

Scoping Study to Develop a Standardized Industry Banana Carton

Tristan Kitchener
Kitchener Partners

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Know-how for Horticulture™

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EXECUTIVE SUMMARY

Within the last 12-18 months, in varying guises, growers, wholesalers, suppliers and retailers have all increased their activity in trialing and assessing different cartons and Returnable Plastic Crate (RPC) solutions. Some are conducting trials in isolation and others in collaboration with supply chain partners, and this activity demonstrates that there is widespread dissatisfaction with the current cartons and that there is a strong appetite to improve the status quo. The intention is that this project will help to consolidate this activity and drive further collaboration within the supply chain to achieve swifter change and wider adoption across the banana industry as a whole.

Early on in the project it became apparent that the task at hand was actually much broader and more complex than simply considering just the existing cartons and RPCs. The project scope needed to be extended to consider all the variables associated with packing bananas, including the supply chain touch-points that can influence carton performance and therefore the quality of fruit arriving at retail stores. Therefore, it was necessary to broaden the scope of the original proposal to include all interdependencies that can influence carton performance, including packing and packaging systems and processes used throughout the supply chain, from grower through to retailer. This helped ensure the suitability of any solutions or recommendations, and was supported by the PRG.

In addition, it is important to emphasise that this project was a scoping study and reliant on capturing known information or hypotheses rather than actually proving or disproving any particular criteria. Rather, data was sense checked and validated with members of the banana supply chain, from growers through to retailers, and then an informed decision made which has enabled a comprehensive list of variables to be collated. Where it is believed that there may be value in further investigation of a particular variable this has been highlighted. Other international markets were also examined, predominantly the UK, which highlighted significant differences in handling and packaging practices.

The key packing variables were examined, namely the pack weight (13kg or 15kg), carton form (2-piece carton or 1-piece carton) and the supply chain model (carton or RPC). Since businesses are likely to have preferences for specific packing alternatives, based on factors such as sunk cost and existing supply chain relationships, rather than steer industry towards one alternative over another the pros and cons for each were clearly articulated, and the differences monetised where possible.

Clear recommendations have been provided to instigate immediate as well as longer term change, through the use of minimum packing and packaging specifications, optimum best-practice guidelines for all stages of the supply chain and opportunities for step-changing the quality of fruit reaching the retail shelf through selecting and trialling the best aspects currently used domestically and internationally, for both cartons and RPCs. In addition, knowledge gaps have been identified and the counter-factual considered.

TECHNICAL SUMMARY

Average waste across Australian retailers is approximately 5-8% of total volume sold, at a retail value between \$51.7 million and \$82.7 million per year. This is significantly higher than other international markets such as the UK and USA where waste is closer to 2% of sales.

The objective of this project was to identify a solution(s) to standardize the current banana carton. The reason for this objective is based upon the understanding that a standardized banana carton will improve product quality at store level. Whilst this does carry some truth, it was considered more important to focus specifically upon the core issue, namely to improve the quality of fruit that arrives at retail stores, rather than trying to simply standardize the carton.

Therefore, the recommendation is to implement practices that will improve quality first and foremost, and in the immediate term *not* pursue a standard industry banana carton. If quality across the whole industry can be improved, then consumers are likely to respond favourably and demand for bananas should increase.

Similarly, given the complexity and general reticence within the supply chain as a whole to use RPCs, this should not be prioritised in the first instance but progressed more slowly with adequate analysis and assessment. Instead, the carton should be the immediate focus.

Therefore, whilst acknowledging the focus upon improving fruit quality, in brief, the recommendations from this project are to facilitate change through three stages:

- Stage 1: Minimum Specification

In the first instance, introduce a *minimum packing and packaging specification* for the 1-piece and 2-piece cartons to ensure all growers are aware of the need to utilise the appropriate type, quantity and combination of packaging and create awareness about the benefits of doing so. This will enable change to occur immediately and with minimal cost.

- Stage 2: Best-Practice Guidelines

The second stage should be to develop *optimum best-practice packing guidelines* for all the packing configurations currently in use, namely the 1-piece and 2-piece cartons, RPCs and 13kg and 15kg pack weights. Including all packaging combinations will allow growers to pack any pack configuration in line with requests from their retailer customers.

- Stage 3: Step-Change Packing Processes And Packaging

Finally, a project could be conducted which focuses upon cherry picking the best aspects of all practices and packaging types both domestically and internationally, and then conducting trials to quantify the benefit and fully understand the costs. This would include both 1-piece and 2-piece cartons as well as RPCs. The aim would be to create a step-change in fruit quality.

Needless to say, Stages 1 and 2 will also rely upon thorough engagement and communication to growers, to ensure unbiased and accurate information is relayed to growers to enable them to make an informed decision that will address their specific business needs.

To date, it has not been possible to achieve alignment within the banana supply chain and the major Australian retailers for acceptance of a standard industry banana carton; previous attempts have failed to gain agreement and highlight the complexity and potential risk in achieving this goal. However, if the recommendations in this report are actioned, it will provide an immediate improvement in quality and a pathway forward to achieve a further step-change across the whole industry, which will ultimately lead to an increase in consumer demand for bananas.

PROJECT BRIEF

From the Horticulture Australia Ltd (HAL) tender brief, dated 26th August 2013, it is understood that HAL requires the completion of a Scoping Study to assess the merits of developing a standardized Industry Banana Carton. Subject to approval by HAL and the Banana IAC, the objective will then be to identify and develop a standard industry banana carton that is accepted by all stakeholders across the banana supply chain, from growers through to retailers. The carton will ultimately improve consumer satisfaction at the retail shelf through the reduction of fruit damage as it travels through the supply chain.

It is noted that the proposal should meet key criteria including:

- *Output focus:* a focus upon practical implementation and NOT simply a situational analysis or an industry review;
- *Methodology:* a robust and detailed methodology;
- *Experience:* Suitably qualified and experienced team members that have a good understanding of the banana industry and supply chain (including both the major and independent retailers) in Australia, and proven experience in the relevant functional sectors, ideally including international experience;
- *Communication:* planning for appropriate communication to all stakeholders and interested parties; and
- *Progress Reports:* provision of progress reports and a Final Report upon completion of project.

PROJECT OBJECTIVES

It is understood that the objective of the project is to identify and develop a standard industry banana carton that is accepted by all stakeholders across the banana supply chain, from growers through to retailers. The first phase in achieving this is to conduct a Scoping Study, which will be used to assist the Banana IAC and HAL in deciding whether or not to support the Main Project. The key considerations within the Scoping Study are:

- *Needs Assessment:* Articulation of the key needs of stakeholders across the banana supply chain;
- *Alignment:* Assessment in regard to the degree of alignment across the banana supply chain, and respective appetite for a standard industry banana carton;
- *Cost-Benefit Analysis:* Appropriate analysis that clearly quantifies the benefits to industry from introducing a standard industry carton, and help prioritize the attractiveness of different solutions and select which option(s) to pursue;
- *Methodology:* Cost-benefit analysis to make recommendations in regard to the most preferred solution(s), that best addresses the issues and maximises the opportunities. A detailed methodology and timelines for implementation of a standard industry carton, including detail around actions and accountabilities to maximize the chance of success; and
- *Budget and Voluntary Contribution:* Development of an approximate budget to develop and implement a standardised industry banana carton, as well as identification of stakeholders that could provide Voluntary Contributions (VC) and approximate amounts.

PROJECT TEAM EXPERIENCE

In order to successfully deliver this project the key skills required by the project team are:

- Commercial credibility and a thorough understanding of horticulture in Australia, and more specifically the banana industry;
- A comprehensive understanding of the supply chain for bananas; both the direct supply to the major retailers and the central markets that supply the independent retailers;
- A strong network of relationships within the banana industry; particularly within the supply chain and the major retailers; and
- A solid understanding of the banana industry from the growers' perspective.

Confidentiality and Conflict of Interest

Given the sensitivities around confidentiality, particularly by the retailers, and the desire of supply chain stakeholders to ensure impartiality, in order to alleviate all concerns, the Project Leader has personally controlled all sensitive and confidential information.

The Project Team view that there is no personal conflict of interest in relation to this study, and there are no grounds to expect that perceptions of a conflict may arise in the future.

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PROJECT OUTCOMES

This project aims to make a meaningful difference to the Horticulture industry through engaging and working closely with the major banana supply chain stakeholders in Australia. To ensure maximum impact, the project was focused upon implementation and not simply provide a situational analysis or industry review, albeit this information has been considered in order to make informed decisions and recommendations.

In order for the project to be successful, there must be transparent alignment between all members of the banana supply chain, and particularly the major grocery retailers, to ensure the requirements of all parties are met. The needs of industry and supply chain stakeholders were identified and developed through one-on-one consultations and interviews as necessary, including an overview of international markets and particularly the UK.

The outcome from this project will help industry progress towards a single (or reduced number) of cartons and improved management practices for use by the whole Banana Industry in Australia, with improved quality of fruit for consumers and therefore increased demand. This in turn will ultimately support a higher level of performance of the banana industry over the next 1-5 years.

PROJECT BACKGROUND

For the last 6-8 years conversations have abounded regarding the potential for a standard industry banana carton, and the Supply Chain Panel debated this issues at the Banana Congress 2013, generating still further discussion. As documented by Eckman (2011), 'significant differences in damage incidence and severity were found between different types of cartons', however, it was difficult to eliminate all variables and accurately attribute a particular quality defect with a specific carton type.

The danger in any project is that one can be distracted early on by the detail, the politics and the history of past attempts to solve the issue. This creates a temptation to dive into solutions before clearly articulating, understanding and measuring the size of the opportunity. Past and current attempts to develop a standardised carton, albeit useful for generating learning, have been considered but used with caution due to the commercial bias and existing sunk costs of the parties involved. Nevertheless, some of the key concerns and questions that have been raised in the past include:

Cause of Fruit Damage:

- Do we know the exact causes of fruit damage?
- Where is the damage occurring along the supply chain?
- Could other actions be adopted that could be used in conjunction or instead of a new carton?

Ripening:

- How would a new carton ensure the best possible airflow for uniform ripening?

Box Material:

- Should the final solution be cardboard or a plastic crate?
- If a plastic crate can be used, can it also become a reusable crate?
- Can a plastic crate be designed that still protects and cushions the fruit versus being a carton that flexes with the product?
- Can it be a plastic crate that inter-stacks with cardboard boxes? When cartons are 'picked' at the Distribution Centres of the major retailers, bananas get mixed with other products therefore maintaining pallet integrity is important.
- Would a standardised carton be robust enough to survive intact along the whole supply chain, given the rigours of fluctuating temp and humidity, vibration etc.?

Implementation

- How will a new carton be implemented?
- Who will own in and who will produce it?
- Will it cost more or less than the current carton?

Retailer Concerns:

- How does the box add-value over and above the current offerings?
- Can it also be retail shelf-ready? Will it look clean and smart enough to be presented on a bunk/shelf to customers?
- Does it communicate freshness? How much of the product can be seen?
- If it is cardboard, will it be recyclable (this is a requirement for the major retailers)?

- How will retail tray-end labels be applied?

Many of the questions above are concerned with what the final carton solution(s) should be or not be, and this feedback has been captured during the Scoping Phase in order to understand the specific needs of all stakeholders within the supply chain. This has helped measure the degree of alignment across all stakeholders and enable the project team to select the most appropriate solution(s), and essentially develop a design brief that would need to be met if a standardised industry carton were to be developed. The development and implementation, in line with the carton design brief, would be included within the Main Project.

The AUS\$/UK GBP exchange rate at the time of writing the final report (January 2014) was used for converting currencies, which was AUS\$1.83 to 1GBP.

METHODOLOGY STAGES

Since there is a broad range of stakeholders across the supply chain with potentially differing needs, it was critical to accurately define the problem in order to gain full alignment at the start of the project and ensure the correct methodology was employed to achieve the required outcomes.

In order to maximise alignment of stakeholders, all the key stakeholders within the banana supply chain were engaged. Where possible, one-on-one meetings were used to allow open discussion and detailed probing to fully understand the needs, issues and opportunities, and ensure the accuracy of the hypotheses developed. The intention was for these interviews to help clearly articulate each stakeholder's needs, and in the process avoid bias, allow open and frank discussion and fully capture all information. This also helped stakeholders develop trust in the process with a view to working collaboratively should further activity be required.

The content of the discussions covered all aspects associated with the banana box, such as believed causes of fruit damage, previous solutions used and reasons for success or failure, and willingness to make a Voluntary Contribution to the development of an industry carton. In addition, current research findings and views of individual stakeholders were validated, and at all times care was taken to not breach confidentiality with any stakeholder.

Facts and information from previous studies and available literature, both quantitative and qualitative, were used to help understand the issues and validate the core hypotheses. This enabled solutions to be generated, supported by cost-benefit analyses, to evaluate and prioritize the attractiveness of each solution. In addition, timelines, actions and accountabilities have been provided for the preferred solutions. This will provide the Banana IAC with the necessary information to make an informed decision in regard to which option(s) to pursue.

Below is an outline of the key steps included within the methodology:

Engagement of Retailers

Given the loudest voice requesting a standard industry banana carton is coming from the major retailers, the retailers were engaged early on in the project. A selection of major retailers were consulted, including Coles, Woolworth's, ALDI, IGA and two further independent retailers in addition to Harris Farms.

Major Retailers

Since the engine room of the retailers are the Buying departments, the Banana Category Buyer was the key contact for the project. Where possible the senior Merchandise Managers and General Managers were also engaged, but focus was placed upon engaging the most knowledgeable individuals initially and then those that could provide access to other functions within the retailers such as Operations, Produce Managers in stores, Technical and Quality Managers, and Distribution Centre staff.

Independent Retailers

Three independent retailers were engaged, to provide an alternative perspective to the major retailers. Independent retailers were selected based on their knowledge of banana handling and willingness to engage and included Gum Tree Good Food (Melbourne) and Fruit on Coventry in

the South Melbourne Market. Harris Farms were also engaged since they are one of the largest independent retailers nationally and a large seller and handler of bananas.

Engagement of Growers

It was important to engage growers, both large and small, to understand current packing and production processes, and capture first hand insights regarding the use of the current banana carton, capture recommendations for improvement of the carton and how changes may impact packing efficiencies or any other processes that could affect growers.

Firstly, in order to understand the typical growers' activities, a visit was conducted around Mackay's Bananas to different farms and packhouses, hosted by Cameron Mackay. This quickly developed the knowledge base of the Project Leader and enable key areas for focus to be highlighted. The second grower engagement phase included a grower workshop, which was held in Tully, FNQ. The PRG, ABGC and HAL Project Manager provided a list of growers that the Project Team contacted. A workshop was held in the Tully Leagues Club on the evening of Tuesday 22nd October 2013 and was attended by 9 growers (please see Table 2 for a list of names). The advantage of the workshop was that it maximised resources and avoided a protracted grower-engagement phase given the limited timelines for the project.

Engagement of Hauliers

Given the large volumes and bulky nature of bananas, a specialist banana haulier, Blenners Transport, was engaged to obtain an understanding of key issues associated with the transportation of bananas.

Engagement of Wholesalers

Wholesalers in the Sydney Central Market and Melbourne Central Market were engaged in order to understand their processes, capture recommendations for improvement of the carton and how changes may impact any processes conducted by wholesalers. The wholesalers selected all supplied multiple retailers, including the majors as well as independent. PW Chew and Moraitis were visited in the Sydney Central Market and Costa Exchange and Lamana in the Melbourne Central Market. In addition, the market floors were walked to capture information regarding banana handling in general and relevant parties engaged as necessary.

