Horticulture Innovation Australia

Final Report

Improved postharvest management of chestnuts - Phase 2

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Summary

This project examined temperatures through a number of supply chains, from farm to wholesale and retail, as well as during shipping to China for processing. A survey was also conducted of chestnut retail displays, price and quality.

Chestnuts which warmed during packing could take hours or days to cool below 3°C, particularly if they were packed inside a polypropylene bag at the centre of a pallet.

Warming also commonly occurred during transport; chestnut temperatures increased during transport in five of the six domestic supply chains examined. Temperatures were over 5°C during transport to Brisbane, and averaged 7.5-8.5°C over four days transport to Perth.

Chestnut temperatures were held close to zero in the long term cool room at the Markets wholesaler. However, product that was displayed during market hours then returned to the cool room each day showed wide temperature fluctuations.

Temperature control was very effective inside a shipping container during transport to China. While temperature varied between different parts of the container, none of the monitored fruit fell below -1°C and temperatures generally varied by only 1°C.

Quality and price of chestnuts was consistent among supermarkets but variable among independent grocers. While supermarket displays were generally refrigerated, they tended to be small with little visual impact. In contrast, some of the independent stores were using chestnuts as a prominent seasonal feature. One store in particular had an excellent display at the front of the store and were offering hot roasted chestnuts as well as easy peel and non easy peel varieties.

It is recommended that the chestnut industry investigate opportunities for retail ready packaging for chestnuts. This would include information on variety (easy peel or not), preparation and cooking, and provide a value added proposition for retailers.

Keywords

Chestnut, Supply chain, Temperature, Wholesale, Retail, Export, Shipping, Transport, Packaging, Display

Introduction

Trials conducted during 2014 examined the effects of different postharvest practices on chestnut quality. These included temperature monitoring during cooling of chestnuts in bins. Major differences in cooling rates were found. Simply placing a plastic or wooden bin in the cool room resulted in very slow rates of cooling, although the process could be improved using pipes to increase ventilation through the stack. Forced air cooling was the fastest method tested, reducing fruit temperatures to close to zero in 2-3 hours. The trials also demonstrated that freezing damage increased once temperature dropped below -2°C, but that temperatures between 0 - 5°C result in acceptable storage life.

These trials aimed to help growers optimise their harvesting and storage practices. However, this is only the start of the supply chain. Packing, transport, management at wholesale markets and finally retail are also likely to have significant impacts on the quality of chestnuts available to consumers.

This project has examined temperatures in domestic and export supply chains for chestnuts. In addition, a short survey has been conducted of retail displays, evaluating quality, price and nature of the display. It is hoped that the results will help industry improve practices within supply chains as well as find more effective ways to market chestnuts to consumers.

Methodology

Supply chain monitoring - domestic

A total of 8 domestic supply chains were monitored, from five different farms in the Yarra Valley, the Victorian Alpine area around Bright and Batlow NSW. Temperature data loggers were placed inside chestnuts packed into bags or cartons transported to markets in Sydney, Brisbane, Melbourne, Perth and Adelaide. Two data-loggers were used for each shipment, with the marked cartons or bags placed in different locations within each consignment.

Three supply chains were chased through to retail, the remaining loggers were retrieved directly from wholesalers.

Supply chain monitoring - export

Temperature data loggers (i-buttons) were inserted into chestnuts which were packed into sacks and exported by sea freight to China for processing. Sacks containing the loggers were placed at 9 different locations within the shipping container, so as to monitor temperature at either end, top centre and middle of the load.

All but one data-logger was retrieved upon arrival at the processing facility in China and returned to Australia for downloading.

Retail survey of chestnut displays

A total of 39 retailers were visited to assess the type of display used for chestnuts as well as price and quality of chestnuts on offer. Most stores were in Sydney, with a few in Brisbane and Melbourne. Stores included 16 greengrocers, 14 Coles supermarkets and 9 Woolworths supermarkets.

Data was collected using an 'app' based on i-Auditor software. The assessor could record the size and attractiveness of the display, chestnut visual quality, price, presence of POS material and display temperature (measured using an infrared temperature gun). Displays were also photographed.

Full details on methodology are included in Appendice 1 of this report.

Outputs

An article was written for and been published by the Nutgrower Magazine. This is attached in Appendice 2.

Two articles have been written for 'Nuts and Burrs', the chestnut growers journal. The first has been published and the second is scheduled for the December edition. Drafts of these articles are included as Appendices 3 and 4.

The project results were presented at the Chestnuts Australia annual conference. This was held in the Yarra Valley in September 2015. The Powerpoint is included as Appendice 5 to this report.

Outcomes

Supply chain monitoring - domestic

Results from the supply chain studies demonstrated that chestnuts packed into sacks, which are then stacked at the centre of pallets, are extremely slow to cool during subsequent storage and transport.

The results also showed that high temperatures can be experienced during transport. Transport temperatures were 4-10°C during transport to Brisbane, and averaged 7.5 and 8.4°C during 5 days of transport to Perth. Chestnuts were kept fully chilled until delivery to market in only one of the monitored chains. There was also evidence that the cooling system inside trucks was turned off at times.

Significant temperature fluctuations were noted during display at wholesale, as products were moved in and out of cool rooms. Temperature fluctuations of 16 to 5°C occurred on a daily basis.

Supply chain monitoring - export

Temperatures recorded inside the packed and loaded chestnuts were very stable during shipment. Temperature inside each of the monitored bags varied by a maximum of 1°C and tended to decline slightly during shipment.

There was significant variation between points in the container, with recorded temperatures ranging from a minimum of -1°C to maximum 2°C. However, these temperatures are suitable for storing chestnuts and would not be expected to result in damage. Outturn quality of the chestnuts was generally good.

Retail survey of chestnut displays

Major differences were observed between independent greengrocers and the major retailers.

The major retailers proved to be a reliable source of 'good' to 'OK' quality chestnuts. Fruit were kept refrigerated and sold at a reasonable price. However, displays were generally small, with low visual impact. In many cases the consumer would have to search for chestnuts in order to find them within the fresh produce section, as the produce on offer was not clearly or prominently displayed.

Independent greengrocers were highly variable, with chestnut quality ranging from 'excellent' to 'poor', with all qualities in between. Some of their displays were large, elaborate, and showed considerable care and effort. They clearly aimed to attract the consumers' attention to a special, seasonal product. Several were selling chestnuts in 1kg net bags, ready for consumers to take away. Some of the fruit available was lower quality, but in most cases prices had been reduced to reflect this.

Only three of 39 surveyed stores had recipe cards or other product information available.

Full details on results are included in Appendice 1 of this report.

Evaluation and Discussion

Supply chain monitoring - domestic

Lack of cooling and self-heating are a significant issue for chestnuts packed in bags: respiration by the chestnuts increases temperature, which increases respiration, creating a positive feedback loop and escalating the problem.

