-operatively due many factors including: lack of trust and transparency, factional infighting within many existing farmer commodity associations, the tyranny of distance between regions and lack of familiarity with single desk marketing. This reluctance to change is a serious impediment to future survival of Australian horticultural industries. In contrast, New Zealand, which has had a previous long experience with statutory regulated marketing, has now established, under deregulation, two globally-based, grower-owned export companies (Zespri, kiwifruit; Turners&Growers, pip fruit). This allows them to compete more successfully in global markets.

Strategy 5. Direct marketing – shortening the supply chain

Under a single desk system, farmer-owned companies could employ their own professional marketer(s) who could be paid a base salary plus bonuses based on the number of trays exported, and not on a commission basis as is customary with farmers selling their produce via merchants/agents. These global companies could also deal directly with the supermarket chains, thus eliminating commissions paid to intermediaries and at the same time reducing transactional costs.

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4.3 NEW CROPS CONFERENCE – GATTON

Improving fruit quality of custard apple (*Annona* spp. hybrids) in subtropical Australia through breeding and selection

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Abstract

The custard apple (atemoya) is in wide demand, particularly by Asian consumers, and the industry is the brink of significant expansion, due to good industry leadership, significant investment in RD and E, and the recent release of new varieties. Considerable progress has been made in selecting new types, identifying appropriate parents and gaining an understanding of the inheritance of desirable traits in custard apple. Inter-varietal crosses have been made between the best selections of custard apple such as KJ Pinks, Maroochy Gold, Palethorpe and Maroochy Yellow and the main commercial cultivars. Inter-specific crosses have also been made between four different species, *Annona cherimola* (cherimoya), *A. squamosa* (sugar apple), *A. reticulata* (Bullock's Heart) and *A. diversifolia* (Ilama). Some 15 000 breeding lines have been field planted since 1998. Fifteen advanced selections are being trialed at six evaluation sites throughout Queensland and northern NSW. The program has successfully developed hybrids with red skin colour and pink internal flesh. Red skin colour may be carried by either a single or double recessive gene. Fruit symmetry, flesh recovery and flavour characteristics of the crosses harvested in 2003 are excellent. Rootstocks with potential dwarfing characteristics such as shortened internodes and short, bushy stature have also been selected out of seedling progeny. These selections are in the process of being clonally propagated for future field-testing with a range of new scion varieties.

Key Words: custard apple, Annona, breeding, selections, varieties, rootstocks

Introduction

Most custard apple cultivars are hybrids of cherimoya (*Annona cherimola*) and sugar apple (*Annona squamosa*). However, other custard apple cultivars are of unknown genetic origin. Few new cultivars of custard apple and cherimoya have been selected in the past 20 years due to the small population of naturally occurring seedlings, and lack of a breeding programs/strategies for these fruits (Wester, 1913, 1915; Whitman, 1972; Popenoe, 1974). In contrast, other subtropical and tropical fruit such as mango have been intensively selected from over several hundred thousand seedlings for more than 100 years. In 1998, an intensive breeding program for custard apple was initiated at the Maroochy Research Station, Nambour, Queensland (George et al., 2002). A range of breeding strategies has been used in this program including conventional polyline crossing and induction of mutations using gamma radiation (George et al., 2002; Hamill, 2003). This program is now releasing potential new varieties to industry for further testing. More recently, several studies have been

conducted to gain an understanding on the genetic diversity and inheritance of desirable traits in custard apple and cherimoya (Ellstrand and Lee, 1987; Rahman *et al*., 1997; Perfectti and Pascual, 1998). This knowledge should lead to the use of genetic markers in breeding programs.