Engagement of Ripeners

Fruit ripening is a key step in the banana supply chain and the carton is fundamental in ensuring uniform ripening and fruit quality. Given the range of ripening facilities in use, a selection of stakeholders at different points in the supply chain and with a range of end customers were engaged:

- Wholesaler: Lamana, PW Chews (Sydney Central Market)
- Major Retailers:
 - Costa Exchange Victoria/ Mackay's Bananas supplying to Coles Victoria
 - Woolworth's Minchinberry Distribution Centre
- Independent Retailer:
 - Harris Farms (Sydney Central Market)

Understanding of Distribution Centres

The Distribution Centres (DCs) are key steps within the supply chain and the DCs for Coles (Laverton, Victoria), Woolworth's (Minchinberry, NSW) and ALDI (Dandenong, Victoria) were visited. This enabled the differences in the way each DC handles, picks and out-loads fruit to be understood, including aspects such as cross-docking, timelines, stock holding and any other aspect that is relevant to the banana carton.

Engaging Packaging Manufacturers

If a new carton is to be developed and implemented, it will be necessary to engage manufacturers to assist in the development, production and testing of prototypes. Both Amcor and Visy were engaged as well as Joe Stacey from Joes' Cartons (who although owned by Amcor, still retains a level of independence and hold significant banana expertise).

Banana IAC Conference Call

In order to understand the current views, concerns and objectives on the banana industry, at the start the project a conference call was conducted with the Project Reference Group (PRG). The PRG members were:

- Doug Philips, ABGC Chair
- Robert Mayers, Banana IAC, R&D Sub-Committee
- Stewart Lindsay, QLD DAFF
- Cameron Mackay, Mackay Bananas
- David Chenu, HAL
- David Weisz, HAL (Project Manager)

This was an efficient means to rapidly collate information and experiences in regard to the banana carton, and help identify any pitfalls that could pose a risk to the project. Two conference calls were held with the PRG (on the 9th October 2013 and 5th December 2013). Pre-reading and meeting minutes were issued as necessary.

Overview of Current Research

Feedback to date from the major retailers has indicated a range of issues with the industry cartons being used currently, namely around damaged fruit arriving at stores, which is creating waste (shrink), requiring handling and sorting by store staff, creating a missed sales opportunity and ultimately dissatisfying consumers.

In order to achieve alignment and consensus, including the identification and articulation of the specific issues, a review of past research was conducted. Key researchers that have completed previous studies were also consulted as required, such as Stewart Lyndsay and Naomi King at QLD DAFF. This helped provide a base level of information and a list of key variables that influence carton performance and resulting fruit quality, which was then validated with stakeholders and adjusted accordingly.

The key insights from existing reports are detailed below, and grouped by variable.

Types of Fruit Damage

Eckman (2011) observed that ‘less neck injury was observed in cartons packed in the traditional 8 layer cartons, and that pre-packs of small fruit had less bruising than the larger fruit packed into normal cartons. A strong trend was evident for large fruit (oversize) being bruised or superficially marked compared to smaller (medium to large) fruit, however, considerable differences in sample numbers per category meant that results were not significant. It is not possible to draw strong conclusions based on carton type, due to problems collecting this information. Despite the differences in sample size between carton types, overall quality was significantly better in the traditional 8-layer carton than either of the 6-layer cartons (1 or 2-piece). Pre-packed fruit was the best quality, the packaging presumably helping to protect smaller fruit from rubs and bruising’.

Eckman (2011) also observed that rubs were the most common damage, and neck injury frequently the most severe damage. Her report confirmed that bruising, rub marking and neck injury are major issues, and decrease retail quality leading to reduced prices that consumers are willing to pay for bananas. Interestingly, approximately 6% of fruit had chilling injury, which most likely occurred after harvest.

Importantly, Eckman (2011) noted that bananas loaded on the top layers of pallets suffered significantly greater fruit rub than those in the centre of the pallet, which suffered virtually none. She also noted that the differences between the 1-piece and 2-piece cartons were minimal.

Liners and Bags

Eckman (2011) noted that packing bananas into bags rather than a slip-sheet with liner reduced average total fruit rub from 13% to 5.4%. The bags also appeared to reduce bruising caused by banana tips impacting fruit lower on the same cluster and nearly halved the incidence of neck injury. This was consistent with feedback from wholesalers and retailers, and also from Fyffes Bananas in the UK.

While carton type had less effect on abrasion damage during transport overall than the other factors examined, there appeared to be an interaction between carton type and liner. Bananas in the 2-piece cartons with liners had more rub marks and skin damage than fruit in the same cartons in bags. While a similar effect was noted on the 1-piece cartons, differences between the internal packing methods were less obvious. It should be noted that care should be taken due to the relatively low numbers of fruit evaluated and considerable differences between individual cartons.

Fruit Cooling

Eckman (2011) noted that flesh temperatures were generally lower for bananas in 1-piece cartons compared to those in 2-piece cartons, most likely due to better ventilation in this carton type. It also appeared that temperatures inside 2-piece cartons tended to rise slightly during low temperature storage, whereas those in 1-piece cartons remained constant. In regard to speed of cooling, the report also noted that bananas in 1-piece cartons cooled more quickly than those in 2-piece cartons and stayed cooler, on average, during transport and ripening.

Eckman (2011) also noted that the average flesh temperature of bananas in bags was effectively the same as those in lined cartons suggesting that bags have little effect on internal temperatures; in other words, packing bananas into bags instead of with a slip-sheet and liner did not appear to increase flesh temperatures during transport and ripening. In addition, no consistent temperature differences were observed between the top and base of the pallets.

It had also been thought that air temperatures might change more slowly in perforated bags (used in the 1-piece cartons) than slitted bags (used in the 2-piece cartons). Although Eckman (2011) did not investigate the interaction between carton type and bag ventilation, it was thought that differences in temperature control between perforated and slitted bags were likely to be relatively slight, especially when compared to factors such as total vent area on the carton.

In addition to the above points, Eckman (2011) also highlighted that significant damage can occur to bananas, even during short supply chains, especially if they are not loaded securely on the delivery truck. Also the increase in damage once bananas are placed on retail display was significant; whilst customer handling is somewhat unavoidable, ensuring ease of unpacking cartons and merchandising by store staff is certainly important to minimise fruit damage.

Defintions of Fruit Damage

To ensure consistency in understanding, the types of damage that can occur to fruit have been classified in line with past reports and based upon current understanding and interpretation within the industry. Whilst not definitive the key types of damage are:

Key Issues	Defect Definition
<i>Rub Marking (Scuffing)</i>	Superficial skin damage includes rub marks from other fruit or the carton itself as well as abrasions which could have occurred during packing and through the supply chain (underlying flesh is unaffected)
<i>Transport Rub (Black Rub; Fruit Rub)</i>	Black rub marks mainly along the fruit ridges, and especially along the outside curve caused by fruit (underlying flesh is unaffected)
	Dark brown skin marking caused by fingers within a hand rubbing against each other during transport (underlying flesh is unaffected)
<i>Compression Bruising</i>	Softened flesh, generally underlying a discoloured area on the skin
<i>Neck Injury</i>	Black marking around all or part of the neck
<i>Sap Burn</i>	Dark staining on fruit skin
<i>Chilling Injury</i>	Grey skin or under-peel discolouration
<i>Incorrect Ripening</i>	Blotchy appearance or green yet with sugar spots
<i>Other Defects</i>	Cuts, splits and rots (neck or blossom end)

Table 1: Summary of key types of banana quality issues

Project Scope

Since this project is a purely a scoping study and not actually engaging in any scientific fact-based research, previous reports and projects have been used as a source of information for making assumptions, which have then been validated and further developed during the course of the project.

8-per-layer and 6-per-layer Cartons

According to carton data supplied by the major carton manufacturers, growers on an annual basis use approximately 25 million cartons. Of this total approximately 22.70 million cartons (90.78%) are supplied as 6-per-layer cartons and 2.3 million cartons (9.23%) as 8-per-layer cartons. Lady Finger growers and those not supplying the major retailers mainly use the 8-per-layer cartons, and at least one major retailer does not accept 8-per-layer cartons since the automatic pallet pickers within their DCs cannot handle them. For these reasons, and with the permission of the PRG, the 8-per-layer carton has been excluded from this scoping study and consideration only given to the 6-per-layer carton.

Extension of Project Scope

All the variables associated with cartons or RPCs listed in research documents were compiled into a spreadsheet matrix. This included a list of all the variables that can affect fruit quality from a packaging perspective, broken down by supply chain stage and activity. As the project progressed it became apparent that in order to recommend the most appropriate solution(s), it would be necessary to consider more than just the attributes of the carton itself, since there are many interdependencies that can affect the performance of any given carton and subsequently the resultant fruit quality.

The use of correct internal packaging practices is critical in the successful delivery of bananas to the end customer. Due to the nature of the product and the further requirement to ripen the fruit before being sold through the supply chain, there is a compromise needed between minimising cost through the quantity and quality of packaging used, whilst also protecting fruit against physical damage; in addition ventilation has to be optimised to ensure evenness of ripening. Therefore, the use of suitable secondary packaging in conjunction with carton performance will better deliver bananas to retail stores in the best possible condition for sale.

Therefore, it was necessary to broaden the scope of the original proposal to include all interdependencies that can influence carton performance, including packing and packaging systems and processes used throughout the supply chain, from grower through to retailer. This will ensure the suitability of any solutions or recommendations. The PRG agreed that it was necessary to extend the project scope.

RESULTS AND DISCUSSION

The PRG confirmed the stakeholders within the banana supply chain that should be consulted; these individuals were knowledgeable and experienced and able to provide balanced and unbiased opinions on behalf of all members for their specific stage of the supply chain. These stakeholders were interviewed by the project team to understand concerns and needs in relation to the current banana cartons in use, capturing both positive and negative aspects, as well as recommendations for any improvements or considerations for a future carton design. The list of individuals and businesses consulted are listed below:

BUSINESS	NAME	POSITION
Project Reference Group		
Horticulture Australia Ltd	David Chenu	General Manager, Marketing
Horticulture Australia Ltd	David Weisz	Marketing Manager, Bananas
ABGC	Robert Mayers	R&D Sub-Committee Member
ABGC	Doug Philips	Chairman
ABGC	Cameron Mackay	R&D Sub-Committee Member
ABGC	Stuart Lindsay	R&D Sub-Committee Member
Growers		
Bartlefrere Bananas	Bernie Devaney	Owner
Johnstone River Produce	Doug Philips	Owner
LMB Farming	Brad Finch	Owner
LMB Farming	Jade Buchanan	Owner
Brighton Bananas	Bob Brighton	Owner
L and R Collins	Len Collins	Owner
Zonte's Bananas	Shane Zonta	Owner
Camuglia Farms	Tony Camuglia	Owner
Camuglia Farms	Charles Camuglia	Owner
Mackay's Banana Marketing	Cameron Mackay	Owner
Transport Companies		
Blenners Transport	Les Blennerhassett	Owner
Wholesalers		
La Manna Group	Angelo Taranto	General Manager
Moraitis Group	Chaise Pensini	National Banana Category Manager
Moraitis Group	Harry Theoharous	General Manager, Bananas
PW Chews	Greg Bradshaw	Owner
Costa Group	Michael Engeman	Sales and Marketing Manager
Ripeners		
Mackay's Banana Marketing	Julian Cook	Ripening Manager
Harris Farms	David Vella	General Manager
Woolworths Supermarkets	Joe Perry	Michinberry DC, NSW State Fruit Buyer
Distribution Centres		
Coles Supermarkets	Robert Papal	Laverton DC, Fresh Produce Manager
Woolworths Supermarkets	Joe Perry	Michinberry DC, NSW State Fruit Buyer
Harris Farms	David Vella	Sydney Markets
Retailers		
Coles Supermarkets	Iluka Davidson	Category Buyer, Bananas
Coles Supermarkets	Edward Palmer	Technical Manager, Fresh Produce
Woolworths Supermarkets	Donald Keith	Senior Category Buyer, Fruit
Woolworths Supermarkets	Warwick Hope	Category Buyer, Bananas
Harris Farms	David Vella	Sydney Markets
IGA	Luke Couch	Fresh Produce Buyer
ALDI	Steven Hastings	Purchasing Director
Gumtree Good Food	Ray Mak	Owner
Fruits on Coventry	South Melbourne Markets	Owner
Packaging Companies		
Joe's Cartons	Joe Stacey	General Manager
Visy Boxes and More N QLD	Barry Campagnolo	Regional Sales Manager QLD
Amcor	Andrew Russo	Regional Sales Manager QLD/NT
Researchers		
Agri-Science Queensland, DAFF	Stuart Lindsay	Senior Development Horticulturist
Agri-Science Queensland, DAFF	Naomi King	Development Horticulturist
International Retailers and Suppliers		
Walmart-USA	Dorn Wenninger	Vice President, Fresh Produce
ASDA Supermarkets (UK)	Damon Johnson	Head of Quality, Fresh Foods
ASDA Supermarkets (UK)	Tina Wiles	Fresh Liaison Manager - Fresh Foods
ASDA Supermarkets (UK)	Matt Leeman	Senior Buyer, Bananas
Sainsbury's Supermarkets (UK)	Simon Hinks	Technical Manager, Fresh Produce
Fyffes Bananas (UK)	John Clarke	National Account Manager
Fyffes Bananas (UK)	Mark Basinger	Operations Manager
Fyffes Bananas (UK)	Andrew Deham-Smith	Commercial Director
Fyffes Bananas (UK)	David Flynn	Managing Director

Table 2: list of stakeholders that engaged during the project

Through detailed consultation with the key stakeholders within the banana supply chain it was envisaged that the key needs for achieving alignment would become apparent and thus enable the project team to select the most appropriate solution(s) for proposing an industry standard carton. However, this was not the case due a number of reasons, namely:

- There are a huge number of variables and interdependencies that can affect carton performance and thus fruit quality; for example, a weaker carton can be compensated through using better taping, pallet sheets, bagging and packing methodology;
- It is difficult to attribute a weighting to all the different variables in regard to its influence on carton performance;
- Some variables still need to be proved or disproved in regard to their influence on carton performance; and
- Some individuals and/or businesses have made significant investment in developing their own intellectual property and are understandably reluctant to share the information with a wider audience that may include their competitors.

It is important to emphasise that this project was a scoping study and reliant on capturing known information or hypotheses rather than actually proving or disproving any particular view, opinion or even fact. Rather, data was sense checked and validated with other members within the banana industry and then an informed decision made and documented with supporting reasoning. Where it is believed that there may be value in further investigation of a particular variable, then this has been highlighted.

It should be noted that within the last 12-18 months, to varying extents, growers, wholesalers, suppliers and retailers have all increased their activity in trialing and assessing the performance of different cartons. Some are conducting trials in isolation and others in collaboration with supply chain partners, and this activity demonstrates that there is widespread dissatisfaction with the current cartons and that there is a strong appetite to improve the status quo. Hopefully this project will help to consolidate this activity and drive further collaboration within the supply chain to achieve swift change and wider adoption across the banana industry as a whole, and thus raise the bar in regard to banana quality in general.