Temperatures are not being well managed during transport. Product that spikes in temperature due to trans-shipping was generally slow to re-cool. Temperature fluctuations are likely to result in condensation, which could increase mould growth.

There is no easy answer to the issue of temperature changes during wholesale display and sale. Clearly product must be placed on display in order to be sold. Returning packed product to the cold room during the day is likely to result in better quality than leaving fruit at ambient daytime temperatures.

Minimizing stock on display and ensuring good stock rotation can reduce overall damage to any single consignment. Moreover, keeping chestnuts cold up until this point will help ensure they are still fresh and mould free during display at wholesale and retail.

Supply chain monitoring – export

In this case the shipping container functioned very well. Temperatures varied very little during shipment, and were appropriate for storing chestnuts. However, shipping containers vary in the effectiveness of their temperature control, calibration and strength of air delivery. Further monitoring is necessary to confirm that shipping containers are not damaging chestnuts through excessively high or low air temperatures.

Retail survey of chestnut displays

It is not known what proportion of chestnuts are sold through independent grocers compared to the major supermarkets. However, it appears that greengrocers may be more able to take advantage of a seasonal product than the major retailers, who tend to be locked into a standard pattern of displays and pricing.

Targeting independent greengrocers through offering opportunities to promote chestnuts, display ideas, and even chestnut roasters could significantly increase sales. It is noted that Fresh Produce Group has already started this process, providing chestnut roasters to a number of independent greengrocer customers in suitable areas of Sydney.

The recipe cards funded by the industry appear to often not be reaching consumers. The lack of information on whether chestnuts are 'easy peel' is a particular concern, as this will directly affect consumer experience (positive or frustrated!).

Recommendations

- If chestnuts warm during packing, care must be taken to thoroughly re-cool packed products. This may involve spreading bags out in the coldroom rather than palletizing, or increasing air circulation around and through the stack.
- Temperature dataloggers are increasingly cheap and easy to use. Single use loggers may be downloaded directly through the Internet without the need for postage back to source. By investing in a few dataloggers, growers can monitor temperatures in supply chains and ensure that their transport company is following agreed procedures. Temperatures should be monitored inside bags, and preferably inside fruit, rather than external air temperatures.
- Promotional opportunities are likely to be better with independent retailers than with major supermarkets. Encouraging retailers to offer hot roasted chestnuts to customers has the potential to greatly increase sales.
- It is strongly recommended that the industry investigate options for packaging chestnuts for retail sale. Some greengrocers already pack chestnuts in bags, so packaging is acceptable to consumers. Packaging allows provision of information on variety specific preparation and cooking directly to consumers. It could help enhance the visual impact of chestnuts in supermarket displays, increase the volume of individual sales and possibly help protect chestnuts from poor handling and display conditions.
- Packaging options should initially be tested with both retailers and consumers to ensure they maximize their 'value add' to chestnuts.

Scientific Refereed Publications

Not applicable

Intellectual Property/Commercialisation

No commercial IP generated

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This project would not have been possible without the generous assistance of chestnut farmers and their market agents.

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Tanya Edwards	Chestnuts Australia Inc.
David Philpott	Fresh Produce Group

Appendices

Appendice 1 Research Report

Appendice 2 Article for Nutgrowers Magazine

Appendice 3 Article for Nuts and Burrs, September 2015

Appendice 4 Article for Nuts and Burrs, December 2015

Appendice 5 Presentation to Chestnut Industry Annual Conference, September 2015

ahr applied horticultural research

Chestnut supply chains

CH14005

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Supply chain monitoring - domestic

Introduction

Trials during 2014 found large differences in cooling rates when different methods were used. Room cooling in bins was extremely slow, although the process could be improved by adding ventilation pipes to increase air circulation through the stack. In contrast, forced air cooling chilled harvested chestnuts within 2-3 hours.

The 2014 work also demonstrated that freezing damage could occur if chestnuts were stored at -2°C or less, and was a certainty if temperatures fell to -5°C. However, few obvious differences occurred if chestnuts were stored between 0 - 5°C, at least for shorter periods. This suggested that storing chestnuts at 0°C would maintain quality while using less electricity (and incurring less risk) than the current industry practice of storing at -3°C.

Implementing these practices on farm has the potential to improve storability of harvested chestnuts. However, it was not known what could occur once chestnuts left the farm gate.

As a smaller volume crop, chestnuts are usually transported with other fruit or vegetables. Truck temperatures may be adjusted to suit those other goods, which may be higher or lower than the ideal temperatures for chestnuts.

At the start of the 2015 season a shipment (or possibly several shipments) of chestnuts arrived at the Sydney wholesale markets with temperatures in excess of 30°C. This suggested that not only had the shipment been left unrefrigerated during transport, but that heat of respiration inside the tightly packed bags had further increased temperatures. Incomplete cooling before transport may have also contributed. Discussions with wholesalers indicated this was not an isolated event, with a similar issue also occurring in Perth.

Although the Sydney wholesaler re-stacked the bags on arrival to facilitate cooling, temperatures likely remained well above 5°C for several hours or possibly days. Even a relatively brief exposure to such high temperatures could increase mould growth, significantly reducing quality and shelf life.

This project was therefore developed to monitor a number of supply chains, examining temperatures of chestnuts from the time they left the farm until arrival at retail stores.

Method

Selection of supply chains

Chains were selected so as to monitor as wide a range of source and destination combinations as possible. A total of 8 domestic supply chains were monitored, with chestnuts transported from growing areas in Victoria and NSW to Sydney, Brisbane, Melbourne, Perth and Adelaide (Table 1). The data loggers were set up in five different farms, located in the Yarra Valley, the Victorian Alpine area around Bright and Batlow NSW (Figure 1).