TABLE 1:
CRITERIA FOR SELECTION OF SUPERIOR CUSTARD APPLE CULTIVARS

Variable	Desired type
Tree morphology	
degree of apical dominance	Low
number of fruit bearing laterals	High
Yield capacity	
percentage of flowers set	>5%
precocity of bearing	2-3 years after planting
tree yield at full maturity	>60 kg
Fruit quality	
excellent taste	>7 on hedonic scale
firm texture	>7 on hedonic scale
no of seed per 100 g of flesh	<5
fruit size range	400-600 g, 600-1000g
skin thickness	moderate to resist bruising
skin colour	green, yellow, red, pink
internal flesh colour	red, pink
fruit symmetry	high
fruit shape	round
skin type	smooth or mildly tuberculate or impressa
resistance to chilling injury	no russetting
fruit rots (*Diplodia, Pseudocercospera*)	resistant
Post harvest	
storage life	>10 days
storage characteristics	little or no skin discolouration
fruit fly susceptibility	low

Materials and methods

Multiple breeding strategies are being used to improve fruit quality characteristics of custard apple in Australia. These have been previously described by George et al. (2002). An update on the breeding strategies used is presented below.

Polyline custard apple crosses

About 300 polyline custard apple crosses have been made between the best selections of custard apple (KJ Pinks, Hiliary White, Martin, Maroochy Gold, Maroochy Red, Palethorpe, R11-T3; R11-T4; R11-T6; Ruby Queen, Bullocks Heart). Whilst the

majority of these cultivars and selections are hybrids between cherimoya (*Annona cherimola*) and sugar apple (*Annona squamosa*), others are of unknown genetic origin. No genetic fingerprinting studies have been conducted to identify their exact origin.

Inter-specific and inter-generic crosses

Inter-specific crosses have also been made between four different species; *Annona cherimola* (cherimoya), *A. squamosa* (sugar apple), *A. reticulata* (Bullock's Heart), *A. diversifolia* (Ilama) and custard apple. Inter-generic crosses have also been made between *Rollinia deliciosa* and custard apple. To date, none of the progeny of these crosses has produced commercial cultivars but red skin colour of selected *Annona reticulata* and *Annona squamosa* has been transferred to the progeny.

TABLE 2.
CHARACTERISTICS OF SELECTED PARENTS WITH DESIRABLE TRAITS

SPECIES	SELECTION NAME	ORIGIN	DESIRABLE TRAITS
Annona squamosa	Red sugar apple	Florida	dark red skin colour
	Noi	Thailand	large size, light yellow skin colour
	Acc.no. 6333	Philippines	seedless
	Lobo	Philippines	big, sweet, few seeds
	Seedless	Cuba/Florida	seedless
	Thai-Lessard, Kampong Mauve	Ex Thailand	violet fragrance, easy peel skin
Annona diversifolia	Imery	Florida	pink skin colour and flesh
	Purple	Florida	purple skin
	Fairchild, Genova Red, Guillermo, Imery, and Pajapita	Florida	white to dark red flesh
Annona reticulata	Camino Real	Guatemala	red skin and flesh, smooth skin
	Fairchild purple	Florida	purple skin colour
	Dr Leon	Guatemala	orange skin and flesh
	Young	West Java	sweet type/low grit
	El Remate	Mexico	red skin and flesh
	Canul	Belize	red skin and flesh
Annona cherimola	Citamex	Mexico	orange skin
	Seedless	Peru and Ecuador	reports of seedless or low-seeded types
	Whaley	Ex USA	produced many semi-dwarf seedling progeny compared with other cherimoya varieties eg White,