Opportunity Assessment

In order to assess the size of the opportunity, major retailers and independents were consulted in order to access data to enable waste (or shrink) to be assessed. The majority of retailers do not accurately measure waste at store level and a better gauge is to in fact calculate the 'discrepancy' or difference between the volume of fruit out-loaded from distribution centres versus the volume of fruit sold on an annualised basis. The difference is a combination of:

1. *Waste*: fruit that is disposed of since it is unsaleable and offers no cost-recovery opportunity;
2. *Markdowns*: fruit that may be slightly marked but is still saleable but at a reduced price, although it should be noted that retailers have different policies in regard to markdowns (the majors often do not markdown product whilst independents will generally bag and sell marked fruit);
3. *Dehydration*: moisture loss from fruit whilst in transit or on display (this is likely to be minimal in comparison to points 1 or 2 and will be compensated by the over-pack; growers will over-fill cartons slightly in order to ensure the minimum net weight is met); and

4. *Theft*: fruit that is stolen from stores by customers (which is likely to be a relatively small contribution in the case of bananas since they are bulky and generally relatively low value).

Of these components of discrepancy, waste is by far the single biggest constituent for the banana category followed by markdowns, whilst dehydration and theft are likely to be negligible, and to all extents can be ignored as causal factors in the context of this project.

In respect of confidentiality, only general figures will be discussed and no specific retailers named. Furthermore, the majors were able to provide an accurate indication of waste, whilst the data from independents were less specific and highly variable (with some not knowing their level of waste). Average waste across Australian retailers is approximately 5-8% of total volume sold, and the current waste in the banana industry is likely to be between \$51.68 million and \$82.68 million per year, assuming:

- Average banana crop of 25 million cartons (average of last 2 years and f.2014);
- Average carton weight of 13kg net; and
- Average retail price of \$3.18/kg (AC Neilson Home Scan latest 12 months MAT, 02-11-2013).

It is difficult to accurately quantify the amount of waste being caused by the current banana carton, albeit the majority of stakeholders attributed the single biggest cause as the carton and associated factors. Similarly other major international retailers have significantly lower waste at less than 2%. It can be conservatively estimated that an improved carton used in conjunction with best-practice packing, handling and transport could easily reduce waste by 2.5% (to between 2.5-5.5%), equating to a saving of \$25.8 million per year. Furthermore, it could also be assumed that this loss could be translated into sales generating extra industry revenue of \$25.8 million per year, whilst also increasing consumer satisfaction and loyalty to the banana category.

No. of Cartons/Yr	Av Retail Price/kg	Weight per Carton (kg)	Waste (min)	Waste (max)	Annual Waste Value Min (\$)	Annual Waste Value Max (\$)	Forecast Waste Reduction	Annual Forecast Sales Increase (\$)
25,000,000	\$3.18	13	5%	8%	\$51,675,000	\$82,680,000	2.5%	\$ 25,837,500

It should also be noted that the majority of discrepancy consists of waste, and all retailers will incur cost in removing and disposing of this waste (consisting of a labour component and the cost of physical disposal and dumping). Similarly, there is a significant labour cost to bag and markdown fruit and these costs would be reduced if quality were improved.

Key Variables Influencing Carton Performance

Previous studies were used to identify and compile a list of variables than can influence carton performance. These variables were then discussed with stakeholders and validated, refined and expanded upon. This enabled a comprehensive list of variables to be compiled and continually improved, and used as a working document for developing a route forwards. The list of variables documented in previous reports which can affect fruit quality *and* are also relevant to carton performance are listed below:

- Packing method;
- Carton liner (slitted bag, perforated bag, slipsheet);
- Carton footprint (6-per-layer versus 8-per-layer);
- Carton type (1-piece versus 2-piece);

- Carton weight (13kg versus 15kg net weight);
- Stacking configuration (column-stacked versus cross-stacked);
- Type of pallet used (CHEP or Loscam);
- Pallet stabilization material (stretchy tape, corner posts or string);
- Pallet stabilization method (around sides of pallet or around side *and* top of pallet with downward pressure on top layers);
- Pallet stabilization application method (hand strapped or machine strapped);
- Carton layer stabilization type (glue versus no-glue);
- Carton layer stabilization glue type (wood glue versus other types);
- Carton location on the pallet (top, center or base of pallet);
- Truck type (short or long wheelbase);
- Position in the truck (A or B trailer, front or back of trailer);
- Road condition combined with driver ability and carefulness;
- Number of pallet movements between farm and retail; and
- Seasonality (wet versus dry season, primarily for FNQ).

It should be noted that certain variables were excluded since they were too far removed from the packing process to be credibly considered, for example packers skill, weather conditions during growing or fruit size and condition (for example, the effects of fertilizer and irrigation on fruit softness).

Each variable will be considered in turn, grouped by supply chain stage, listing the observations made by stakeholders, the optimum recommendation for carton performance and fruit quality, and where necessary, a recommendation for further investigation or fact-based analysis (see Tables 3 to 10 below). Where possible supporting photographic evidence has also been included at the end of the tables (Figures 1 to 25).

It should be noted that whilst the focus of this project was to assess the merits of developing a standardized industry banana carton, the data within this section is valuable information for ongoing improvement of packing and packaging systems and processes used throughout the banana supply chain in the form of best-practice guidance.

Pallet Stabilisation

Table 3: Variables related to pallet stabilization

Carton Variables	Observation	Preferred Solution	Further Requirements
<i>Glueing between Carton Layers</i>	For the 2-piece carton some growers are glueing just mid-level layers, others just the top layers, whilst other are glueing the majority of layers; no glue is used for the 1-piece carton	Glue all cartons on all layers	Identify and specify the minimum number of carton layers that require glue application
<i>Glue Type and Adhesiveness</i>	Different glues are being used (e.g. PVA cold-melt wood glue, waxes etc) with different levels of adhesiveness; when the wrong glue is used it creates a manual handling issue at the retailers DCs as increased force is required to separate cartons (estimated to be equivalent to be >16kg carton weight). Some growers are also diluting glue with water, also leading to variation in adhesiveness	The glue should be 'tacky' and not too sticky to hold cartons in place but also come apart easily without tearing or requiring excessive force; only palletising or hot-melt glue should be used	Specify the optimum type and amount of adhesive to be used and optimum method of application
<i>Amount of Glue</i>	There is a large variation in the volume of glue applied to each carton; some growers are squirting glue from empty drink bottles, diluting glue with water and often applying more glue than actually required	Use a single application of glue, approximately the size of a 20 cent coin, which will spread over a sufficiently wide area when a carton is place on top of it	Confirm the benefit if a single spot application versus several application areas across the carton surface
<i>Corner Posts</i>	Growers are generally not using corner posts at all	If the carton is strong enough there is less need for corner posts, but for weaker cartons it would be beneficial. Even for the current Mackays 2-piece carton, it would help achieve straighter pallet sides and reduce transport damage, and facilitate ventilation and ripening quality, NB: all UK retailers use corner posts, even though road distances are considerably less and sea freight considered to be more stable (cost \$1.10/post, plus labour to apply)	Assess if there is a need for corner posts for long-distance freights and/or at certain times of the year and/or in combination with certain carton types (such as column stacked 2-piece cartons with no cross-stacking)
<i>Pallet Strapping</i>	Hand strapping with variable tightness versus automatic strapping with more even tightness	Automatic strappers are better than hand strapping and effectively wrap over the top of the pallet creating downward force, which reduces rub marking in the upper pallet layers. Machines cost \$17k	
<i>Pallet Strapping Material</i>	An array of strapping material is be used including string, plastic strapping, sellotape, clingwrap and 3M stretch-tape	Use 3M stretch-tape (or equivalent) which has a memory and maintains tension and holds the cartons together on the pallet	Benchmark the performance and cost-benefit of different pallet strapping materials
<i>Strapping Configuration</i>	The majority of pallets are strapped horizontally with only the 3M tape (applied by machine) extending over the top of the pallet and providing downward force to prevent movement of the upper carton layers. Some DCs have noted difficulties in handling 3M tape as it gets stuck around forklift wheels, and also creates waste	It is vital to have strapping extending over the top of the pallet, however, this tape must have 'memory tension' to compensate for pallets settling in transit (rigid strapping will work loose in transit); 3M memory tape is preferred for this reason	Investigate other strapping alternatives that can extend over the top of the pallet to provide downward force. Work with DCs to enable them to handle memory tape more effectively
<i>Strapping Application Method</i>	The majority of pallets are hand strapped whilst larger growers are using machine strapping, generally with the 3M tape (which needs to be applied by machine costing c.\$17k each)	Machine application is preferred since it ensures consistency in positioning around the pallet and optimum tensioning	Quantify the cost-benefit of hand versus machine applied and the benefit that machine strapping provides in terms of positioning around the pallet and tensioning
<i>Pallet Sheets</i>	Pallet sheets are used by a minority of growers on the pallet base and then below every most cross-stacked layers; cost \$0.80/sheet and 2-3 sheets are usually used per pallet	The inner of the locking sheet is beneficial to use halfway up the pallet to lock the columns together and the outer of the locking sheet can be used on the top of the pallet; the pallet received with empty cartons can be used for this purpose	Pallet sheets are providing additional support, but for the cost involved, other pallet supporting alternatives (such as corner posts) may provide a greater benefit for only slightly more cost. It would be worthwhile benchmarking the performance and cost-benefit of pallet sheets versus other forms of supporting packaging
<i>Pallet Caps</i>	Some growers, particularly those using the 1-piece carton, are placing a cardboard pallet cap on the top of the pallet. Opinions are mixed in regard to the benefits this provides, such as providing additional stability and insulating the fruit against chill damage during transit	It is possible to re-use the card that covers pallets issued by packaging companies when sending empty cartons to growers as a pallet cap, however, it is unlikely to be worth purchasing card specifically for this purpose	Assess the incidence of chill damage on the top carton layers and any benefit that a pallet cap provides, including pallet stability
<i>Carton Taping</i>	For the 2-piece carton, some growers are taping the lid to the base to help hold fruit more tightly, occasional growers are taping completely around the carton, and the majority of packers are not taping at all	Lid taping is recommended, particularly for the top 3-4 carton layers on the pallet	Complete a cost-benefit to assess the reduction in rub marking due to lid taping

Bags, Liners and Slipsheets

Carton Variables	Observation	Preferred Solution	Further Requirements
<i>Bag or Liner</i>	Fruit in bags have less rub marking than fruit in liners (with no bag), since the bag completely covers the fruit whilst a liner will still allow fruit to rub against the carton sides. Fruit can also be held tightly in bags which reduces rub marking caused by vibration in transit, which is particularly important for the top 3-4 carton layers. However, bagged fruit takes longer to cool to avoid excessive ripening of fruit, and must have holes or slits	Pack fruit into bags and ensure heat is removed to avoid excessive ripening	
<i>Bag Ventilation</i>	The main types of bags used are either 'slitted' or 'perforated'. There is better temperature management with slitted bags (1 degree per 1 hour drop) than perforated (1 degree per 4 hours drop) as slits can self-regulate as required	Use slitted bags since fruit can breathe more easily since holes expand as required (self-regulate)	
<i>Bag and Liner Material</i>	Variable guage plastics in use with little information available regarding pros and cons of different types; liner thickness varies between 15 to 25µm and between High Density, Medium Density and Low Density PE	As long as the bag is of a reasonable thickness, the type of plastic is likely to make minimal difference to the quality of the fruit since the bag is largely acting as a physical barrier rather than relying on the performance ability of the plastic	Benchmark the performance and cost-benefit of different bag plastics
<i>Carton liner or slipsheet</i>	A range of different slip sheets and/or liners are in use, which vary in material (paper or plastic) and form (with holes and without holes). The majority of packers are placing a liner or slipsheet between each layer of fruit	Some form of separation is required between each layer of fruit, and is dependent on the fruit packing methodology used (see below). Paper in the base of the carton (inside the bag) should be used and extra paper placed under the crown ends when sap flow is high during summer months and plastic slip sheets between fruit layers to allow fruit to slide and minimize rub marking	Benchmark the performance and cost-benefit of different paper and plastic liners
<i>Packing Methodology</i>	Fruit is packed in 2 or 3 layers, although a wide range of packing techniques and variations are being used in regard to liners and bags	If fruit is bagged, then a liner or slip sheet can be used between the bottom and second layers of fruit and the bag folded between the second and top layer of fruit, before folding the other side of the bag over the top layer of fruit and sticking down or tucking under the bottom layer (see diagram); alternatively bags should be tied using a method that ensures the fruit is firmly compressed and cannot move	
<i>Fruit Size</i>	Currently all cartons are packed with uniform sized fruit. Packing mixed size cartons with large on the bottom and extra-large on top, has been suggested to fill the carton better and reduce fruit damage. Mixed opinions have been received from retailers in regard to the size of bananas preferred by consumers; currently 70% of consumers prefer large over extra-large, and there is growing demand for lunch-box sized fruit with an increasing presence of pre-packs satisfying this need The majority of consumers want a mix of sizes, however, uniformed sized fruit presents better on the retail shelf, and therefore mixed-size cartons would not be as visually appealing on the retail shelf	Until evidence can be presented to retailers that demonstrate the size preference of consumers, and the relative proportions of sizes desired, then the status-quo of uniform sized fruit in a carton will not change	The retailers are willing to engage in further dialogue around fruit size. There is a need to compile consumer driven evidence around fruit size preference, supported by the potential improvement to fruit quality and supply chain efficiency that could be achieved through packing mixed-size cartons. The current 'International Pack', consisting of smaller fruit on the bottom layer and larger fruit on the top layer, could be used as a learning source
<i>Bag Closure</i>	The main methods that packers are using to seal bags are: leaving the bag unsealed, tying a knot, using a neck tie, folding the bag under the fruit, taping the bag closed, locking the bag in two slits on the short end of the carton, and even twisting the bag neck and inserting the bunched plastic into a hole that is made in the bag	The bag should be sealed as tightly as possible to firmly compress the fruit to prevent vibration during transit, which can lead to rub marking. Twisting the bag is the method that holds the fruit the tightest but does lift the height of the fruit, and care should be taken to ensure it does not lead to increased compression damage	Investigate the best method to seal bags as tightly as possible to provide stability whilst not over-compressing fruit and causing other issues that adversely affect fruit quality. Assess feasibility of using stretchable bags with 'memory' (as per 3M stretch tape)

Table 4: Variables related to bags, liners and slipsheets

Palletizing

Carton Variables	Observation	Preferred Solution	Further Requirements
<i>Pallet Stacking Configuration</i>	A mix of column stack, and mixed column and cross-stacking with either 1, 2 or 3 cross-stacked mid-layers, or cross-stacked bottom and/or top layer. The cross-stacked layers are more prone to collapse and compression damage on the long side of the carton due to the corners of the cartons above digging in, and also more prone to more forward ripening since their orientation on the pallet leads to poorer ventilation and therefore less able to cool after ripening	Ideally the whole pallet should be column stacked to optimize de-stacking at DC by pallet pickers and uniformity of airflow during ripening producing evenly ripened fruit, however, this is not feasible for 2-piece cartons and a maximum of one mid-layer can be cross stacked at the 6th or 7th layer as well as the top layer	Assess the cost-benefit of cross-stacking in terms of pallet stability and ripening consistency
<i>Pallet Type (Loscam and CHEP)</i>	Both Loscam and CHEP pallets are being used. Loscam pallets are a soft-wood and appear more prone to damage/breakages, which can then affect pallet and/or carton integrity if appropriate precautions are not taken. Loscam pallets are lighter (c.20kg each) and cheaper to hire (about \$0.06/day cheaper), whilst CHEP pallets are hardwood and heavier (c.40kg each) and more expensive to hire. The majority of Loscam pallets have 8 planks and thus minimize the gaps between boards, whilst CHEP pallets are a mix of 7 and 8 planks; pallets with 7 planks can cause more damage as cartons are more likely to be compressed between the larger gaps	All pallets should be checked for structural integrity throughout the supply chain and ideally only be used by forklifts with 'pallet protectors', particularly in the case of Loscam pallets. Pallets with 8 planks should be used over pallets with 7 planks	
<i>Forklift Pallet Protectors</i>	Many forklifts are not using 'pallet protectors', which ensure the forward momentum of the forklift is transferred into the stonger pallet base and protects the edge plank on the pallet top from being damaged, as well as the lower carton layers. Once the edge plank is damaged, cartons are more prone to collapse and brusing damage. This is particularly important for use with Loscam pallets, which are soft wood (as opposed to CHEP pallet, which are hardwood)	Use pallet protectors on all forklifts within the supply chain (cost is \$80-100 each)	