Table 1 - Chestnut supply chains monitored during trials

Supply chain	Supply chain destination	Farm ID	Farm location	Chestnut cultivar	Date of setup
1	Sydney	A	Yarra Valley, Victoria	Purtons Pride	27/4/15
2	Sydney	D	Alpine Victoria	Red Spanish	29/4/15
3	Sydney	E	Alpine NSW	Purtons Pride	30/4/15
4	Brisbane	A	Yarra Valley, Victoria	Purtons Pride	27/4/15
5	Melbourne	A	Yarra Valley, Victoria	Purtons Pride	27/4/15
6	Perth	B	Alpine Victoria	Red Spanish	28/4/15
7	Adelaide	C	Alpine Victoria	April Gold	28/4/15
8	Adelaide	D	Alpine Victoria	Red Spanish	29/4/15

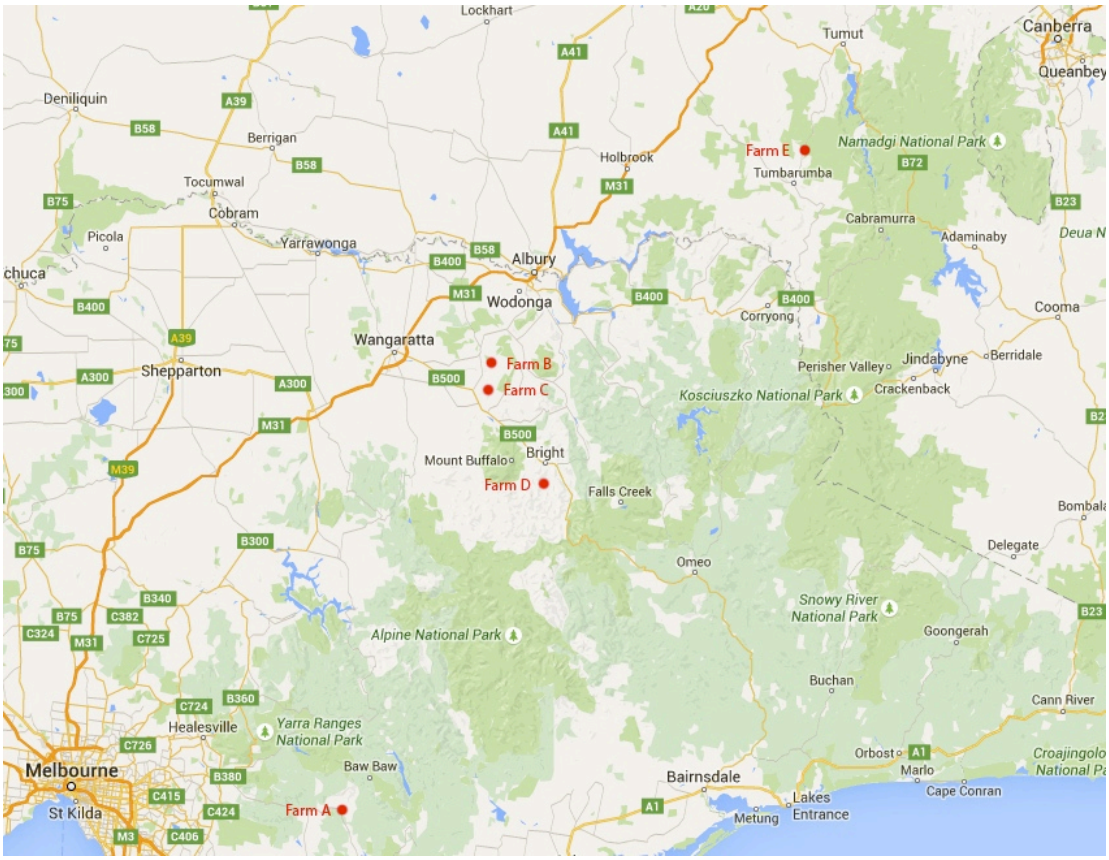


Figure 1 - Locations of farms used for domestic supply chain studies

Temperature recording

For each supply chain monitored, temperature data loggers were placed in two separate bags of chestnuts on location at the farm. Data loggers used were either i-buttons, which were inserted entirely into individual chestnuts, or LogTag recorders with probes that could be inserted and secured inside a chestnut. While the i-buttons have the advantage of being small enough to insert into a whole chestnut, they are accurate only to 0.5°C, whereas the LogTags are accurate to approximately 0.1-0.2°C. Air temperatures inside the sacks were also monitored in some cases.

All chestnuts with loggers inserted were placed inside mesh bags and marked with flagging tape so they would be easily found and removed. The bags were sewn shut, as normal commercial practice, then clearly marked with stickers, signs and fluorescent paint to ensure that all loggers would be removed before sale. The two bags per shipment were placed with one on the edge of the pallet and the other close to the centre of the pallet.

Figure 2 - Setup of temperature data loggers for chestnut supply chains using LogTags with probes (top) or i-buttons (bottom)

Retrieval of loggers

All wholesalers were notified in advance that the loggers would be included in the shipment and advised on removal. Instructions on removal and self-addressed Express post satchels were included in the bags with the loggers.

Temperature records included the cold rooms used by wholesalers in Brisbane (1) and Sydney (2).

Three supply chains within Sydney were traced from the wholesaler through to retail stores. These were to one small supermarket (FoodWorks) and two greengrocer shops. Unfortunately it was not possible to trace product through to the larger retailers. This was partly because the traceability systems used at the Distribution Centres do not allow tracking of an individual carton, but also because of concerns relating to supply of product containing a foreign object (ie a data logger), no matter how well marked the bag.

Results

Despite repeated requests, none of the loggers sent to Adelaide could be retrieved. Data was also lost due to malfunction of one logger, from which data could not be extracted. The results from the other supply chains are presented below.

Supply chain 1 – Farm A to Sydney

A large difference was observed between the temperature of chestnuts inside a sack at the centre of the pallet compared to the temperature of chestnuts inside a bag at the outer edge of the pallet.

The pre-cooled chestnuts warmed up to approximately 8°C during packing. Chestnuts inside a bag at the edge of the pallet cooled back down to 2°C within a few hours. However, chestnuts in the bag placed at the centre of the pallet took nearly 5 days to come back down to 2°C (Figure 3).

The chestnuts stayed at the farm for another 6 days before transport. Transport occurred in two stages, the fruit being taken from the farm to Melbourne, and then loaded onto a truck for Sydney. Although the outer fruit warmed to around 14°C during the first stage of transport, they cooled down in the truck during travel to Sydney. The truck appears to have arrived late in the evening and turned off the cooling system. However it was not unloaded until several hours later. During this time the outer chestnuts again warmed, reaching close to 16°C. However, it is clear that the chestnuts at the centre of the pallet stayed cold throughout, until the logger was removed from the sack at about 8:30am on day 7.

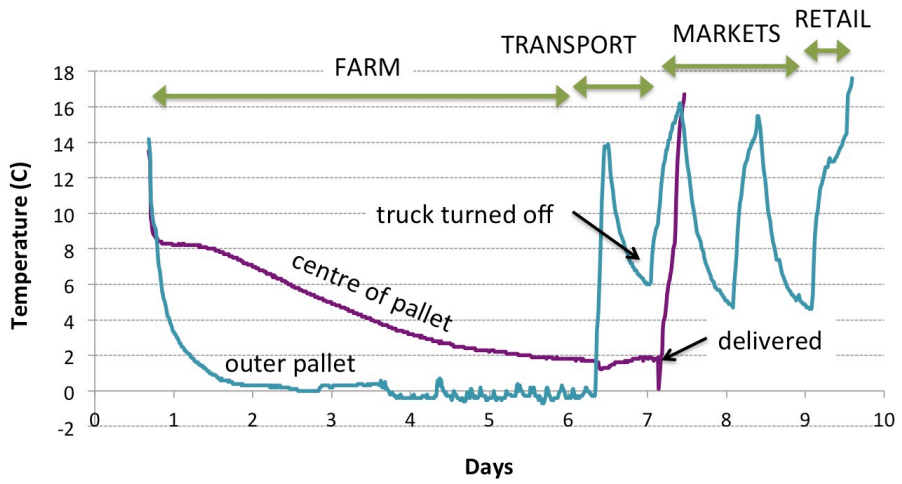


Figure 3 - Temperatures recorded in supply chain 1

The remaining logger was left inside the sack until it was sold on day 9. The sack appears to have been displayed on the market floor until around 9:30am each day, after which it was returned to the coolroom. This resulted in daily temperature fluctuations between 5-16°C.