SPECIES	SELECTION NAME	ORIGIN	DESIRABLE TRAITS
			Bays etc
Custard apple/cherimoya x *Annona reticulata* hybrids	75-9 (Spain cherimoya x Canul reticulata)	Florida	purple skin
	Fla 47-18 (Gefner custard apple x San Peblo reticulata)	Florida	pink skin, late season harvest
	Fla 4-5 (Priestly custard apple x Fairchild Purple reticulata)	Florida	purple/maroon skin, late season harvest
	Fla 47-18 X Maroochy Gold, many selections	Ex Maroochy Research Station, Nambour	red and purple flesh, late season harvest
Annona diversifolia X custard apple/cherimoya		Ex Maroochy Research Station, Nambour	distinctive flavour characteristics – sherbet, fruit salad
Custard apple cultivars (*Annona squamosa* x *Annona cherimola* hybrids)	Maroochy Yellow	Ex Maroochy Research Station, Nambour	very firm flesh and long post-harvest life >2 weeks at ambient, may be useful for increase storage life of custard apple.
	Maroochy Red	Ex Maroochy Research Station, Nambour	dark maroon skin colour, excellent flavour
	Maroochy Gold	Ex Maroochy Research Station, Nambour	tangy flavour characteristics, more acidity than other varieties, chilling tolerance
	KJ Pinks	Keith Paxton farm, Woombye, bud sport of Pinks Mammoth variety which has very low fruit set	exceptionally high fruit set compared with parent tree, able to set under a wide range of conditions, chilling tolerance
	15 Unnamed selections, various crosses	Ex Maroochy Research Station, Nambour	potentially dwarfing characteristics, short internodes and branching structure

Selection of dwarfing rootstock progeny

Rootstocks with potential dwarfing characteristics such as shortened internodes and short, bushy stature have also been selected out of seedling progeny.

Progeny evaluation

About 15 000 breeding line progeny have been planted at the Maroochy Research Station at Nambour, Queensland since 1998. Progeny are being evaluated for low-seed number, smooth skin, symmetrical shape, flavour, texture and high natural fruit set (George et al., 2002).

Advanced selections

Fifteen advanced custard apple selections have been made to date and these are being tested in a wide range of subtropical environments in Queensland and northern New South Wales.

RESULTS AND DISCUSSION

Polyline crosses

Since the start of the breeding program in 1998, 15 advanced selections have been made from breeding progeny at the Maroochy Research Station**.** Progeny of custard apple x *A. reticulata* and cherimoya x *A. reticulata* crosses produced fruit which were late maturing (spring in Queensland) because they have inherited the flowering and fruiting characteristics of *A. reticulata*, which flowers in autumn and matures fruit in late spring under subtropical conditions of Australia. Progeny have inherited high levels of internal grittiness from *A. reticulata*. Further evaluation of the F2 progeny, particularly of crosses with red-pink skin types is being carried out. Attractiveness is a key factor in selling any fruit. Exciting possibilities exist to develop new varieties with external and internal pink-red colour.

Dwarfing rootstocks

Fifteen potentially dwarfing rootstock progeny have been selected. Clonal propagation techniques, using softwood cuttings (George et al., 2003) are being developed to quickly multiply up this germplasm. The best scion varieties will then be field tested on these clonal dwarf rootstocks.

NEW VARIETIES

Commercial custard apple production in Australia is currently based on three cultivars, African Pride, Pink's Mammoth and Hillary White, which all exhibit either fruit quality defects or are unable to set good crops naturally, without hand pollination. Fifteen advanced selections have been released from the conventional breeding program to date. Two of these selections appear to have commercial potential. The first selection is Maroochy Gold, a Hillary White x red sugar apple cross. This selection has excellent flavour. The second selection is KJ Pinks, a budsport of Pink's Mammoth, which was selected by a commercial farmer near

Nambour. Natural fruit set of the budsport KJ Pinks was found to average 34% during the 2003 season, compared with its parent, Pink's Mammoth, which was less than 6% (R.J. Nissen pers. commun., 2003). A description of the main selection is presented below.

VARIETAL CHARACTERISTICS

KJ Pinks (Bud sport of Pinks Mammoth selected at Palmwoods by Keith and Judy Paxton, and being propagated by ANFIC)

Advantages

- Very heavy fruit set
- Appears to be adapted to a wide range of climates from semi-tropical to cool subtropical (better fruit set in dry rather than wet conditions)
- Very early bearing
- Fruit are moderate to large size (600-800g)
- 5 seed per 100g of flesh (same as Pink's Mammoth)
- Flavour and ripening characteristics similar to Pinks Mammoth
- Fruit does not appear to russet in cold conditions

Disadvantages

- Some misshapen fruit which may require thinning
- Fruit may soften quickly within 5 days, and need to be harvested in a short period of time
- Has some susceptible to the fungus *Pseudocercospora* which attacks African Pride