Table 5: Variables related to palletizing

Carton Material and Construction

Carton Variables	Observation	Preferred Solution	Further Requirements
<i>Board Material (virgin or craft versus recycled card)</i>	Recycled card absorbs moisture more easily and therefore is more prone to collapse. Recycled card will be cheaper 90% of the time	The quality and quantity of recycled card used needs to be measured and controlled; ideally no more than 10% recycled card	Define optimum specification and tolerances for recycled versus craft content
<i>Board grade thickness</i>	Thicker board grade = stronger carton less prone to collapse	A thicker board grade provides a stronger carton and results in less fruit damage	Identify the optimum board thickness in relation to cost-benefit, and agree a minimum specification
<i>Lid Type ('pop-up' lid versus glued/taped)</i>	'Pop-up' lids are quicker to use but provide little structural support and more prone to collapse. Taped lids provide more support but the strongest lids are glued	Taped or glued lids should be used, however, consideration must be given to other factors used in combination such as card thickness, structure and lid tightness; the combined strength of the inner and outer lid is critical, i.e. for a weaker inner, only a glued or taped box lid must be used to provide additional support	Understand the strength properties of taped versus glued lids
<i>Lid Tightness</i>	The tighter the lid the more structural support it provides, albeit it takes longer for the lid to be placed over the inner carton	Ensure the lid fits tightly over the inner carton	Agree a minimum specification for lid tightness
<i>Carton Height</i>	Variable carton heights are in use; too low = compression bruising and neck damage, whilst too high = fruit movement and rub marking. The higher carton shifts loadbearing from the fruit to carton, and requires increased side wall strength. Visy 2-piece cartons are 156mm & 160mm, Amor 2-piece 158mm, and Amcor 1-piece 175mm. NB cartons used by the larger growers is 5-6mm higher than standard cartons (and there is still some compression bruising on the bottom layers, suggesting cartons could be increased by another 2-3mm). Banana neck length also varies throughout the season leading to differing amounts of neck damage through the season	A higher carton will reduce fruit damage but must have adequate side wall strength to compensate; the carton height is largely a function of the decision made in regard to many of the other variables listed	Identify the optimum height carton in conjunction with other variables
<i>Carton Coatings</i>	Some cartons are covered with a moisture resistant coating that absorbs less water and results in the carton being less prone to carton collapse; during the wet season particularly, the greater humidity results in weaker card due to absorption of moisture leading to carton collapse and cartons on neighbouring pallets rubbing together, removing the side of the box and damaging the fruit	Use a more moisture resistant stronger carton (perhaps containing a resin or with a PET laminate), or reduce the holding time of empty cartons in high moisture environments to minimise absorption. Surface laminates are beneficial but add about \$0.23c/carton for laminated paper on the base board, up to \$0.30-0.40/carton for a PET laminate on all carton surfaces	Understand moisture absorbency in relation to carton strength of different board materials during the wet and dry seasons, and also the quality, appropriateness and cost-benefit implications of using laminated card
<i>Carton Ventilation</i>	There is variation in size and frequency of holes for air flow and ventilation, impacting ripening and temperature maintenance within the supply chain. Virtually all cartons have adequate ventilation, however, ventilation becomes compromised by other factors which subsequently require specific actions to be taken in order to avoid ventilation then becoming an issue; e.g. if bags are used they should have slits, longer cooling times should be used (minimum 24 hrs in the ripener). With 1-piece cartons fruit can become chill damaged due to increased ventilation and appropriate adjustments should be made to processes used for 2-piece cartons	The more holes and ventilation in the carton the better, and ventilation across the majority of cartons is generally adequate	
<i>Carton Holding Times</i>	Many growers (especially smaller growers) are holding cartons on-farm for 5-6 weeks before using them. This allows cartons to absorb moisture from the high humidity environment and results in a weaker box that is more prone to collapse, particularly during the wet season	Adopt just-in-time delivery of cartons in wet season to ensure cartons are used within 1-2 weeks, to avoid cartons absorbing excessive moisture and increasing likelihood of collapse	Agree a minimum specification for holding empty cartons, including type of storage area and season (wet or dry)

Table 6: Variables related to carton material and construction

Transport

Carton Variables	Observation	Preferred Solution	Further Requirements
<i>Truck Quality</i>	Trucks are generally of an extremely high standard, and hauliers have made significant investment in their fleets	Current fleets are fit-for-purpose, and there is little opportunity to invest further to improve fruit quality	
<i>Trailers</i>	A-Trailer has more fruit damage (particularly rub marking) than B-Trailer, as does the very front and back of each trailer	It is not commercially feasible to only use B-Trailers, but where possible (such as for mixed product loads) B-Trailers should be prioritised for bananas	
<i>Suspension</i>	Hauliers are generally using trailers with air suspension as standard	Ensure all trucks have air-suspension as standard	Appropriate suspension should be used for on-farm vehicles that are transporting banana, albeit this concerns more robust green fruit; little comment has been made in this regard
<i>Loading Procedures and Methodology</i>	A-Trailers are being stabilised with plywood sheets, foam padding and metal bars (extending side to side and roof to floor in the truck); B-Trailers are stabilised with plywood sheets, foam padding and metal bars across the front 4 pallets, back 4 pallets and the back door. Some hauliers are using plastic inflatable air-bags in combination with sheets and metal bars to achieve the same result. All packaging material is reuseable	As long as pallets are stabilised in the trucks, the methods for achieving this have little importance. Some wholesalers have reported that on occasions air-bags have been punctured by forklifts or disposed of by forklift drivers who do not realise what they are or that they should be returned; improved training and signage on the side of bags would help address this. The skill and knowledge of the haulier is also important to ensure minor variables are handled appropriately; for example, if a pallet is leaning slightly then the leaning pallet side should be placed against the passenger side of the truck so the road camber can help support it	
<i>Driver Skill and Ability</i>	Given the long distances that fruit is travelling, driver skill is increasingly being considered a core competency, such as driving slower over poor quality roads. Appropriate training and awareness of drivers is critical, and is well addressed by hauliers		
<i>Driver and Trailer Monitoring</i>	Hauliers are using GPS to monitor driver competence, as well as motion sensors to monitor truck movement	Ensure all hauliers are using GPS and motion sensing technology	
<i>Temperature Management</i>	Trucks are pre-cooled before fruit is loaded, and cooling is maintained throughout the fruit journey	Ensure best-practice temperature management is used and monitor remotely with GPS and temperature loggers. It is also important that the fruit has already been cooled prior to loading and that the truck is NOT being used to cool the fruit; trucks have limited ventilation due to the need to pack pallets tightly to avoid movement leading to rub marking	
<i>Cross-Docking</i>	Most loads are cross-docked in Brisbane and then transhipped to other markets; the majority of fruit is transported by truck rather than rail. Often loads can be mixed with other products and temperature management and banana specific handling needs are not always adhered to	Ensure the minimum amount of cross-docking is used, and where possible fruit should be handled by companies that have banana handling experience	

Table 7: Variables related transport

Ripening

Carton Variables	Observation	Preferred Solution	Further Requirements
<i>Room Age</i>	Newer rooms generally have better fans and cool more effectively producing a more evenly ripened product		
<i>Carton Buldge</i>	Cartons with bulging sides are impacting the effectiveness of the ripening process, creating inefficient and variable ripeness throughout a pallet. In addition, the new generation Advanced Technology Ripeners can only be used with pallets that perfectly straight sides	Use cartons with perfectly straight sides where possible	
<i>Ripener Fill</i>	Full loads ripen more evenly and produce better quality fruit	Ripen full loads	
<i>Single Grower Loads</i>	Ripeners should only contain fruit from a single grower and not contain mixed loads from different growers in order to avoid inconsistency in ripening	Do not mix fruit from different growers in the same ripening load if possible	
<i>Bagged Fruit</i>	If fruit is bagged then a longer cooling time post ripening should be allowed (at least 24 hrs)		

Table 8: Variables related ripening

Distribution Centre

Carton Variables	Observation	Preferred Solution	Further Requirements
<i>Mechanical De-stacking</i>	Adequate carton strength is necessary to enable mechanical de-stacking; cartons with pop-up lids are more prone to collapse compared to taped or glued lids. Interlocking lugs need to be tapered to assist layer picking		
<i>Temperature Reveal</i>	Different DCs have different temperature receive requirements, ranging between 14-20 degrees, which is creating confusion for all parts of the supply chain. Chill damage is documented to occur below 12.6 degrees (UC Davis)	Hold fruit at 14-16 degrees	Advise DC of the appropriate holding temperature for bananas (considered to be 14-16 degrees)
<i>Pallet Tape</i>	DCs need are handling a wide variety of different tape types; pallets are destacked on arrival and tape is often left hanging off the pallet. The least preferred is the 3M tape since it stretches and can wrap around the wheels of fork-lift trucks if not handled appropriately	Work with DC owners to be able to handle the preferred tape options	Introduce protocols for handling pallet tape within DCs to ensure fork lifts are not hindered by tape wrapping around wheels
<i>Stackability</i>	Bananas are often picked first at the DC and other products are placed on top, therefore, inter-stackability is important. Coles and Woolworths use CHEP pallets but ALDI uses a smaller Dusseldorf pallet or D-pallet measuring 800mm x 600mm x 160mm	No issues with 2-piece cartons but DC processes will need to be adapted with 1-piece cartons, albeit other 1-piece 6-per-layers cartons (mangoes, stonefruit, apples) are handled currently without issues	Engage with retailers to help them accommodate 1-piece cartons

Table 9: Variables related to distribution centres

Store Handling

Carton Variables	Observation	Preferred Solution	Further Requirements
<i>Disposal at Store</i>	Maximise ability to compress carton; box disposal at stores is expensive with the average store needing to handle and crush 30 cartons/days (equating to 60 pieces if they are 2-piece cartons), which is expensive from a labour perspective but also means that store staff are working in the back-room rather than on the shop floor serving customers and merchandising product	Preference for 1-piece carton over 2-piece carton since less manual handling required to dispose of empty cartons	
<i>Recyclability</i>	In order to meet environmental regulations, carton need to be made out of recyclable card	Ensure carton is recycable	
<i>Air-Stacking at Store</i>	Variable compliance at store level	All 2-piece cartons should be air-stacked; 1-piece cartons will minimize the need for air-stacking, but if bagged still should be air-stacked (ideally slitted bags, which vent better)	
<i>Fruit Holding/Storage</i>	Most stores do not have warm-rooms for holding fruit at the correct temperature	Ensure bananas are not placed in coldstore rooms	Engage with retailers to communicate the cost-benefit of installing warm-rooms in all stores; influence store renewal teams to include warm-rooms as a standard and encourage retailers to provide stores with temperature sensitive tray-end labels (or equivalent)

Table 10: Variables related to store handling

Practices Requiring Attention



Figure 1 & 2: Excessive and incorrect glue creating increased 'breaking strain' when cartons are separated causing cartons to tear



Figure 3: Inappropriately secured loads allow pallets to rub together and cartons are separated and tearing cartons



Figure 4: Forklift trucks without 'pallet pickers' can damage cartons



Figure 5 & 6: Over-tensioned pallets causing cartons to collapse



Figure 7 & 8: Damaged pallets and pallets with planks spaced too far apart cause damage to bottom layer cartons



Figure 9 & 10: Lack of support during transit allows pallets to become unstable



Figure 11: Liners can allow fruit to touch the carton side and lead to rub marking



Figure 12: Bowing pallets in leading to compression of fruit



Figure 13 & 14: Fruit packed proud in the carton is prone to compression bruising, albeit some settling will occur

Practices That Aid Product Quality



Figure 15 & 16: Bags tied tightly to prevent fruit vibration during transit leading to rub marking



Figure 17: Lid taped to base to minimize fruit movement



Figure 18: Pallet sheet consisting of detachable inner and outer locking sheet



Figure 19 & 20: Automatic pallet strapper with memory tape to provide tension during transport; note straps pass over the top of the pallet



Figure 21: Slitted bag



Figure 22: Pallet of 1-piece cartons; note pallet cap and column stacking providing straight sides to the pallet



Figure 23 & 24: Foam padding and plywood sheets used to help stabilize pallets and prevent movement during transit



Figure 25: Forklift pallet protector (blue)

International Solutions

It is likely that other countries have experienced similar challenges around the use of cartons for transporting bananas. An assessment was made of the USA and UK markets in regard to the cartons that are currently used and any key points that may have relevance to the Australian market. Both the USA and UK actually procure bananas from the same sources, and as a result there are many commonalities in their processes, systems and the cartons that are used. Each will be considered in turn, but with particular focus upon the UK market since this was visited and examined first hand.

USA Market Overview

The Vice President of Fresh Produce (California) at Wal-Mart was consulted. The USA uses a 40lb (18.14kg), 2-piece carton, and is essentially the same carton design that has been used for the last 30-40 years. Fruit is packed into three or four rows depending on size, and a plastic 'bag' liner and a paper/light cardboard sheet separates the bottom two layers from the top two layers (to prevent fruit rub).

Whilst no specific figures were provided, fruit markdown and waste at retail appears to be significantly lower than in Australia. The USA market appeared satisfied with their current carton, and as a consequence there has been little innovation over the past 40 years in carton design (greater emphasis has been placed on specific parts of the supply chain such as ripening).

Fruit in the US land in five different ports on the east, central, and west coasts; weekly vessels arrive at Long Beach (LA) on the west, Wilmington or Philadelphia in the northeast, Miami in the southeast, and Gulfport or Galveston in the Gulf of Mexico (central). This means fruit actually does not travel that far via road; about 2-3 days as a maximum.

UK Market Overview

Fyffes Bananas (UK) were consulted closely, including a visit to their headoffice and ripening centre in Basingstoke, UK. The UK market value is approximately £880 million per year (AUS\$1.61 billion), and Fyffes currently supply and ripen almost 50% of this volume. Fyffes are the leading banana business in the UK, supplying fruit to all the major retailers, and ripen and sell approximately 230,000 cartons of 18.14kg per week. The UK market is approximately 55% loose fruit and 45% pre-pack fruit; most retailers range at least five different pre-pack lines including a Fairtrade, Family Pack, Organic, 5-Pack and Kids Pack. Retail pricing is extremely stable with loose fruit at £0.39 per lb or £0.85 per kg (AUS\$0.71 per lb or AUS\$1.56 per kg); this price may be artificially low since the UK retailers use loose bananas as Key Value Item (KVI) to drive consumer price perception throughout the store. Pre-pack fruit is mainly sold by catch-weight per kg but also per finger in convenience stores; at £0.30 per banana (or AUS\$0.55).