Transport to the retailer was under ambient conditions, but of short duration.

Supply chain 2 – Farm D to Sydney

Chestnuts at Farm D were packed into cartons 2 days after temperature monitoring began. The cartons remained at 6-7°C until they were dispatched the following morning. Temperatures rose to 15°C during transport to Sydney (Figure 4).

After arrival at the markets, the temperature of chestnuts inside one carton continued to increase, reaching over 21°C before being finally placed inside a coolroom just after midnight on day 5. This carton was moved in and out of the small onsite cool store several times before it was sold to a retailer on day 9. Again, movement in and out of the coolroom caused significant fluctuations in temperature.

In contrast, chestnuts inside a carton placed inside the (long term) coolroom at the agents' main facility quickly cooled to around 2°C. They remained very stable at this temperature for the remainder of the trial. Air temperature was also measured inside the long term storage room. Air fluctuated between 1.2-1.5°C, demonstrating excellent temperature management and resulting in RH averaging approximately 90%.

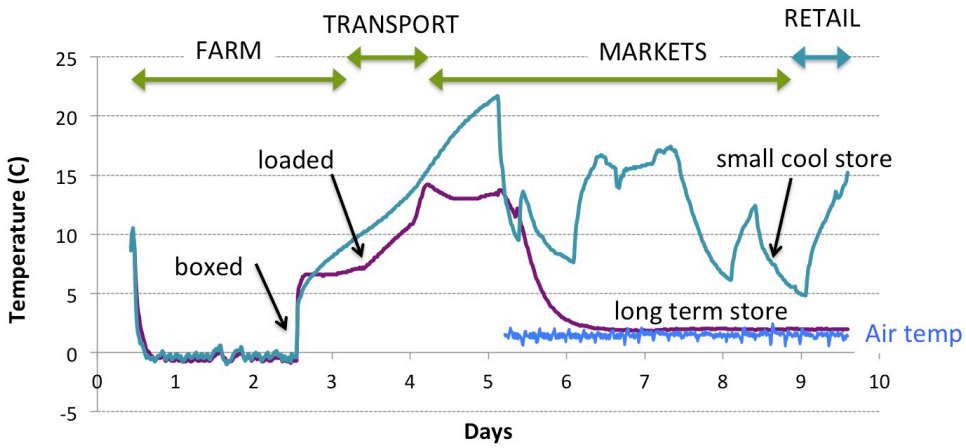


Figure 4 - Temperatures recorded in supply chain 2

Supply chain 3 – Farm E to Sydney

As found in supply chain 1, there was a large difference between chestnuts inside a sack at the centre of the pallet compared those inside a sack at the outer edge. Chestnuts warmed to around 10°C during packing, and were left at ambient conditions overnight before delivery to the depot the following morning. Once at the depot it took two days for the central chestnuts to cool to 3°C, although those on the outer edge cooled in only a few hours (Figure 5).

In this case, temperatures did not increase during loading and transporting, but remained low until reaching the Sydney Markets. There, as observed for the other consignments,

chestnuts warmed during display on the market floor, but cooled once returned to the onsite coolroom at around 9:30am each day. This consignment was sold after one day at the markets, and again transported the short distance to the retail store under ambient conditions.

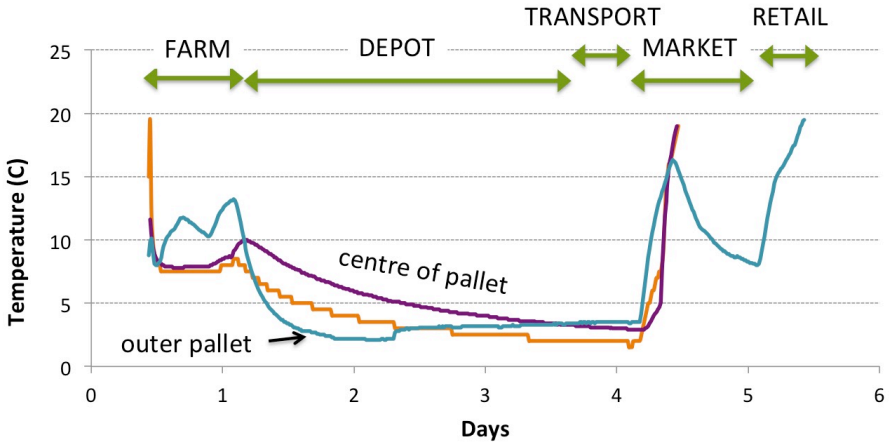


Figure 5 - Temperatures recorded in supply chain 3

Supply chain 4 – Farm A to Brisbane

As observed for supply chain 1, transport was a two stage process, with large fluctuations in temperature occurring for chestnuts in sacks at the outer edge of the pallet, but almost no fluctuations when fruit were at the centre of the consignment (Figure 6). Chestnuts were transported to the Melbourne depot on day 6, then transferred to a truck for transport to Brisbane Markets, arriving two days later.

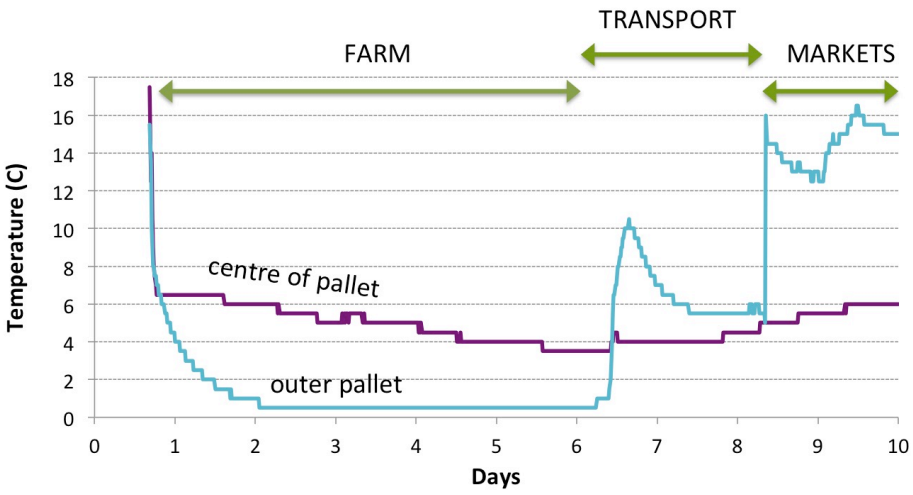


Figure 6 - Temperatures recorded in supply chain 4

It seems likely the logger in the outer pallet was detected on arrival, removed and left in the office until dispatch.