Maroochy Gold (selected from the Department of Primary Industries and Fisheries Breeding Program at Maroochy Research Station, Nambour, Queensland)

Advantages

- Tangy flavour compared with Pinks Mammoth types
- Seems to self pollinate reasonably well, but still dependent on weather conditions
- Fruit have the capacity to continue to size during the harvest period
- <5 seeds per 100 grams of fruit weight
- Fruit well accepted by panels of Brisbane and Melbourne consumers in taste tests
- Internal woodiness is not common
- Tree vigour similar to African Pride
- Fruit does not appear to russet
- Does not appear to be susceptible to disease
- Does not have great mealybug problem, as fruit skin is reasonably smooth
- Easy to visually determine when fruit are ready to pick
- Fruit will hang longer on the tree

Disadvantages

- Fruit tips may be pointy (4 points at flower end), but not usually a problem
- Pruning probably similar to African Pride
- Liked by birds

Maroochy Palethorpe (selected from the Department of Primary Industries and Fisheries Breeding Program at Maroochy Research Station, Nambour, Queensland)

Advantages

- Good eating quality
- Lovely internal flesh texture
- Large fruit with good shape, commonly 600-800 grams in weight
- Fruit have the capacity to continue to size during the harvest period
- Few small fruit or misshapen fruit
- Little sign of chill injury so far
- Pendulous habit of branches, possibly due to large heavy fruit
- Moderate bearer, apparently no problems with self pollination
- Thickish skin, but no or little granular texture near skin
- Fruit appears to stay firm, does not soften quickly when ripe
- 8 seeds per 100 grams of fruit weight
- Later variety, with picking starting in late April in south-east Queensland
- Does not appear to get disease on the fruit skin
- Does not appear to get much russetting on the skin
- Woodiness does not appear to be an issue
- Open tree
- Not vigorous in growth habit, so less pruning required
- May not be so susceptible to mealybug, due to even fruit shape, and fewer bumps
- Easy to determine when fruit are ready to pick, but more work for marketing and transport required

Disadvantages

- Slow to mature (about 6 years), but could be well suited to top working existing trees, particularly in NSW. In addition it might be possible to use dormancy breaking chemicals to bring trees into earlier production.
- Susceptible to fruit fly, which would need to be controlled through a regular management program
- Skin marks easily because of pendulous fruit, especially if windy
- Birds like the fruit
- More maturity work to do

Maroochy Yellow (selected from the Department of Primary Industries and Fisheries Breeding Program at Maroochy Research Station, Nambour, Queensland.)

Advantages

- Flavour is good but does not rate as high as KJ Pinks or Maroochy Gold
- Small to moderate round fruit (around 400-600 grams), no pointed carpels
- Very smooth, yellow skin
- Looks excellent when packed in socks
- Appears to self pollinate reasonably well (no extensive data)
- Has long shelf life of 2 weeks, but tends to ripen unevenly. However may be suited to export marketing. Will probably need to be ethylene ripened if grown in cool subtropical regions.
- May be more suitable to warmer regions eg Yeppoon
- Not much mealybug as fewer bumps and crevices on smooth skin
- Low vigour similar to African Pride

Disadvantages

- More work on deciding stage to pick is required
- Does not ripen evenly, so will require work on ethylene ripening
- Susceptible to anthracnose, which appears over the long fruit ripening period. May be better suited to drier areas eg Yeppoon, Bundaberg etc. No fungicide sprays used on trees to date.
- Fruit skin loses glossy appearance within 5-7 days
- Trees need good light interception to achieve maximum fruit size
- Skin marks easily eg through rub, scratching etc.

PRELIMINARY RECOMMENDATIONS

- Based on limited data, the two best varieties for planting appear to be KJ Pinks and Maroochy Gold. Both varieties have good all round performance, with KJ Pink's being a much more precocious and prolific bearer.

- The Maroochy Palethorpe variety may be better suited to top-working but needs an effective fruit fly management program.