Key points to note are:

- *Fruit Origin:* Fruit is packed on farm in the tropics, transported in reefer ships to UK ports and then trucked to ripening centres where fruit is quality inspected, ripened and then delivered to retail customers. 100% of arrivals are green fruit in clusters;
- *Carton Use:* The vast majority of loads arrive in retail-ready 2-piece cartons. Fruit is packed into a bag within the carton base and a lid is then placed over the carton, and then the whole pallet is *inverted* and turned upside down so that fruit travels neck up which

significantly reduce neck damage. Fruit is ripened in the carton and on arrival at store the base is removed and the lid used as the on-shelf display vessel. Fruit is removed by the neck which is a faster means of merchandising and is likely to significantly reduce handling damage.

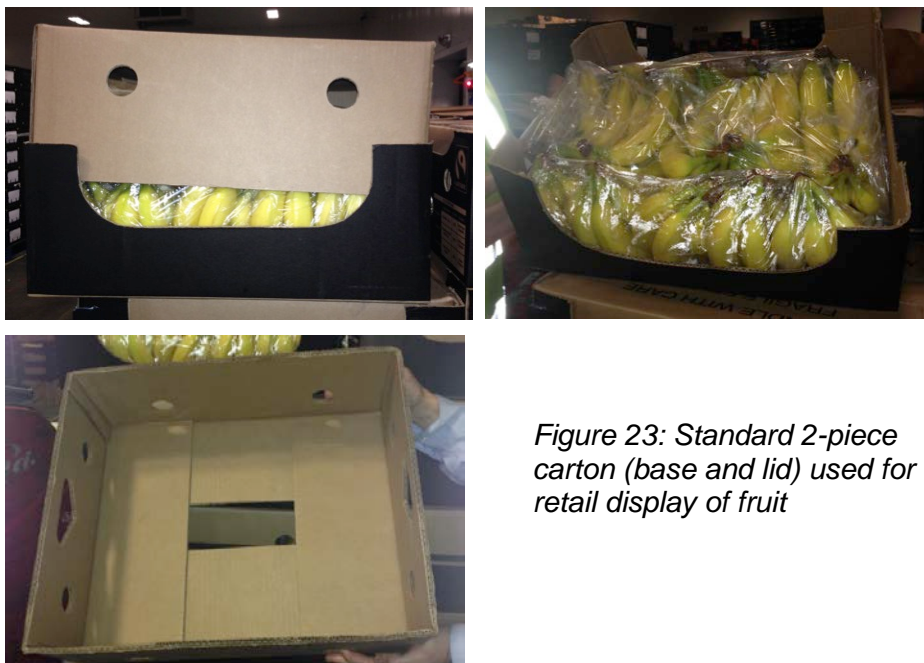


Figure 23: Standard 2-piece carton (base and lid) used for retail display of fruit

Strict standards are in place for the receipt condition of cartons with thorough QC inspections. Non-conformances are relayed to source locations to allow corrective actions to be implemented immediately. Particular attention is paid to ensure:

- Pallets are straight with no excessive leaning or damage;
 - There are no cartons with base-sag, which can lead to rub marking on fruit in the cartons below;
 - No cardboard is in direct contact with fruit since it can lead to fruit dehydration; and
 - ‘Piano packing’, whereby fruit is consistent and uniform in size with interlocking fingers resembling a piano keyboard, in order to reduce fruit movement and micro-vibration that can lead to rub marking.
- **Carton Weight:** Fruit is packed predominantly into 17kg or 18kg nett weight cartons, and to a lesser extent a 13kg nett weight carton. 13kg cartons are generally used for smaller sized fruit for pre-packing and singles, whilst 17kg and 18kg cartons are for loose fruit (the reason for the introduction of the 17kg carton came about when retailers moved to Shelf Friendly Packaging (SFP), requiring a more robust carton which could be inverted, the base removed and the lid used as a display unit and placed directly onto the retail shelf) displaying the fruit crown up;
 - **Carton Shape:** the carton footprint in the UK is a 6-per-layer that fit a 1.2m x 1.2m pallet, resulting in cartons that are shorter and wider in dimension (60cm x 40cm) than the Australian carton footprint;
 - **Carton Manufacturing:** Fyffes manufacture all their cartons in Dorset (UK) for both the Fyffes branded cartons and also their retailer customers, and transport flat packed cartons

out to the tropics where they are assembled and glued before use. Cartons are highly specified and include recycled board, water resistant resins and designed to maximise strength with minimal side-bowing and base-sag (further detail was not provided due to confidentiality);

- *Carton Management:* Fyffes control the carton process end-to-end to ensure that stock levels and inventory are closely managed and used quickly to prevent cartons weakening in the humid conditions;
- *RPCs:* The only retailer to use plastic crates is ASDA, who uses a 6-per-layer black IFCO crate holding 17kg nett weight; fruit is packed into crates in the tropics and handled in the same way as cartons throughout the supply chain by Fyffes (with bags and liners), with a crate cycle time of approximately 10 weeks. The crate has smooth and curved internal sides to minimize damage to fruit. The main drivers for ASDA are cost savings, reduced environmental impact and less fruit handling by store staff since crates are placed onto retail shelves without requiring decanting. It is understood that limited volumes of fruit are being transported in crates currently as the model is being refined;



Figure 24 and 25: RPC used by ASDA to transport bananas direct to stores from the tropics (note the smooth internal faces)

Pre-packs: Pre-packs are mainly ripened and packed in the UK, and the original cartons that the fruit arrived in are often re-used for delivery of pre-packs to retail customers. Some pre-packs are also pack at source in the tropics and then ripened in the UK. RPCs are also used as required for specific retail customers. Paper liners are used to separate layers of pre-packs;



Figures 26: Pre-packs with paper liner between bags

- **Pack Configuration:** As per the USA, loose fruit is packed into three or four rows depending on size, and a plastic 'bag' liner and a paper/light cardboard sheet separates the bottom two layers from the top two layers (to prevent fruit rub);



*Figures 27 and 28:
Packing configuration
with liner between pre-
packs to reduce rub
marking*

- **Pallet Stabilization (packing):** For green fruit arrivals, all pallets have corner posts (either plastic or card); plastic corner posts are made from recycled on-farm banana bags and if still in a good condition on arrival are even sent back to the growing sources for re-use. Corner posts are also cut or snapped when pallets are split into half-pallets, so that the pallet is still supported with corner posts whilst within the packhouse. Corner posts are usually not used with ripened fruit out-loading to supermarkets and other customers, however, it should be noted that the distances that ripened fruit is transported is generally a maximum of 4 hours (whilst green fruit can be transported for up to 8 hours);
- **Pallet Stabilization (transit):**
 - **Trucks:** no packaging or additional support are used within trucks, and in fact hauliers are often *not* banana specialists unlike Australia where generally specialist banana handlers are performing the majority of fruit movement (although UK roads could perhaps be considered to be less rough than Australian roads);
 - **Reefer Ships:** Generally pallets are stacked closely together and no additional support is provided apart from below deck pallets where sometimes inflatable bags are used to fill any spaces around the hatches;
- **Glueing:** no glue is used between carton layers whatsoever;
- **Pallet Heights:** pallet height are maximised where possible, ranging in height up to 14 layers.
- **Pallet Strapping:** the preferred method of securing pallets is plastic strapping that is tightened and crimped with metal clasps, with up to nine straps per ten layer pallet (see figure 29 and 30); the top two carton layers are often also strapped together with vertical and horizontal straps and small pieces of corner posts used to prevent cartons being compressed by the plastic straps (see Figure 31). No memory tape, string or other forms of strapping are used;



Figure 29 and 30: RPC used by ASDA to transport bananas direct to stores from the tropics (note the smooth internal faces)



Figure 31: Top two carton layers are strapped vertically as well as horizontally, and pieces of corner posts are used to spread the force of the straps (as indicated by the red arrow)

- **Bags:** 100% of fruit is bagged and sometimes arrived with high humidity and condensation within the bags, however, this was deemed acceptable and in fact preferred as it avoided the risk of dehydrated fruit that could cause quality issues during and after ripening;
- **Pallets:** there is no tolerance for broken or damaged pallets due to OH&S risks and damage to fruit, to the extent a ‘pallet exchanger’ machine is used which can tilt a full pallet on its side and allow the pallet to be removed and replaced by a new pallet;
- **Mechanical De-Stacking:** the majority of pallets were broken down by mechanical de-stackers to ensure safe working heights;



Figure 32: Mechanical de-stacking of pallets (note corner posts have been broken off at half-height and retained to support the lower part of the pallet)

- **Staff Wages:** the average fully-costed packhouse wage (i.e. including super contributions and the equivalent of work cover) is £9.50 (or AUS\$17.38) per hour, with typical Australian labour rates on bananas farms around AUS\$23-27 per hour;
- **Retailer Distribution Centres:** DCs have generally removed their banana holding rooms and now operate with only two temperature zones, at one degree and six degrees. Bananas are held in the six degree zone for up to three hours whilst awaiting outloading to stores; the limited air movement and tight packing of pallet means fruit does not warm excessively or suffer chill damage and is considered acceptable by suppliers and retailers. A notable exception to this process is Morrisons who include bananas within their bread supply chain, and hold banana in bread warehouses set at approximately 14 degrees;
- **Store Processes:** Store staff should air-stack bananas on arrival but compliance is very low in this regard, and the UK retailers have adopted a realistic approach in regard to the capabilities of stores and are continually assessing methods for simplifying in-store tasks. Very few stores still have ‘warm rooms’ or designated banana rooms in the back of store (the space has generally been converted into retail selling space). Fruit is generally kept in an ambient holding area and stock levels are tightly managed to minimize daily carry over of fruit. During winter months ambient holding areas can get below 8 degrees and tools have been implemented to assist stores with temperature management of fruit including:
 - **Temperature Sensitive Carton Labels:** some retailers are using cartons with an end label with the word ‘COLD’ written in temperature sensitive ink (see below), which will appear when the carton is exposed to temperature below 10 degrees. Stores use this an early warning sign to indicate that fruit is held in an area that is not suitable for bananas and should be moved to a warmer location. Once the fruit is placed back in the correct temperature the sensitive ink showing ‘COLD’ will disappear. This has helped reduce the incidence of chilling injury.



Figure 33: Temperature sensitive carton label used by UK retailers to prevent chilling injury

- **Banana Blankets:** Stores have banana blankets (pictured below) to protect bananas from chilling injury at temperatures below 13 degrees. This is essentially an insulated fleece sock that slides over the whole pallet (see below). Each blanket costs approximately GBP120 (AUS\$220) and is used predominantly during winter months;



Figure 34: Banana blanket for protecting fruit from chilling injury

- *Plastic Shrouds*: if fruit is being sent to the wholesale markets then a pallet shroud, similar to a large plastic bag, is placed over the whole pallet at a cost of £1.20 (or AUS\$2.20) per shroud;
- *Merchandising*: there is an even split between stores merchandising banana in the original carton and/or RPC, versus decanting and displaying on banana shelves, as demonstrated below. When cartons are used as the display vessel, the lid is removed and the top of the bag, which is perforated, is pulled away to expose the fruit. This avoids the need to handle or touch the fruit.



Figure 35 and 36: Shelf-ready cartons in UK retailer (Sainsbury's)



Figure 37: Fruit display in banana merchandising fixture in UK retailer (Tesco)

Key Differences Between the UK and Australian Market

In general there is significantly more packaging used for protecting green fruit in the UK market than Australia, namely:

- Plastic liners and paper slipsheets between *all* fruit layers (in loose and pre-packs);

- Corner posts on all green fruit pallets;
- Up to nine individual plastic straps per ten layer pallet on green fruit pallets;
- Top two carton layers are strapped vertically and horizontally, and supported by pieces of corner posts to avoid damage by straps digging in and ensure cartons are held securely; and
- Carton inventory is tightly managed to ensure they are used quickly to prevent weakening in the humid conditions.

In addition:

- No glue is used between carton layers;
- Non-specialist hauliers are used to transport fruit; and
- There is less concern over humidity.

It is interesting to note that even though all flowers are removed from banana ends, which often lead to increased rub marking, both a plastic liner and also a paper/light cardboard sheet are placed between rows of fruit. This is a stark comparison to Australian practices that tend to use less liners and/or paper, even though fruit is not de-flowered.

It was also interesting to note that the UK packers and ripeners are adept at handling a range of different pack formats in terms of packaging configurations, which is certainly on par with the range of pack formats used in Australia. Quality Control, receipt and ripening personnel are well trained in understanding the requirements of different fruit origins and how to ripen and manage the fruit to optimize quality. Staff are also involved in assisting growers in source countries to ensure best-practice processes are in place. Within the packhouse extensive retention samples are kept to monitor fruit quality; a sample is kept for seven days for every out-loading delivery for each source. This allows accurate and ongoing monitoring of fruit quality, including taste testing, which provides benefit to the retail customer and also allows ongoing refinement of internal practices to maximize fruit quality.

In summary, the UK and USA markets have shorter supply chains than the Australian market, yet use more packaging to protect fruit to ensure it arrives at retail stores in the best possible condition. The benefits of these practices and resulting return on investment are perhaps best illustrated by the fact that banana waste and markdown at retail level in the UK is only around 1.5-2% as opposed to 5-8% in Australia.

Cost-Benefit Analysis

Aside from the many variables associated with packing and packaging systems and processes, there are a number of key alternatives that need to be agreed before a harmonised industry-wide solution could be recommended and then adopted. These are:

1. Pack Weight: 13kg or 15kg;
2. Carton Form: 2-piece carton or 1-piece carton; and
3. Supply Chain Model: carton or RPC.

In order to make an informed decision in regard to the most preferred option(s), the merits and downfalls of each must be assessed. Businesses will most likely have preferences for specific alternatives, based on factors such as sunk cost and existing supply chain relationships, and therefore rather than steer industry towards one alternative over another it is best to clearly articulate the pros and cons for each, and monetise these differences where possible. Each of the alternatives listed above will be assessed in this manner.

Pack Weight: 13kg Or 15kg

In Australia, the decision regarding carton weight has largely been dictated by OH&S legislation and the internal policies of the major retailers designed to ensure workers are not exposed unnecessarily to risks arising from manual handling.

Whilst the UK and USA market has a well established 18.14kg (40lb) carton, this would be challenging to introduce into Australia and the major retailers are unwilling to increase their maximum manual handling limit of 15kg as it would expose their staff to excessive risk of injury. This leaves both a 13kg and 15kg as viable options. Challenging legislation and existing OH&S rules would be complex and challenging objective that has a high unlikelyhood of failure.

As detailed in Table 11 below, the advantage of the 15kg carton is that a 900kg net weight per pallet can be achieved, whereas for the 13kg the net weight per pallet is only 858kg. Since growers are generally paying per pallet space, rather than the weight of the pallet, there are efficiencies to be gained by using a 15kg carton.

In addition, most growers over-pack the carton by 0.5kg to ensure the minimum weight is met, be it a 13kg or 15kg carton. As a percentage this equates to a 3.85% over-pack for the 13kg carton and 3.33% over-pack for a 15kg carton. Since the grower is essentially not being paid for the over-packed fruit, a 15kg will minimize the fruit give away.

Variable	13 kg Carton		15 kg Carton	
	Pros	Cons	Pros	Cons
Packing Efficiency		Lower pallet weight: 66 cartons @ 13kg = 858 kg/pallet	Higher pallet weight: 60 cartons @ 15kg = 900 kg/pallet	
Over-pack Give Away		Higher relative over-pack (3.85%) assuming a 0.5kg give away	Lower relative over-pack (3.33%) assuming a 0.5kg give away	

Table 11: Pros and cons of using a 13kg verses 15kg carton

Carton Form: 2-Piece Or 1-Piece Carton

The Australian market has long been established around a 2-piece carton, however, over the last 3-5 years greater interest has arisen in regard to a 1-piece, particularly as a 15kg carton. Most of the major growers and wholesalers have conducted trials with 1-piece cartons. Below is a table that list the pros and cons.