Chestnuts inside the sack at the centre of the pallet showed relatively minor temperature changes throughout on-farm storage, transport, and then storage at the Brisbane Markets.

They were clearly well insulated from temperature changes in the surrounding environment. The logger in this bag was retrieved nearly 2 days after arrival. Temperature ranged from 3.5-6.5°C.

Supply chain 5 – Farm A to Melbourne

One of the data-loggers in this trial malfunctioned, so only one record is shown. Following packing, these chestnuts took several hours to cool below 2°C. In this case temperatures rose during transport from the farm to Melbourne markets. They remained high during display and sale (Figure 7).

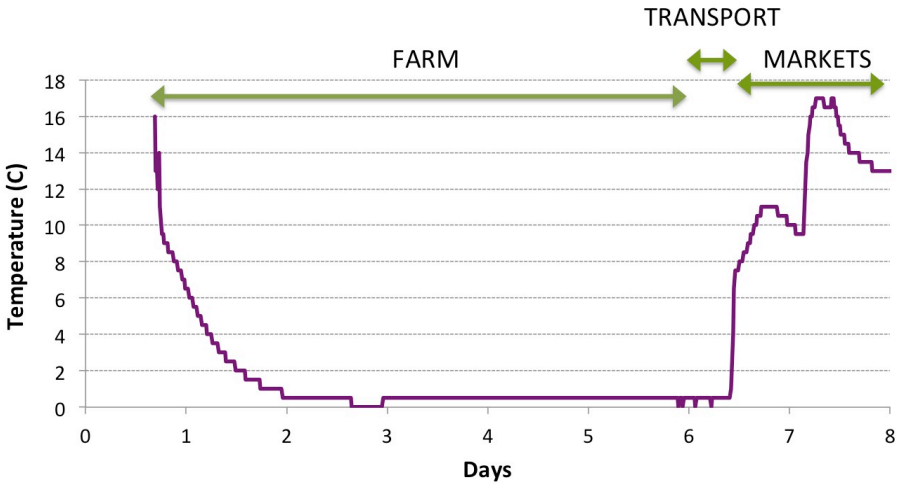


Figure 7 - Temperatures recorded in supply chain 5

Supply chain 6 – Farm B to Perth

This shipment likely had multiple transport stages, taking it from the farm near Stanley to the Perth Markets. It was initially loaded for transport on the morning of day 1. Temperatures did not fully come back down after this initial warming, particularly for chestnuts packed in the center of the pallet.

During transport temperatures fluctuated between 5-11°C. It appears that the refrigeration system of the long distance haulage truck was not powerful enough to cool the products within the load, but simply maintained temperature or allowed it to rise slightly.

The pallet was re-stacked in the early hours of day 6. This is evident from the reversal of the cooling rates of chestnuts inside the two monitored bags; the bag at the centre of the pallet moved to a position where it was more exposed, while the bag previously on the outer edge of the pallet was relatively insulated from subsequent temperature changes. It is possible that this was when the pallet was delivered to the market rather than early on day 7, or that another depot was initially used. Average temperatures of the chestnuts during transport (to this point) were 8.4°C and 7.5°C.

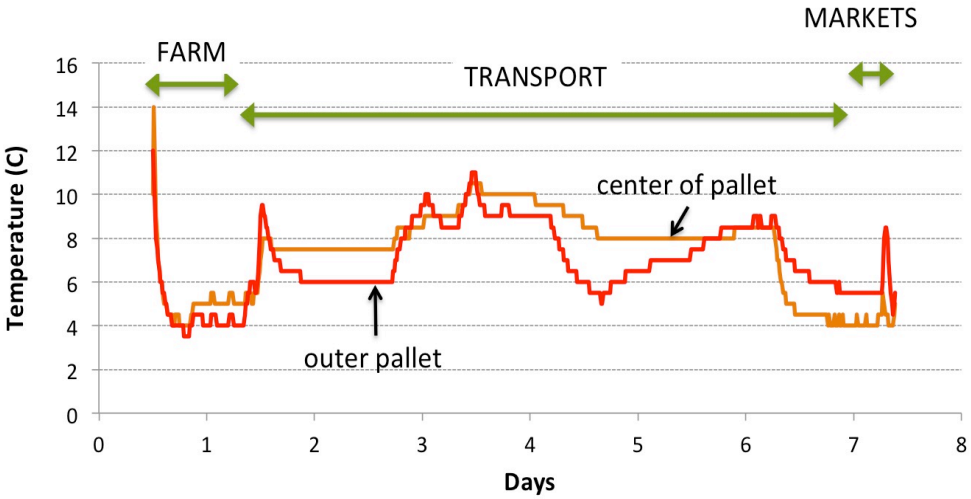


Figure 8 - Temperatures recorded in supply chain 6

Conclusions

Chestnuts packed inside sacks which are then stacked at the centre of pallets are extremely slow to cool during subsequent storage and transport. Under these conditions, self heating has the potential to become a major issue: respiration by the chestnuts increases temperature, which increases respiration, creating a positive feedback loop and escalating the problem. It seems likely that this is what caused the high temperatures of some consignments of chestnuts when they arrived at the markets.

The polypropylene sacks which are used to pack chestnuts are not ventilated and, unlike the vented cartons commonly used for other products, do not allow airflow through a packed pallet. While they are a cheap and effective packaging material for cold chestnuts, care must be taken to re-cool chestnuts that have warmed during packing – perhaps by delaying full palletisation of a shipment, or increasing the rate of airflow across pallets.

The results also show that high temperatures can be experienced during transport. Transport temperatures were well over 5°C within the two longest supply chains monitored, to Brisbane and Perth. Chestnuts warmed up during transport in five of the six chains studied: only the transporter used by Farm E kept chestnuts fully chilled until delivery to market. There was evidence that the cooling system inside trucks was turned off at times, while product that spiked in temperature due to trans-shipping was slow to re-cool.

Finally, significant temperature fluctuations were noted during display at wholesale, as products were moved in and out of cool rooms. There is no easy answer to this issue, as clearly product must be placed on display in order to be sold. Minimizing stock on display and ensuring good stock rotation can reduce overall damage to any single consignment. Moreover, keeping chestnuts cold up until this point will help ensure they are still fresh and mould free during display at wholesale and retail.