- Maroochy Yellow may be more suited to the warmer subtropical regions such as Yeppoon and may need to grown on a trellis system to maximise light interception, and fruit size.

- We recommend that growers plant only small numbers of the new DPI&F varieties, and assess how the trees perform on individual farms, and in individual areas.

- Negotiations are currently underway to license the new trademarked DPI&F varieties to Australian Custard Apple Growers' Association. These varieties will initially be available from selected nursery propagators, who will provide trees only to growers who are licensed by ACAGA to grow these varieties. Please contact ACAGA on 02 6629 5333 for details of access to the DPI&F varieties.

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4.4 FIELD DAYS AND FARM WALKS

Field days and farm walks

Regular field days and meetings were held in various districts each year during this project. A minimum of five field days/farm walks per year was held in the southern growing districts, with visits to north Queensland in one year only.

Growers were addressed on the latest developments of the RD and E program, and given opportunity to ask questions of researchers. Where field days were held on farm, inspections of trial sites and new selections were invariably included.

4.5 NEWSLETTER ARTICLES

4.6 PRESS RELEASES

25 June 2004

CUSTARD APPLE GLASSHOUSE MOUNTAINS FIELD DAY

Custard Apple growers from throughout south east Queensland converge on the Sunshine Coast on July 14 for a major industry field day.

Department of Primary Industries and Fisheries senior principal horticulturist Roger Broadley said growers and industry representatives would attend the custard apple pruning field day at Peter Korczynski's farm, 21 Barrs Road, Glasshouse Mountains.

The day is being held to advise growers of the latest developments in tree pruning and management, including the advantages, disadvantages and legal rights to top working.

DPI&F principal horticulturist Bob Nissen will advise growers on top working older trees to new varieties.

"A pruning forum will look at what techniques are currently being used in pruning and orchard management and how they affect tree health, vigour, yield, labour efficiency, worker safety and pest management," Mr Broadley said.

A mechanical pruning demonstration will also be held.

Mr Broadley said discussion would also feature control measures for the yellow peach moth and DPI&F principal entomologist Dan Smith would advise on the results of mealy bug trials over the past two seasons.

Further information	Howard Archard	07 5484 3413
	Roger Broadley	07 5444 9610

18 March 2005

BRIGHT FUTURE PREDICTED FOR CUSTARD APPLE INDUSTRY

A bright future has been predicted for Australia's custard apple industry.

The 3rd National Custard Apple Conference held at Ballina last week was told while challenges still faced the industry the future was looking very good because of major opportunities for growers.

Department of Primary Industries Industry Development Officer, Roger Broadley, said the two-day conference attracted some120 growers from Darwin to Perth and North Queensland to Coffs Harbour.

Participants were told many Australians had yet to taste custard apples and both the domestic and export consumer markets had huge, untapped potential.

Mr Broadley addressed the conference on his 2003 Winston Churchill Fellowship award, which enabled him to study the leading technical developments in sustainable production of the fruit. The fellowship involved visits to Chile, Brazil, Spain, and Taiwan, some of the world's largest producers of cherimoya and sugar apple fruits, overseas counterparts of Australian custard apple.

Mr Broadley said his trip reinforced his view that Australian custard apple research, development and extension programs are among the best in the world. Our breeding program is the world's biggest and we have been able to achieve significant advances in clonal propagation.

Two new varieties, K.J.Pinks and Maroochy Gold are being commercially produced and first trays are expected to appear on supermarket shelves this spring. As well researchers expect that up to half a dozen new varieties out of fifteen major custard apple selections may go to on-farm testing later this year.

He said a major strength of the Australian industry was the leadership in evidence at all levels and great partnerships, which saw all members working for a single purpose. He said the industry was aided by their representatives who had superior management skills, excellent working committees, strategic thinking and teams who worked together to create niche markets.

Mr Broadley said while overseas countries have been producing close relatives of custard apples for long periods, no other country has developed a national strategic plan as Australia had done which puts our growers at the forefront of research and development and enables them to plan for the future.