Variable	1-Piece Carton		2-Piece Carton	
	Pros	Cons	Pros	Cons
Cost		\$0.20-30 premium; NB The extra cost for 1-piece cartons could be a reflection of the dominance of 2-piece cartons and sunk cost in production infrastructure. Should more growers request 1-piece cartons it is likely the costs will come down	No price premium	
Lid Application	Labour saving as no carton lid is required			Labour cost for lid to be applied
Ventilation	Better ventilation allows more uniform ripening and better temperature management within the supply chain	During winter may be increased likelihood of chill damage if pallets are not handled appropriately	Better able to handle external temperature variations	
Pallet Fill	Can pack with 15kg and achieve greater pallet weight of 900kg (60 cartons in 10 layers)			Lower pallet weight of 858kg (66 cartons in 11 layers)
Pallet Pickers	Straighter and stronger cartons sides facilitate Pallet Pickers	Lugs need to be tapered to ensure they can still be handled by Pallet Pickers		More variable carton strength and greater likelihood of minor compression bruising when lifted with pallet pickers
Manual Handling/ OH&S		Need to 'lift and place' in order for lugs to align rather than slide cartons, could lead to OH&S issues	Easier to stack as cartons will slide; less OH&S issues	
Glueing	No glue required			Glue required
Picking in DC		Harder to cross-stack with other products when being 'picked' in the DC; consideration should be given to a 1-piece with foldable flaps along the long edge of carton to allow cross-stacking	Easier to cross-stack with other products when being 'picked' in the DC	
Ripening	Straighter sided cartons and no cross-stacking allow the use of new generation ripening facilities, providing more uniform ripening and a lower cost of ripening			Often carton sides are bowed which disrupts air-flow and can lead to inconsistent ripening; limited opportunity to use tarpless ripeners
Store handling	Less reliance for air-stacking by retail store staff due to better ventilation			Need to air-stack at store to slow continued ripening of fruit
Store Merchandising		Fruit displayed in the carton crown downwards, requiring handling of hands to display on shelves (resulting in more skin marking)	Fruit displayed in the carton crown upwards, facilitating display on shelves (resulting in less handling and skin marking)	
Stacking	No cross-stacking results in less damage due to mid-layer compression on cross-stacked carton layer			Cross-stacked layer is often damaged by compression from cartons above

Table 12: Pros and cons of using 1-piece verses 2-piece cartons

1-piece has a greater risk of chilling injury; it is worth noting that Eckman (2011) recorded 6% if deliveries with chilling damage. Eckman (2011) also noted that during cooling, internal air temperatures fell quickest in the 1-piece carton with liner, and slowest in the 2-piece carton with bagged fruit, potentially reflecting differences in ventilation. However, the increased ventilation of the 1-piece avoids the reliance on store staff to air-stack pallets in the back of store, which is beneficial for the major retailers that can sometimes struggle with store compliance. The shelf-life benefit from increase ventilation is likely to be approximately 0.5 days, and perhaps slightly more in more northern stores where ambient temperatures are greater.

An added complication for the major retailers is in regard to the pick cycle within the DC. Since bananas are a high volume line, they are often used to construct the base of the pallet and other products then stacked on top. With the 1-piece, the pick cycle needs to be altered to ensure other

products are not stacked upon on the carton causing damage to fruit. Since 1-piece 6-per-layer cartons are used for many other products such as stonefruit, mangoes and truss tomatoes, it is clearly possible for these changes to be made but ideally the 1-piece should have a lip on the top of the carton to enable cross-stacking of cartons (similar to the avocado carton).

Supply Chain Model: Carton Or RPC

All of the major retailers have in the past or are currently investigating the merits of RPCs. Previous analysis by independent supply chain consultancies suggested that the financial benefits may be weighted significantly towards the retailers rather than growers or other parts of the banana supply chain; in addition to the quality benefits of a one-touch system in minimizing handling of fruit, depending on the specific design, the RPC model can generate significant revenue and this is likely to be a strong incentive for retailers but not necessarily aligned to the interests of industry.

Taking into account existing sunk costs, there is a temptation for retailers to simply use crates that are already in use within their supply chain rather than design a bespoke version that is ideally suited to bananas. All the RPCs in the market place currently, have not been designed with bananas specifically in mind and have sharp edges with limited curvature which could cause bruising to fruit; there is a significant risk of exacerbating quality issues if these crates are not used in conjunction with a bespoke cardboard liner or equivalent, or alternatively the crate is redesigned.

Furthermore, the greatest danger of any RPC model is if it is specific to only one major retailer and it in fact leads to greater fragmentation within the banana industry; a concern for growers is the risk that order requirements are reduced or product is rejected at the DC and it is difficult and expensive to then sell on the product whilst it is in a retailer specific RPC.

Consultation with stakeholders during the course of this project has identified widespread concerns with RPCs, perhaps compounded by growers' mixed experiences with the Coles implementation of RPCs in 2005. However, understanding of RPCs through the supply chain is also variable and whilst the RPC model itself is sound, there is limited information available in regard to their specific use with bananas, and the project team struggled to obtain objective data on which to provide a more informed decision.

To a large extent the RPC can be considered a plastic version of a 1-piece carton, and 1-piece cartons have been proved to work well in the Australian market place. With increasing environmental pressures, RPCs are certainly the right avenue to explore. The key challenges are:

- To ensure the RPC model is financially equitable to all stakeholders;
- The model does not fragment the industry, but instead is industry-wide;
- The crate is designed specifically for bananas;
- The correct packing processes and required secondary packaging are used; and
- Growers and the completed supply chain are trained and educated about how best to handle RPCs.

A disadvantage of both the 1-piece and RPC is that, unlike the 2-piece carton, neither can be inverted to display the fruit crown up (displaying fruit crown up aids store staff in merchandising fruit with minimal handling). In addition, the net weight of fruit that can be carried on a pallet in RPCs is lower, at 728 net weight for a 13kg RPC and 840kg net weight for a 15kg RPC.

Below is a table that summarises the pros and cons of RPCs verses crates.

Variable	Returnable Plastic Crates		Cardboard Carton	
	Pros	Cons	Pros	Cons
Cost	Variable; often the crate model is designed to be cost neutral when compared to cartons		Growers are able to negotiate individually to secure the best price and agree an optimum carton specification to meet their needs	
Packaging Weight		The RPC can weigh as much as 1.5kg each, resulting in a maximum of 54 crates per pallet (9 layers) equating to net fruit weight of 728kg for a 13kg RPC and net fruit weight of 840kg for a 15kg RPC	A 1-piece carton weighs approximately 0.8kg and a 2-piece between 0.85kg-1kg, allowing a higher net fruit weight per pallet of 858kg for a 13kg carton and 900kg for a 15kg carton	
Hygiene/ Sanitisation		There is a risk of dirty crates which can exacerbate fungal disease development and spread e.g. crown-end mould	Less risk of dirty cartons and disease risk	
Crate Casing	No variability in construction quality	The hard casing of the crate can increase fruit bruising	Card is softer and less damaging to fruit	Construction quality can vary during the year based upon recycled card quality
Storage	Crates can be stored indefinitely with no deterioration			Cartons should be used within a few weeks to avoid absorbing moisture and weakening, particularly during the wet season
Stability		If a crate side is knocked in low down on a pallet it can not be reinserted without de-stacking the pallet; if left it is an OH&S risk and liable to collapse		Dependant on using the appropriate type and quality of secondary packaging
Pallet Fill		A crate can weigh up to 2.3kg verses a carton at 0.6kg, resulting in 1 layer of crates having to be removed (60 crates/pallet instead of 66 cartons/pallet)	Cartons are lighter and therefore more fruit can be transported on a pallet	
Fruit Quality	Fruit should be less prone to compression bruising, assuming fruit can be secured tightly within the crate and not be subjected to vibration leading to rub marking; since crates are a 1-touch system there is less handling of fruit by store staff	Since there is no weight from above layers to hold the fruit firmly in place it is evenly more critical to bag fruit tightly to reduce movement and prevent rub marking	Less prone to rub marking caused by vibration as fruit can be held tightly (in bags etc.)	More prone to compression bruising as some weight will be carried by the fruit; fruit needs to be decanted from cartons before being merchandised requiring more handling which can impact quality
Store Efficiencies	Crates are easy to merchandise and require limited operational training; no disposal of crates required since they are simply back-hauled to the DC and then wash plants	Fruit can not be inverted or provided to stores crown up to aid merchandising and minimize fruit handling	2-piece cartons can be inverted in order to display fruit crowns up to aid merchandising and minimize fruit handling	Store staff need to be better trained in order to understand how to handle and merchandise cartons; cartons need to be collapsed and placed into compactors in order to be disposed; this has labour cost element plus a disposal cost
Environmental	Using a returnable plastic crate system is environmentally preferable to using card			More environmentally impactful

Table 13: Pros and cons of using RPCs verses cartons

Optimum Packing Option

If there were a clean slate with no packing options currently in use, the preferred option would be a 15kg 1-piece carton, since this would present the lowest packing cost per carton and maximum fruit weight on a per pallet basis. In addition, column stacking the complete pallet together with the straighter carton sides facilitate more uniform air movement and therefore more evenly ripened fruit. Greater ventilation also avoids the need to rely so heavily upon retailers to air-stack bananas on arrival at stores where compliance can often be poor, albeit there is perhaps a greater risk of

chill damage if not handled appropriately. Supply chain expects estimate the increased air-flow with 1-piece cartons can provide an additional 0.5 days shelf-life gain.

In regard to growers, the 1-piece allows less room for error and requires more stringent handling with specific secondary packaging, such as pallet locking sheets. Therefore the 1-piece is probably most suitable for growers that are prepared to take the additional time, care and attention and adopt the suggested accompanying practices, to ensure quality issues do not arise.

The cost comparison in Table 14 demonstrates that packing the 1-piece could generate a saving of \$3.88 per pallet in comparison to a 2-piece, and also a proportionally lower over-pack give away of 3.33% (as opposed to 3.85% for the 2-piece). However, the cost of the 1-piece is currently \$0.20-0.30 more than a 2-piece. Given only a small percentage of the grower pool currently use a 1-piece, it is likely that 1-piece manufacturing costs would reduce significantly if more growers were to transition to its use.

Assessment Of Alternatives

As illustrated in the above comparisons, there are well-balanced arguments for all alternatives and the criteria for selecting the most preferred combinations will be a function of specific business objectives and existing sunk costs. Based on the criteria above, the main packing options are:

1. 13kg 2-piece carton;
2. 15kg 2-piece carton;
3. 13kg 1-piece carton;
4. 15kg 1-piece carton;
5. 13kg RPC; and
6. 15kg RPC.

Given the fragmentation and complexity of the industry, clear pros and cons for different configurations and the wide range of variables surrounding the use of secondary packaging, proposing a single one-size-fits-all solution is not appropriate. Rather a number of solutions are required that address the preference that individual businesses will have in regard to pack weight (13kg or 15kg), carton form (2-piece carton or 1-piece carton) and the supply chain model (carton or RPC), in their respective combinations. This premise will form the basis of the recommendations.

Voluntary Contributions

The project scope included the identification of stakeholders that could provide Voluntary Contributions (VC) and approximate amounts. Since the development of a standardised industry carton is not the definitive recommendation from this report it has not been possible to determine the exact quantities of support different stakeholders are willing to provide, since a total proposed project cost has not been identified.

During the engagement phase stakeholders understood that the project path would be somewhat emergent, and accepted a number of potential outcomes were likely. Given this premise, stakeholders confirmed that they were willing to make a contribution to support outcomes from this scoping project but that the amount of any contribution would be determined based upon what the specific activity included and the total cost of this activity.

The recommendation is for the Banana IAC to first review this report and select their preferred a

route forwards from the recommendations provided, and then the cost for further work can be calculated and the stakeholders re-approached to determine what exact contribution they would be prepared to make. Based upon the initial conversations with stakeholders, it is anticipated that the majority of stakeholders would make a contribution and other parties not consulted during the course of this project could also be approached.

RECOMMENDATIONS

The objective of this project is to standardize the current banana carton. The reason for this objective is based upon the understanding that a standardized banana carton will improve product quality at store level. Whilst this does carry some truth, it is perhaps more important to focus more specifically upon the core issue, which is to improve the quality of fruit that arrives at retail stores, rather than trying to simply standardize the carton (although this will be discussed in due course).

Therefore, the recommendation of the project team was to implement practices that will improve quality first and foremost, and in the immediate term *not* pursue a standard industry banana carton. If quality across the whole industry can be improved, then consumers are likely to respond favourably and demand for bananas should increase.

Similarly, given the complexity and general caution within the supply chain as a whole to use RPCs, this should not be prioritised in the first instance but progressed more slowly with adequate analysis and assessment to address the issues that are causing concern. Instead, the carton should be the immediate focus. Therefore, whilst acknowledging the focus upon improving fruit quality, in brief, the recommendations from this project are to facilitate change through three stages:

- Stage 1: Minimum Specification

In the first instance the recommendation is to introduce a *minimum packing and packaging specification* for the 1-piece and 2-piece cartons to ensure all growers are aware of the need to utilise the appropriate type, quantity and combination of packaging and create awareness about the benefits of doing so. This will enable change to occur immediately and with minimal cost.

- Stage 2: Best-Practice Guidelines

The second stage should be to develop *optimum best-practice packing guidelines* for all the packing configurations currently in use, namely the 1-piece and 2-piece cartons, RPCs and 13kg and 15kg pack weights. Including all packaging combinations will allow growers to pack any pack configuration in line with requests from their retailer customers.

- Stage 3: Step-Change Packing Processes And Packaging

Finally, a project could be conducted which focuses upon cherry picking the best aspects of all practices and packaging types both domestically and internationally, and then conducting trials to quantify the benefit. This would include both 1-piece and 2-piece cartons as well as RPCs. The aim would be to create a step-change in fruit quality.

Stages 1 and 2 will also rely upon thorough engagement and communication to growers, to ensure unbiased and accurate information is relayed to growers to enable them to make an informed decision that will address their specific business needs.

Stage 1: Minimum Packing and Packaging Specifications

Based upon consultation during this scoping study, a recommended minimum packing and packaging specification has been developed. Throughout the supply chain there are a huge number of variables that influence quality and these have been documented earlier within this report, including the preferred solution and any further requirements. In order to enable growers to take immediate action to improve quality, it is critical that the correct combinations of variables are used.

Fruit should ideally be packed into a slitted bag, which will allow airflow, maintain humidity and avoids rub marking at the short ends of the carton. A slip sheet should be placed between the bottom and second layers of fruit and the bag folded between the second and top layer of fruit, before folding the other side of the bag over the top layer of fruit and sticking down or tucking under the bottom layer (see diagram); alternatively bags should be tied using a method that ensures the fruit is firmly compressed and cannot move. An absorbent paper liner should be placed inside the bag under the bottom layer of fruit. As a minimum, cartons on the top 3 layers of the pallet should have twisted bags and/or tied to hold the fruit tightly together to prevent movement leading to rub marking, or be firmly taped in order to minimise movement.