Supply chain monitoring - Export

Introduction

An opportunity arose during the project to evaluate a sea freight shipment of chestnuts to China. Chestnuts are regularly exported to the Chinese processing facility to be cooked, peeled then frozen for return to Australia as a ready to use, packaged product.

In previous years, an issue had been noted with a large variation in colour of the processed chestnuts, varying from pale yellow to dark brown. This variability does not normally occur in Australian chestnuts. One suggested explanation was that the ventilation rate in the container was to low. As a result, the internal CO_2 concentration could be increasing to levels damaging to the chestnuts. However, if this was causing the problem then it could be expected that all fruit would be damaged rather than the scattered occurrence which was observed.

Another possibility was that low temperatures were damaging some of the chestnuts during shipment. Trials conducted in 2014 showed that the likelihood of freezing damage increases as temperatures fall below -2°C. Freezing damage was somewhat sporadic, but generally resulted in external darkening and rancid flavours.

Temperatures within different parts of a shipping container can vary by several degrees depending on the settings of the condenser, ventilation rate, air circulation patterns and both external and internal temperature loadings. As the shipping container had been set to -1°C in previous shipments, the delivery air would be somewhat lower than this, raising the possibility that some chestnuts were being cold damaged.

An additional supply chain study was therefore added to the originally planned activities. This involved monitoring temperatures inside a shipment of chestnuts sent to China for cooking, peeling and then freezing. A 20ft sea freight container was used for the shipment, set at 1°C.

Method

As previously, i-button temperature recorders were inserted into chestnuts, which were placed inside mesh bags and marked with flagging tape. Each mesh bag was then re-packed into a sack of chestnuts and sewn closed. Bags with black text were used for the temperature monitoring: red and green bags were used for all other fruit. To further ensure retrieval, fluorescent labels were sewn onto the outside of each bag (Figure 9).

Figure 9 - Data loggers inserted into chestnuts were placed in marked bags and loaded into the sea freight container for export to China

Data loggers were located in the top (left back, left side and right front), middle (back, centre and front) and bottom (right back, centre and left front) layers of sacks loaded inside the container (

The dataloggers were removed after arrival at the Chinese processing facility, apart from a single logger in the top layer by the door, which was taken by the Chinese authorities. They were returned to Australia for downloading and analysis.

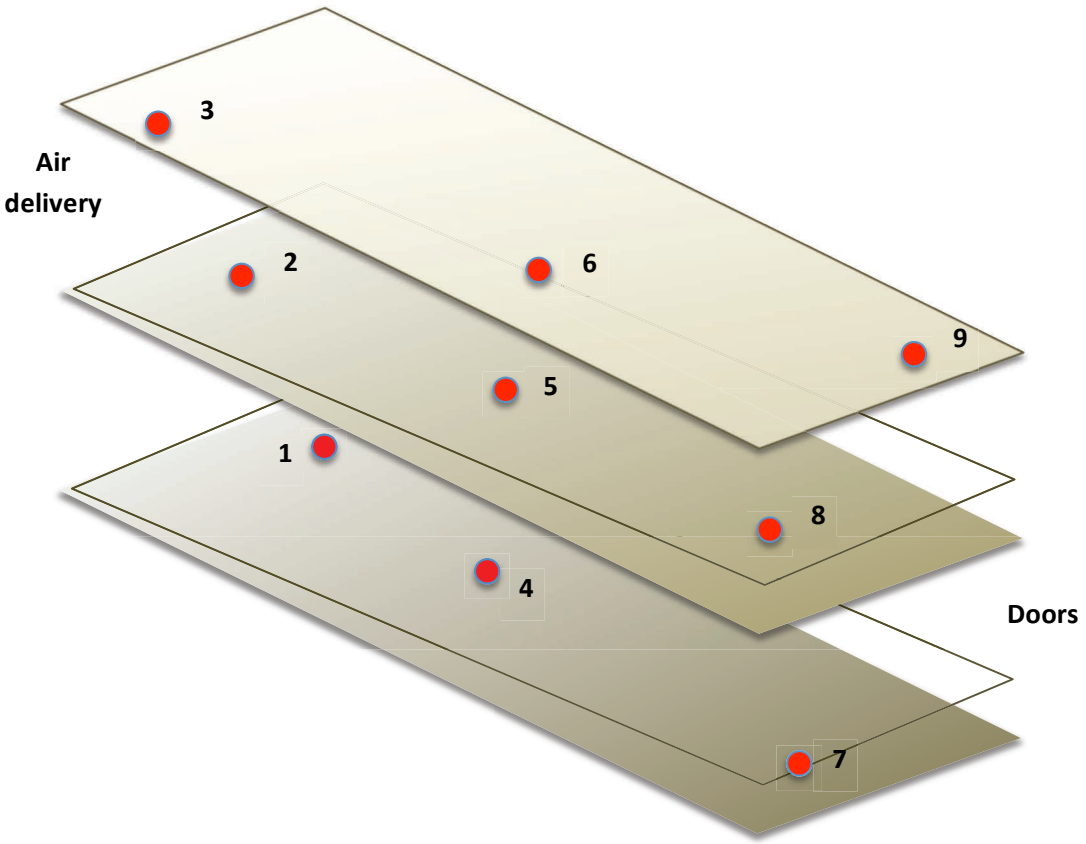


Figure 10 - Representation of locations of data loggers inside sacks located in three layers loaded inside the shipping container. Loggers were located in the top, middle and bottom layers and at either end and the centre of the container.

Results and Conclusion

Temperatures recorded inside the packed and loaded chestnuts were very stable during shipment. Temperature inside each of the monitored bags varied by a maximum of 1°C and tended to decline slightly during shipment. For this reason the data is presented as linearized plots, rather than raw values (Figure 11).

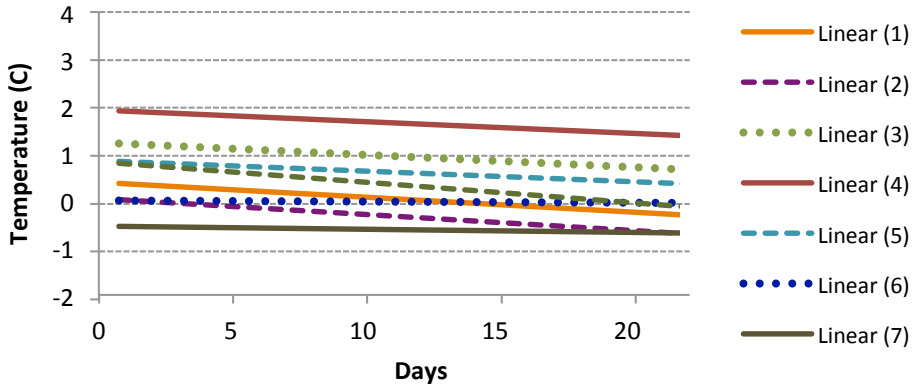


Figure 11 – Linearised temperature plots of loggers inserted into chestnuts in locations 1 – 8 inside a refrigerated shipping container during transport to China. Data loggers were in the top (dotted plots), middle (dashed plots) or bottom (solid lines) layers of sacks inside the container.