He said he obtained rootstocks which will benefit the industry and could provide further windows of opportunity for domestic consumption and export trade.

"Custard apple is a crop that needs greater consumer exposure. The main purchasers of custard apple are of Asian extraction – 40 percent of Australian consumers have

never eaten a custard apple. However when they do, their response is almost invariably positive.

Custard apples are available from February to November, with peak production in the March-June period."

The 3rd National Custard Apple Conference was held on Thursday 24 and Friday 25 July 2003 at the Ballina Beach Resort.

Further information Roger Broadley 5444 9610

25 June 2004

NEW CUSTARD APPLE VARIETIES TO AID WEIGHT LOSS, OBESITY AND DISEASE CONTROL

People seeking to lose weight are being advised to include custard apples and other fruits and vegetables in their weight loss planning as the Department of Primary Industries and Fisheries is developing new fruit varieties with improved health benefits.

DPI&F principal horticulturist Roger Broadley said custard apple breeding programs at the Maroochy Horticulture Research Station, Nambour were studying the benefits of anti oxidants and other beneficial compounds in new custard apples.

The Australian Custard Apple Growers Association (ACAGA) said Asian countries are well aware of the health benefits from eating custard apples and other natural foods, but many Australians remain ignorant of the fruit's health benefits.

ACAGA Management Committee Member Rebecca Rogers said custard apples need greater consumer exposure and currently most purchasers are of Asian extraction. About 40 per cent of Australian consumers have never eaten the fruit, but when they do, their response is almost invariably positive.

Rebecca said "I would love to see more Australian consumers taking advantage of the health benefits from eating custard apples"

Custard apples are high in potassium, calcium, and magnesium and are an excellent source of vitamin C. Just one custard apple provides well over the daily-recommended allowance of Vitamin C. They have no cholesterol

Custard apples are being promoted as a natural means to help the 67 per cent of Australian males and 53 per cent of females who are overweight or obese according to the National Obesity Taskforce.

Overweight people are being advised to become more active to expend more energy and swap takeaway foods for fresh fruit and vegetables.

Nutrition experts are backing calls for obese people to increase their intake of foods with a low Glycemic Index (GI) measurement such as custard apples. Low GI diets can help people lose weight, and improve diabetes control.

Low GI foods make those who eat them feel fuller for longer so they reduce their intake and can prolong a person's physical endurance. GI is a ranking of carbohydrates based on their immediate effect on blood glucose levels with those carbohydrates, which break down slowly releasing glucose.

For more information contact Rebecca Rogers ACAGA 0266 281 246
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Issued by

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5.0 RECOMMENDATIONS

Recommendations from project

- That the breeding program continue
- That new rootstocks from Taiwan, Brazil and our own breeding program be evaluated.
- That IPM programs continue to be developed
- That new ways of managing fruitspotting bugs be developed, and that field trials with promising chemicals be completed
- That vegetative or clonal propagation be investigated further as a means of rapidly multiplying elite material
- That the mechanism used by KJ pinks to set fruit be investigated further
- That more efficient tree management and tree trellising systems be developed and tested
- That the effects of netting on fruit quality and yield be measured, with concurrent evaluation of the effect of netting on insect and other pest damage

6.0 ACKNOWLEDGEMENTS

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Many people have contributed to this successful custard apple project. I would like to acknowledge the following people and groups, which are too many to list individually:

- ACAGA Management team
- All custard apple growers involved in testing new varieties, new pesticides, new IPM systems and other RD and E work associated with this project
- Nev and Sandy green for allowing us extensive access to their orchard for trials on control of pests and diseases
- Staff members of HAL Ltd which assisted with this project
- Fellow colleagues of QDPI and F
- Farm staff and facilities manager of Maroochy Research Station, Nambour
- Casual staff involved in the project
- Brett Polar for his continuing assistance with many aspects of the program
- In particular, we would like to thank David Bruun for his help within this project, and without whom we would have achieved very little
- Administration staff at MHRS for their helpful advice and other assistance during the project
- Many other industry participants for their assistance with RD and E activities.

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