For the 2-piece carton glue should be used to hold cartons in place; the glue should be tacky but not too sticky and palletising glue is most appropriate. 3M strapping should ideally be used, which extends over the top of the pallet and provides downward force, and ideally be machine applied for consistency, positioning and optimum tensioning. In terms of pallet stacking configuration, column stacking is preferred, be it for the 1-piece or 2-piece carton, although for a 2-piece carton a maximum of one mid-layer can be cross stacked at the 6th or 7th layer as well as the top layer.

Given the large number of variables, further detail is provide below in regard to the ones that have most impact in regard to optimising fruit quality:

- *Slitted Bags:* Fruit can breathe more easily since holes expand as required (self-regulate), and humidity is retained to prevent against dehydration;
- *Paper Liners and Slip Sheets:* A paper liner in the base of the carton (inside the bag) should be used and extra paper placed under the crown ends when sap flow is high during summer months, as well as plastic slip sheets to allow fruit to slide and minimise rub marking;
- *Stretch (Memory) Tape:* Ideally 3M memory tape (or equivalent), which has a memory and maintains tension and holds the cartons together on the pallet. Machine application is preferred since it ensures consistency in positioning around the pallet and optimum tensioning. It is highly beneficial to have strapping extending over the top of the pallet, and ideally this tape must have 'memory tension' to compensate for pallets settling in transit (rigid strapping will work loose in transit) and 3M memory tape is preferred for this reason;
- *Bag Closure:* The bag should be sealed as tightly as possible to firmly compress the fruit to prevent vibration during transit, which can lead to rub marking. Twisting the bag is the method that holds the fruit the tightest but does lift the height of the fruit, and care should be taken to ensure it does not lead to increased compression damage;
- *Glue:* For 2-piece cartons every carton should have glue applied and the glue should ideally be 'tacky' and not too sticky, in order to hold cartons in place but also come apart easily without tearing or requiring excessive force. Only palletising or hot-melt glue should be used with an amount approximately the size of a 20 cent coin which will spread over a sufficiently wide area when a carton is place on top of it;
- *Carton Taping:* For 2-piece cartons lid taping is recommended, particularly for the top 3-4 carton layers on the pallet, since it provides additional stability (the top layers on the pallet are most prone to rub marking caused by vibrations); and

- *Pallet Locking Sheet*: Locking sheets often consist of an inner and outer part that can be separated. The inner of the locking sheet is beneficial to use halfway up the pallet to lock the columns together and the outer part of the locking sheet can be used on the top of the pallet. Often empty cartons are delivered with a locking sheet that can be re-used for this purpose to save cost. 1-piece cartons need at least two locking pads included within the pallet whilst 2-piece cartons need to be column stacked for at least the bottom five layers before cross stacking to maximise load bearing capacity of the carton.

It is hard to determine if the above recommendations are more or less than what the average grower is currently doing, and ideally a cost-benefit analysis should be used. The cost-benefit analysis is a key tool to help assess the merits of different recommendations, and will assist HAL and the Banana IAC to make an informed decision in regard to the potential benefit.

Ideally a small number of recommendations should be assessed where all the cost and benefit variables are monetised. However, given the significant variation between grower practices it is difficult, and perhaps also an over-simplification, to assume a 'typical' or 'average' amount, type and method of packing used by growers without actually assessing and measuring a representative sample, which is beyond the scope of this project. Similarly, it is hard to quantify and monetise the quality improvement without extensive trials at significant cost. Rather, it is better to fully cost the above recommendation, which is considered an appropriate amount, type and method of packing that growers *should* ideally use as a minimum, based upon materials and labour. This will then allow growers to compare their activities individually against the proposed recommendation, and assess what changes are appropriate to make to meet their specific business needs.

Table 14 details the costs associated with implementing the recommendation above, including all materials and labour, with labour costed at \$25 per hour (\$0.007 per second) including superannuation and payroll costs (grower reported paying labour rates ranging from \$23 to \$27 per hour and therefore an average of \$25 was assumed). Excluding the carton cost, the best-practice costing for a 2-piece carton is between \$27.85 and \$31.62 per pallet, and for a 1-piece carton \$23.96 to \$27.74 per pallet; therefore it is \$3.89 cheaper per pallet to pack a 1-piece carton. Please note all figures are exclusive of GST.

Item	Cost Assumption	Lower limit		Upper Limit	
		Cost Per Pallet (66 cartons/ pallet)	Cost Per Carton (13kg/ carton)	Cost Per Pallet (66 cartons/ pallet)	Cost Per Carton (13kg/ carton)
Bag (Slitted)	\$0.15 - \$0.18 each @ 3 sec to place in carton	\$ 11.29	\$ 0.17	\$ 13.27	\$ 0.20
Paper Liner	\$32 per 20kg pack (1800 sheets) = \$0.0178 @ 3 sec to place in carton	\$ 2.56	\$ 0.04	\$ 2.56	\$ 0.04
Slip Sheet	Varying range of thickness used; most common for 6-per-layer is 50µm @ \$50/1000 roll and 75µm @ \$60/800 roll, @ 3 sec to place in carton	\$ 4.69	\$ 0.07	\$ 6.34	\$ 0.10
Stretch Tape	Roll @ \$79 per 500m, with 45 pallets per roll on automated machine, @ 10 sec to place pallet on machine and start wrapping process	\$ 1.76	\$ 0.03	\$ 1.76	\$ 0.03
Bag Closure	Twisting and sealing bags (with x1 10cm tape @ \$20 per 1000m), on top 3 layers of pallet (18 cartons) @ \$0.002 for tape and 15 sec labour per carton	\$ 1.93	\$ 0.03	\$ 2.07	\$ 0.03
Total		\$ 22.22	\$ 0.34	\$ 25.99	\$ 0.39

PLUS EITHER					
Carton (2-piece)	Add cost of carton				
Glueing (all cartons on pallet)	\$125 per 20 litre palletising glue (with c. 9,000 cartons per 20 litres) @ 2 sec per carton	\$ 1.84	\$ 0.03	\$ 1.84	\$ 0.03
Taping Carton Lid to Base	x2 30cm of tape @ \$20 per 1000m to seal lid to base for top 3 layers of pallet (18 cartons) and 10 sec labour	\$ 1.48	\$ 0.02	\$ 1.48	\$ 0.02
Placing Lid on	Placing lid on carton @ 5 sec per carton	\$ 2.31	\$ 0.04	\$ 2.31	\$ 0.04
Sub-Total (2-piece)		\$ 5.63	\$ 0.09	\$ 5.63	\$ 0.09
TOTAL (2-piece)		\$ 27.85	\$ 0.42	\$ 31.62	\$ 0.48

OR					
Carton (1-piece)	Add cost of carton				
Pallet Locking Sheet	Cost for 1 locking sheet per pallet @ \$1.43 each, with inner to be placed on row 7 or 8 over internal corners and side lugs, and outer to be placed over pallet top; 45 sec labour to separate and place on pallet	\$ 1.75	\$ 0.03	\$ 1.75	\$ 0.03
Sub-Total (1-piece)		\$ 1.75	\$ 0.03	\$ 1.75	\$ 0.03
TOTAL (1-piece)		\$ 23.96	\$ 0.36	\$ 27.74	\$ 0.42

Assumptions:

Average buy prices have been assumed and slightly lower prices could be achieved if buying in larger volumes
 Labour costs \$0.007/second, based on \$25/hr average labour cost including superannuation and payroll costs
 Excluding CAPEX for automatic stretch tape machine

Table 14: Estimated packing cost for optimum packing and packaging (including all labour and materials, excluding GST)

Minimum Carton Specification

The carton is clearly the single largest cost and highly technical in terms of construction and composition. It is difficult to accurately assess the merits or failures of different cartons based upon technical analysis, and instead supply chain stakeholders (and particularly retailers) were questioned to ascertain which of the cartons currently available in the market place they felt performed most favourably in terms of quality and least damaged fruit. In regard to the 2-piece, the Mackay's carton was most favoured for its performance, whilst for the 1-piece all were favoured relatively equally (probably a reflection of the fact that there are less 1-piece cartons available and that the growers that have transitioned to a 1-piece have conducted adequate research to ensure they have a carton that is fit for purpose).

It was also apparent that there are a significant number of 2-piece cartons that are sub-standard and not adequately protecting fruit. In regard to the ability of the carton and fruit to share the load bearing, the view was that premium cartons split the carton load from above as 90% carton and 10% fruit, whilst for budget cartons the split was 70% carton and 30% fruit, hence the increased likelihood of compression damaged fruit with the later.

Growers are understandably cost conscious, and many are far removed from the end market and do not fully appreciate the impact that cheaper cartons can cause in terms of higher waste levels for their customers. Herein lies the opportunity for the banana industry as a whole to improve upon this situation.

Based on the qualitative feedback from stakeholders, carton specifications have been drafted for both a 1-piece and 2-piece carton. These specifications have been developed in conjunction with packaging companies and findings identified by the project team, and the recommendation is that industry should promote and educate growers in regard to the need to adhere to a minimum carton specification. It is important to stress that these specifications should be considered a good starting point but should be further validated and tested by other stakeholders within the supply chain before issuing to growers as a definitive recommendation.

Item	2-Piece		1-Piece		Comments
	Lower Limit	Uper Limit	Lower Limit	Uper Limit	
Pack Depth (internal height)	158mm (minimum)	165mm (ideal)	175mm		
ISO Pack Compression	>10,000N		>12,000N		
ISO Stack Compression	n/a		>10,000N		With positive location features to prevent premature telescope failure (trays falling into each other)
Base Sag	<20mm		<20mm		Excessive sag escalates telescope failure of trays due to base deformation
External Material Water Absorptiveness (AS1301 Cobb Value)	<150gsm/30mins		<150gsm/30mins		
Moisture Resistance Treatment	Some use of treated papers to protect the strength of the board from moisture uptake and damage		Greater use of treated papers to protect the strength of the board from moisture uptake and damage		
External Material Burst Strength (AS1301 Burst Value)	>500kPa		>500kPa		
Ventilation	8%	10%	8%	10%	Featuring standard mid panel as well as top flow ventilation to allow warm air to rise and escape, and vertical vents in base also assist with removing hot spots within pack
Lid Tightness	As tight as possible without excessively compromising ability to place the lid over the base		n/a		
Interlocking Lugs	n/a		Lugs should be tapered to allow mechanical picking in DCs		

Table 15: Specifications for 2-Piece and 1-Piece cartons

Essentially the carton must to take into account the need for the pallet stack height and weight to fit within transport regulations and transit constraints, and it ultimately falls to the grower to ensure ‘chain of responsibility’. Any carton must take into account ventilation; due to respiration and ripening, cartons need dual ‘top flow’ and vertical ventilation patterns in order to maximise forced air ventilation. This is critical for quality post-ripening and to enable appropriate back-of-store temperature management.

Indicative Carton Costs

Since the cost of the carton is largely dictated upon volume purchased and existing business relationships with packaging manufacturers, the cost of cartons are highly variable. In addition, it is difficult to obtain accurate data given the commercial sensitivities but best estimates have been

provided for the 2-piece carton in Table 16; a costing has only been provided for the 2-piece since this is the predominant carton in use. The weighted industry average carton cost is estimated to be around \$2.35 per carton for a 2-piece, with a premium of \$0.20-0.30 for a 1-piece carton, albeit it is likely this premium would reduce significantly due to manufacturing scale benefits if demand increased.

Farm Size	Lower limit (cost per carton)	Upper Limit (cost per carton)	
50-100 acre farms	\$ 2.36	\$ 2.42	
100-250 acre farms	\$ 2.30	\$ 2.32	
250+ acre farms	\$ 2.32	\$ 2.25	Justifies full truck loads and the potential for machine erecting on site
Industry Average	\$ 2.35		

Table 16: Indicative 2-piece carton costs

Communication To Growers

The recommendation for Stage 1 is for the packing and packaging information above to be compiled into a format that can be easily and simply communicated to growers, in both hard and soft copy form. Growers will then be able to compare their activities with those recommended and decide upon the changes that they wish to make. In order to facilitate uptake and adoption by the supply chain, a 'push-pull' strategy could be used, whereby growers are engaged to 'push' the benefits of the minimum specifications and retailers are engaged to explain the benefits to their grower-base i.e. 'pulling'. Targeting both ends of the supply chain will help drive the required change in processes and behaviours in the shortest period of time.

Consideration should also be given to additional means of communication to the different parts of the supply chain to maximise adoption, including:

- Presentations and information sessions at regional grower meetings;
- Extension of communication activity; for example extending the current activity being conducted by Naomi King (QLD DAFF);
- Banana Newsletter; and
- Banana Congress 2016 (albeit a long time away).

Whilst many businesses have developed relationships that extend along the length of the supply chain, it is important to ensure a wide communication base with as many touch-points as possible to maximise the likelihood of adoption and positive action. Furthermore, given the influence of the major retailers, it would be well worthwhile meeting with each individually to explain the benefits and the need for their support, and also the support that industry could provide to them in return.

Ideally the communication strategy should be led and controlled by the ABGC or a party that is unbiased, as there is the risk that other commercial entities with a vested interest will attempt to influence growers which could potentially jeopardise the process.

Stage 2: Optimum Best-Practice Guidelines

Assessment of the current supply chain from growers through to retailers has identified significant opportunities to improve current practices, and Stage 2 should build upon the minimum

specifications as detailed in Stage 1. The focus of Stage 2 is to encourage industry to adopt *optimum* best-practice guidelines, in order to raise the quality of the total industry.

This report has conducted and collated qualitative analysis of the key variables that can affect carton performance and thus fruit quality, as well as minimum carton specifications. The recommendation is to develop optimum (rather than minimum) guidelines for each of the main packing configurations, namely:

- 13kg 2-piece carton;
- 15kg 2-piece carton;
- 13kg 1-piece carton;
- 15kg 1-piece carton;
- 13kg RPC; and
- 15kg RPC.

The guidelines for each pack configuration should extend along the full length of the supply chain and include growers, packers, hauliers, wholesalers, ripeners, distribution centres and retail stores (both majors and independents). This is an immediate solution to address some of the causes of damaged fruit and variable quality that is received at store level, and is a simple and cost-effective means to instigate change and improve the status quo.

Guidelines could be developed quickly and cheaply by building upon the findings of this report and seek input from key industry experts (many of whom have been consulted within this project). The recommendation is to *not* conduct detailed scientific analysis unless deemed absolutely necessary, since majority of the answers are already known; following the Pareto Principle that 80% of the improvement benefits will be made from the top 20% of issues identified.

Best-practice guidelines could simply consist of a double-sided A4 sheet with a mix of text and pictures to describe what activities should or should not be completed. This could be easily circulated both electronically and in hard copy form. The communication plan could follow a similar approach to that articulated in Stage 1.

Stage 3: Step-Change Packing Processes And Packaging

A minimum carton specification and optimum best-practice guidelines will go some of the way to improving carton performance and fruit quality, however, there is also a need for a more significant step-change to truly move the quality position of the banana industry forwards.

This stage is broken down into two parts, the first that considers cartons and the second that examines RPC.

Improving The Current Carton

There are stark contrasts between Australia and the UK and USA markets, and certain processes and packaging used in these markets should be examined more closely and tested in the Australian market. The fact that these overseas markets, with equally as challenging supply chains, experience waste at less than 2% of sales verses Australia where waste is generally between 5-8%, strongly suggests that a large opportunity exists.

As detailed previously under 'Key Differences Between the UK and Australian Market', there is significantly more packaging used for protecting fruit imported in cartons into the UK market

compared to Australia, including plastic liners and paper slipsheets between fruit layers (in loose and pre-packs), many plastic straps (almost one strap per carton layer) and strapping the top two carton layers vertically to create downward force. However, perhaps most significantly is the actual carton itself, both in terms of construction and materials.