However, there was significant variation between points in the container, with recorded temperatures ranging from a minimum of -1°C to maximum 2°C.

As shown in Figure 12, the average temperatures recorded at different points inside the container ranged from +1.6°C to -0.6°C. These temperatures are suitable for storing chestnuts and would not be expected to cause any freezing injury. This is supported by outturn quality reports that the chestnuts were good quality and cooked and processed well, with little discolouration or other damage noted.

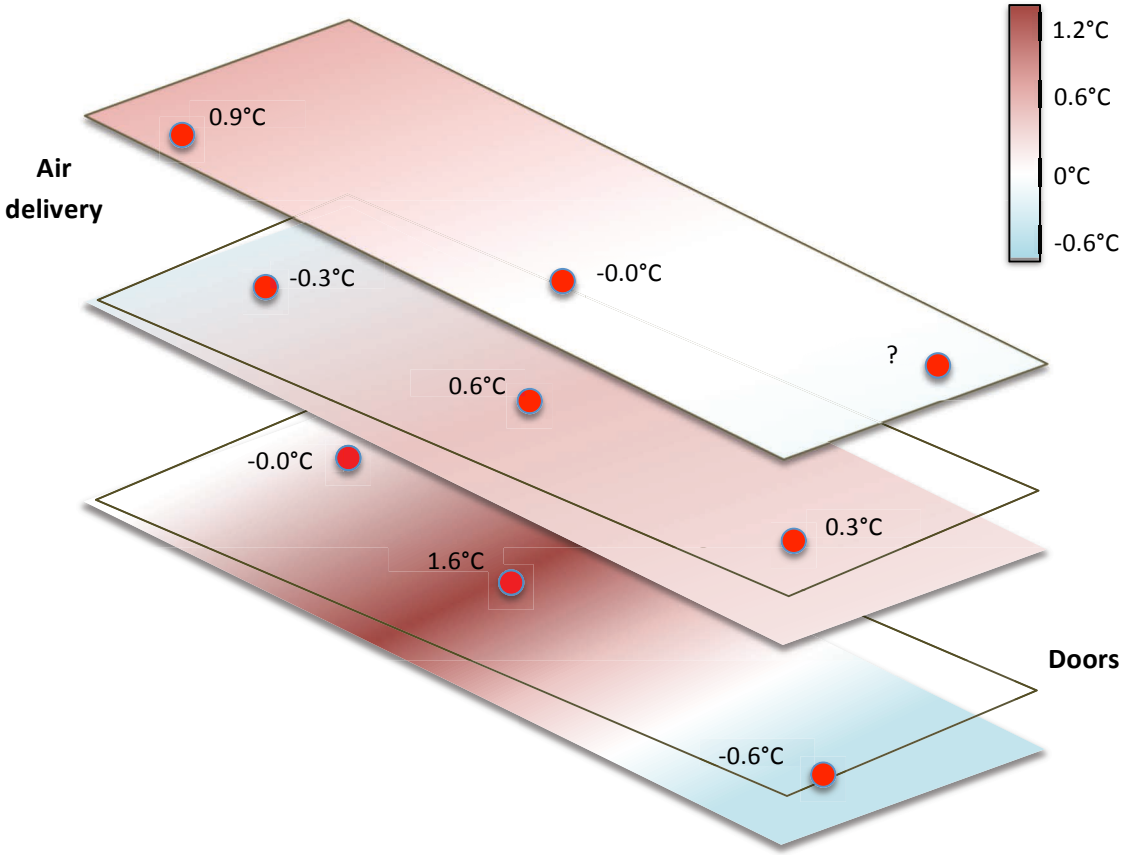


Figure 12 - Average temperatures recorded inside the shipping container loaded with chestnuts

It can be concluded that during this shipment the container functioned well and the temperatures and ventilation settings were appropriate to chestnuts. The bottom air delivery system inside the shipping container appears to have effectively forced the cold air through and around the stacked sacks of chestnuts, resulting in excellent temperature control.

Shipping containers vary in the effectiveness of their temperature control, calibration and strength of air delivery. Moreover, previous shipments had used lower storage temperatures. It is suggested that future shipments should also be independently temperature monitored, and the results compared with any damage observed in the cooked and processed chestnuts. This should indicate whether the temperatures during shipment are affecting end quality, or whether other factors are responsible for the observed external discolouration.

Retail survey – chestnut displays and visual quality

Introduction

Chestnut growers often take great pride in the quality of their product. As an annual crop with a short marketing season of only a few months, it is essential to keep chestnuts fresh and appealing as they move through the supply chain. Only by ensuring that chestnuts are excellent quality at retail can the industry maintain or increase demand for their product.

Previous research has examined harvest and postharvest practices on farms. The supply chain monitoring activities identified that a number of breaks commonly occurred in chestnut cold chains. However, the effect of such practices on retail quality is not well understood. Moreover, although chestnut sacks and cartons carry labeling stating they should be kept as cold as possible, retailers may not understand or follow these instructions. Even if everything else has been optimised, poor retail practices can potentially undo earlier efforts to optimise handling of chestnuts.

The current study was undertaken to provide initial information on the type and quality of displays used for chestnuts in supermarkets and by independent retailers. Although by no means comprehensive, the aim was to identify whether there is an issue with retail displays, and whether there is potential to increase sales of chestnuts through improving their management at retail.

Method

Retailers

A total of 39 retailers were visited to assess the type of display used for chestnuts, as well as the quality and price of the chestnuts on offer. These included 16 greengrocers (including two Thomas Dux stores) and 23 supermarkets (14 Coles and 9 Woolworths). Other retailers, including IGA and Aldi, did not appear to be stocking chestnuts at the time of the survey.

Most stores were located in Sydney, however two additional stores in Melbourne and seven in Brisbane were also visited during these assessments. Not all retailers had chestnuts available. This particularly noted in Queensland, where only two of seven stores had chestnuts in stock.

Data collection

To facilitate data collection, an app was developed based on i-Auditor software. This enabled easy recording of display attributes as well as the appeal of the chestnuts themselves (Figure 13).