Significant learning could be gained from analysing and better understanding the UK cartons, in regard to its specification and also how it is handled within the supply chain. Whilst the carton could be reverse engineered to identify its constituent parts, a better route would be to collaborate with international suppliers (such as Fyffes) and share intellectual property. Australia will not be viewed as a competitor to the UK and therefore UK businesses are likely to be comfortable with engaging.

There are also other differences in the use of secondary packaging that may be worth investigating, specifically the use of corner posts, additional pallet strapping, use of liners with slipsheets and vertical strapping of top two to three carton layers. Calculating the cost in labour and materials, and the benefit in terms of quality and waste avoided, will enable each of these items to be assessed.

For example, indicative costs for the use of corner posts are estimated to be approximately \$5.82 per pallet (see below), and whilst the benefit would have to be measured by running trials it is likely that the benefit value would well exceed the cost:

Item	Cost Assumption	Cost Per Pallet (66 cartons/ pallet)	Cost Per Carton (13kg/ carton)
Corner Posts	\$1.10 per corner post (\$4.40 per pallet), 15mm strapping tape at \$0.025/m for 1 strap and 1 buckle @\$0.035 each, and 3 min labour; pallet will be stretch taped so only 1 strap is necessary	\$ 5.82	\$ 0.088

Table 17: indicative cost of using corner posts

Pallet Inverting at Source (Packing Fruit Crown Up)

Fruit arriving at stores in Australia are all packed crown down and required store staff to turn the carton over before removing the carton base to expose the fruit crown up. Fruit also travels through the supply chain crown down. For fruit supplied to the USA and UK, complete pallets are often inverted at source and fruit travels and arrives at stores crown up, saving the need (and reliance) on store staff to turn over cartons before merchandising. The one-touch 2-piece 17kg carton allows fruit to be picked up by the neck and avoids the need for any other part of the banana to be handled, and thus reduces potential handling damage by store staff.

The current system in Australia is reliant on compliance within stores to follow correct operating procedures, and similar to air-stacking, it is likely that compliance is variable and fruit is often decanted from the carton crown down. Since most Australian retailers manually decant from cartons and place fruit on the retail shelf, whilst there may be limited attraction to a one-touch carton system, there is a labour saving in merchandising time and quality improvement opportunity for retailers if fruit is packed crown up.

It is recommended that trials are conducted in transporting fruit crown up, and if this demonstrates there is no quality impact then the use of pallet inverters should be investigated for the Australian market. Clearly this system would only be appropriate for 2-piece cartons, and not 1-piece or RPCs.

Retailer Engagement

The major retailers justifiably have the loudest voice across the supply chain in regard to the ideal carton solution, since they provide access to the end consumer. All retailers, apart from the top-end independent retailers that are able to cherry-pick small volumes from the very best growers, assert that they fail to receive consistently good quality fruit and largely attribute this to failings in the cartons currently being used. However, the major retailers are highly receptive to change and eager to partner with industry to identify the optimum carton solution(s).

Coles, Woolworths, IGA and ALDI are receptive to developing and running trials on an improved 2-piece and/or 1-piece cartons, and will consider transitioning to a 15kg carton as long as a compelling argument can be developed to demonstrate the cost-benefit advantages and that OH&S will not be compromised. Industry should assist the retailers in building business cases to address the individual needs of each retailer, and help address the change management hurdles that they will need to be overcome internally. Developing ongoing collaborative partnerships with the retailers will be highly beneficial for the whole industry and facilitate rapid change with minimum cost.

Cost Efficiencies

As the ABGC develops a route forward for the banana industry it is likely that there will be natural consolidation in the types of carton and secondary packaging used. Once retailers have identified and confirmed their preferred packing specification(s) there will be rapid change through the grower base and most likely a harmonization in the types of packaging used.

This presents industry with an opportunity to reduce growers' costs through the efficiencies that will be generated. If growers agree to use the same carton specification, albeit with bespoke branding, it will create manufacturing efficiencies for packaging companies and should enable the purchase price for growers to be reduced. Similarly, if growers can combine their volumes in order to enable larger production runs then again prices should be reduced; the lychee industry, supported by this project team, managed to agree a reduced packaging price for growers when transitioning to a new industry carton by negotiating the combined grower volumes with a single packaging manufacturer.

In addition, industry should be cognisant of the structural changes that may occur within the packaging industry. For example, the extra cost for 1-piece cartons is currently \$0.20-\$0.30, and the reason for this could be a consequence of the dominance of 2-piece cartons and existing sunk cost in production infrastructure. Should more growers request 1-piece cartons it is likely that the cost of production will reduce and it is important that growers are aware of these market changes and in a position to share in these cost savings. For this to happen the ABGC will need to monitor the structural changes and provide guidance to growers.

Similarly, given the duopoly structure in Australia within the packaging industry, whilst there will always be a reliance on the existing packaging manufacturers for their logistical capabilities and reach into remote growing areas, it would be worth benchmarking carton costs against other international packaging companies. In addition, taking a more involved and directional approach in regard to innovation and new product development would also help industry take a stronger leadership position and influence key issues that are hugely important for the long-term success of the banana industry.

Developing a RPC Solution

Given the increasing environmental pressures around the excessive use of cardboard, continued support should be provided to further develop a RPC model that works for the banana industry and does not compromise quality, nor fragment the industry. Whilst current RPC designs may not be perfectly suited to bananas, the strategic intent of RPCs are sound, and it is more a case of either adapting current designs, developing new designs or replicating designs that have been used and proven in other markets.

The use of RPCs are likely to require packing and handling disciplines that are a step above those used for cartons, and even the 1-piece carton, since the risk of rub marking through vibration in transit is significant if fruit is not bagged firmly. However, similar to the 1-piece this can be managed with bagging and securing fruit (albeit a plastic crate will provide less give than a carton), and the RPC is probably more suitable for growers that are prepared to take the additional time, care and attention and adopt the required accompanying practices to ensure quality issues do not arise.

The majority of stakeholders within the supply chain believe that the types of RPCs available currently are not suitable for transporting bananas and risk causing damage and waste; for growers to feel confident, trials would need to be completed in order to modify or re-develop the crate itself. However, stakeholders were generally satisfied with the supply model itself.

The profitability of an RPC model often lies in the running and management of the RPC operation. Growers would only switch to an RPC model if the cost savings were attractive enough and all quality concerns were addressed, or if they were requested to do so by their retailer customer. The ideal situation would be for the RPC model to *not* be owned by an individual retailer since it would immediately fragment the industry, yet alternatively the complexity in aligning multiple retailers to jointly take on this role may prove challenging. The ABGC is a potential candidate, and whilst this would enable an industry wide carton solution to be delivered, it is not core to their business. Furthermore, the capital and operational expenditure is likely to be high and specific expertise would need to be secured, and it could prove a distraction to the other activities of the ABGC.

This then leaves an independent third party, ideally with experience in this area. Again endorsement would need to be sought from all the major retailers and the interests of all parties aligned, supported by an agreed governance structure. Whilst perfectly possible, this is likely to take time and be a complex alignment project but is probably the most suitable option. The most suitable candidate would be a packaging manufacturer or equivalent organisation, with established industry relationships and infrastructure.

In the first instance, the recommendations in Stage 1 and 2 should be progressed, with particular focus on the uptake of the 1-piece carton. Should the 1-piece increase in penetration it then sets a good precedence for the development of a RPC solution, in line with the parameters outlined above. Nevertheless, most of the major retailers have expressed interest in RPCs, to the extent that some are actually conducting trials currently. Given this appetite, it is important for the ABGC to stay abreast of developments in this area, to ensure they can contribute from an informed perspective and justify a seat at the table if any retailer should implement a RPC strategy in the near term. Therefore a recommendation is for the ABGC to continue to assess all RPC developments both domestically and internationally. For example, it would be well worthwhile developing a relationship with Asda and Fyffes in the UK, in order to better understand the RPC and supply model they are using to import fruit from the tropics (as detailed in this project report).

Any of the above recommendations can be scoped and costed more accurately based on the preference and guidance of the Banana IAC.

Knowledge Gaps

During the course of this project a number of knowledge gaps have been identified that should be considered for further investigation. Whilst some of the points listed may have been considered in varying degrees within other reports, engagement with the supply chain demonstrated that these points were not clearly understood or opinion was divided. The knowledge gaps include:

- *Glue Application:*
 - Identify and specify the minimum number of carton layers that require glue application;
 - Specify the optimum type and amount of adhesive to be used and optimum method of application;
 - Confirm the benefit if a single spot application versus several application areas across the carton surface
- *Corner Posts:* Assess if there is a need for corner posts for long-distance freights and/or at certain times of the year and/or in combination with certain carton types (such as column stacked 2-piece cartons with no cross-stacking);
- *Pallet Strapping Material:* Benchmark the performance and cost-benefit of different pallet strapping materials;
- *Strapping Configuration:* Investigate other strapping alternatives that can extend over the top of the pallet to provide downward force. Work with DCs to enable them to handle memory tape more effectively;
- *Strapping Application Method:* Quantify the cost-benefit of hand versus machine applied and the benefit that machine strapping provides in terms of positioning around the pallet and tensioning
- *Pallet Sheets:* Pallet sheets are providing additional support, but for the cost involved, other pallet supporting alternatives (such as corner posts) may provide a greater benefit for only slightly more cost. It would be worthwhile benchmarking the performance and cost-benefit of pallet sheets versus other forms of supporting packaging;
- *Pallet Caps:* Assess the incidence of chill damage on the top carton layers and any benefit that a pallet cap provides, including pallet stability;
- *Carton Taping:* Complete a cost-benefit to assess the reduction in rub marking due to lid taping;
- *Bag and Liner Material:* Benchmark the performance and cost-benefit of different bag plastics;
- *Fruit Size:* The retailers are willing to engage in further dialogue around fruit size. There is a need to compile consumer driven evidence around fruit size preference, supported by the potential improvement to fruit quality and supply chain efficiency that could be achieved through packing mixed-size cartons. The current 'International Pack', consisting of smaller fruit on the bottom layer and larger fruit on the top layer, could be used as a learning source;
- *Bag Closure:* Investigate the best method to seal bags as tightly as possible to provide stability whilst not over-compressing fruit and causing other issues that adversely affect fruit quality. Assess feasibility of using stretchable bags with 'memory' (as per 3M stretch tape);
- *Pallet Stacking Configuration:* Assess the cost-benefit of cross-stacking in terms of pallet stability and ripening consistency;

- *Board Material (virgin or craft versus recycled card)*: Define optimum specification and tolerances for recycled versus craft content;
- *Board Grade Thickness*: Identify the optimum board thickness in relation to cost-benefit, and agree a minimum specification
- *Lid Type ('pop-up' lid versus glued/ taped)*: Understand the strength properties of taped versus glued lids;
- *Lid Tightness*: Agree a minimum specification for lid tightness;
- *Carton Height*: Identify the optimum height carton in conjunction with other variables;
- *Carton Coatings*: Understand moisture absorbency in relation to carton strength of different board materials during the wet and dry seasons, and also the quality, appropriateness and cost-benefit implications of using laminated card;
- *Carton Holding Times*: Agree a minimum specification for holding empty cartons, including type of storage area and season (wet or dry);
- *Truck Suspension*: Appropriate suspension should be used for on-farm vehicles that are transporting banana, albeit this concerns more robust green fruit; little comment has been made in this regard;
- *Temperature Receival at DCs*: Advise DC of the appropriate holding temperature for bananas (considered to be 14-16 degrees);
- *Pallet Tape in DCs*: Introduce protocols for handling pallet tape within DCs to ensure fork lifts are not hindered by tape wrapping around wheels;
- *Carton Stacking*: Engage with retailers to help them accommodate 1-piece cartons; and
- *Fruit Holding in Stores*: Engage with retailers to communicate the cost-benefit of installing warm-rooms in all stores; influence store renewal teams to include warm-rooms as a standard and encourage retailers to provide stores with temperature sensitive tray-end labels (or equivalent).

Finally, the outcomes of this project are almost entirely focused upon improving the physical condition of the fruit in regard to visual appeal. Whilst this will encourage consumers to purchase bananas, consideration should be given to how the fruit tastes and the consistency of flavour in order to drive repeat purchase. UK packers were continually testing fruit for taste (every single out-loading delivery was assessed and documented), and this information is continually being relayed to the growing sources in the tropics.

Counter-Factual Considerations

It is important to also consider the counter factual impact should a new industry carton *not* be introduced. Although the impetus for a standardised industry carton has largely been driven by the major retailers, as mentioned previously, this is largely a function of the frustration caused through incurring excessive waste and millions of dollars of financial loss on the single largest product line within the supermarket.

It has been assumed that a standardised industry carton will reduce waste and improve financial return but this is not necessarily true, and there is a danger of putting the cart before the horse. Rather if industry can demonstrate a proactive approach to improving quality as a whole, perhaps using the recommendations within this document, then as practices are improved quality will also

improve. Furthermore, as quality improvements filter through the industry it will mostly likely lead to gradual alignment and harmonisation regarding which are the optimum cartons and RPCs, and how best they are packed and handled.

CONCLUSION

There are likely to be risks in any project that is attempting to align the interest of many stakeholders, and there are challenges around private versus public work in that commercial interests and/or competitive advantage can result in only incomplete views being provided. The banana carton has been a contentious subject for a significant period of time, and there is always the risk that history and past events make it difficult for individuals to see beyond this. Nevertheless the project team has strived to allay any concerns and map a route forwards for the banana industry.

Throughout this report a commercially pragmatic approach has been adopted. As agreed with the PRG, in order to recommend the most appropriate solutions, it was necessary to consider more than just the attributes of the carton itself, since there were many interdependencies that can affect the performance of any given carton and subsequently the resultant fruit quality. Similarly, there are a large number of variables across the supply chain that influence carton performance, some which can be approximately monetised but others which would require much more detailed analysis in order to attach an accurate value. Rather, it is perhaps more appropriate to broadly acknowledge that a benefit exists, and the estimated scale of the benefit, but not attempt to spend funds conducting complex and costly analysis to prove what is largely already known.

All businesses within the supply chain will have specific preferences in regard to the pack weight (13kg or 15kg), carton form (2-piece carton or 1-piece carton) and the supply chain model (carton or RPC), in their respective combinations. In reality, the greatest influence on deciding which combination is preferred will most likely arise from retailers, and then secondly growers, and in all likelihood the supply chain partners will adapt accordingly. Nonetheless, the ABGC is well placed to assist and guide all members of the banana supply chain, through providing the necessary information to optimise the packing and transportation of fruit in the range of packing configurations available, and ensure retail stores receive the best quality fruit possible. Notwithstanding this, it is important that all members of the banana supply chain take on the responsibility for implementing actions based upon this information.

Industry should avoid trying to find the single 'perfect' solution in which to invest, rather than spreading the risk across a number of solutions. In reality every solution is partially right and partially wrong, and innovation often arises at the intersection where different ideas collide. The success of any solution will rely upon bringing together businesses at different parts of the supply chain to test ideas and learn from the limitations of any single solution and figure out how to overcome them. This will require trust and patience. Whilst the 'fail fast' approach is favoured by many industries, there is a risk in trying to move too quickly without properly considering the details associated with execution, and this is particularly relevant to the handling of RPCs.

Furthermore, often even the most successful organisations fail to innovate because they are built to optimize their current business model. Therefore, consideration should be given to assessing the opportunity to create different business models, where ideas can be tried and most can be allowed to fail, and fail safely.

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