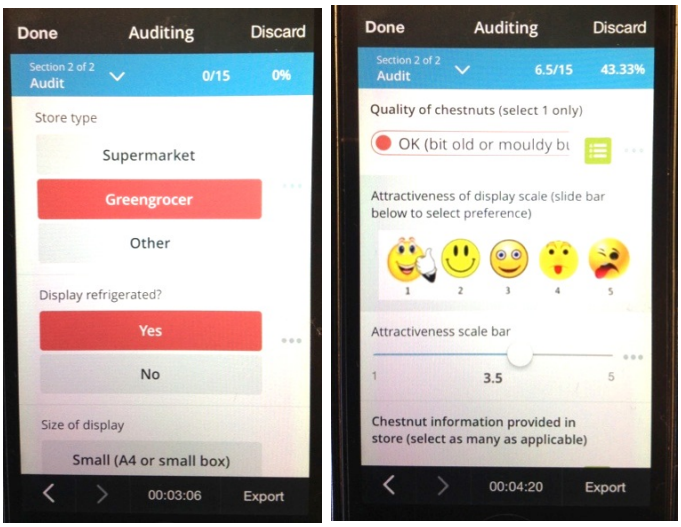


Figure 13 - Screen shots of 'app' used to assess chestnut displays and fruit visual quality

Attributes recorded included:

- Display refrigerated or not
- Size of display
    - Small (A4 or small box)
    - Medium (A3 or fruit tray)
    - Large (>A3 or multiple trays)
- Display attractiveness
    - Sliding scale from 1 – 5 where 1 is best and 5 extremely poor
- Chestnut visual quality
    - Excellent, fresh and glossy
    - Good – would buy
    - OK – A bit old or mouldy but might buy
    - Poor – buy if desperate
    - Total rubbish
- Chestnut information provided and if so what type
- Price $/kg
- Display temperature (measured using an infrared temperature gun)

A photograph was taken of each display and in some cases a small sample of chestnuts was purchased for more detailed quality assessment and photography.

Results

There were clear differences between the supermarkets and specialist greengrocers.

Display temperature

The majority of supermarkets were keeping chestnuts refrigerated, either in a wall cabinet or on a flat but refrigerated shelf display. In contrast, only two of the greengrocer stores surveyed were using refrigerated display units for chestnuts. As a result, chestnut temperatures were higher overall in greengrocer shops compared to supermarkets (Figure 14.

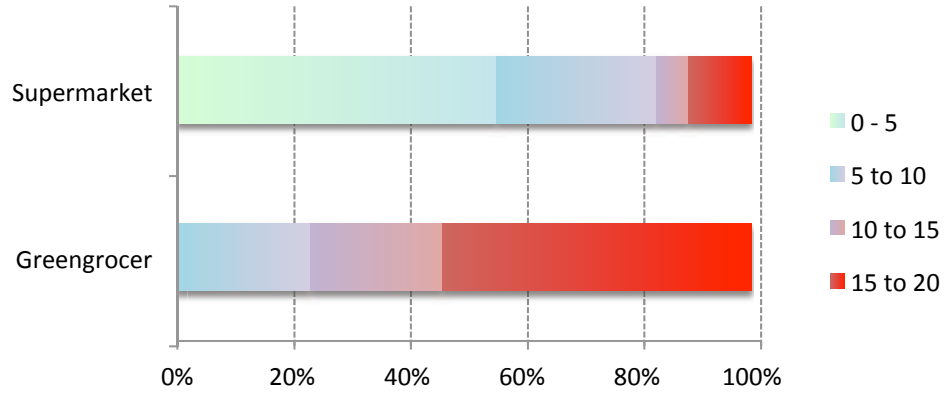


Figure 14 - Percentage of supermarket and greengrocer displays of chestnuts which were between 0-5°C, 5-10°C, 10-15°C or over 15°C.

Overall, average temperature of chestnuts in supermarkets was 5.7°C while in greengrocer shops it was 13.8°C

Display format

Nearly all of the retail displays in supermarkets comprised a single small box or tray. Greengrocer shops, however, often had much larger displays, with most being medium (A3 size or tray) or even larger (Figure 15). A number were using chestnuts as a focal point within the store, making the most of them as a seasonal point of interest to attract consumers attention.

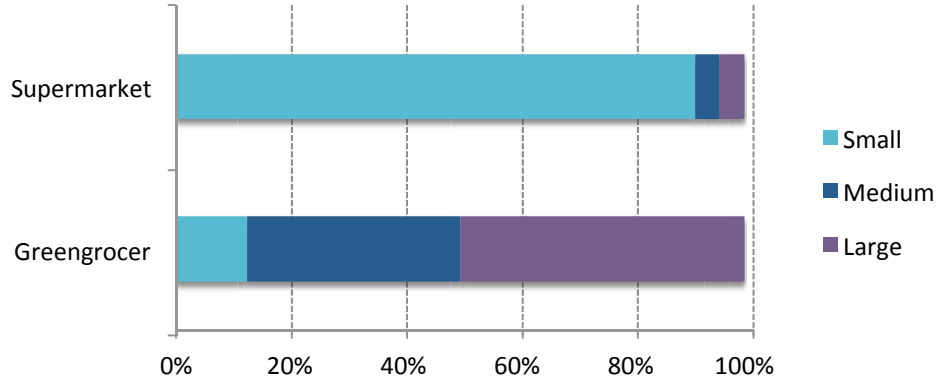


Figure 15 - Size of chestnut displays in supermarkets compared to those in greengrocer shops.

Because the supermarkets were keeping the chestnuts refrigerated, they were often in a box on the wall, so could be hard to spot on first inspection of the store. Likewise, the chestnuts inside the box were largely hidden from view by the box itself and products on the shelf above (Figure 16). As a result, supermarkets generally scored poorly in terms of the attractiveness of the display itself, even though this type of display is certainly functional. Only one supermarket had any information available (a recipe card) at the point of sale.

Figure 16 - Supermarket displays of chestnuts were generally small and often difficult to easily spot on the shelves. Display at right is a mixture of chestnuts and carambola.

Greengrocer stores often had made more effort in terms of the display of the fruit. Chestnuts were displayed in barrels, on centre stands and other prominent locations with handmade signage and other means of attracting the consumers' attention (Figure 17). Unfortunately, as with the supermarkets, point of sale information was rarely provided. Only two of the 16 stores surveyed had the chestnut industry recipe cards, with another store providing some cooking instructions and noting that the chestnuts were an easy peel variety.

Figure 17 - Greengrocer displays of chestnuts were often more distinctive, some clearly seeking to make them a seasonal focus of consumer attention.

One independent greengrocer particularly stood out. FruitEzy at Chatswood had a large display at front of store of loose L1 size Red Spanish (non easy peel) and bagged 'Ezy peel' chestnuts. The store had gone to considerable effort, including a "gas fire", extensive signage, and tastings of hot, freshly roasted chestnuts (Figure 18).

Figure 18 - Chestnut display at FruitEzy, Chatswood.

Hot, roasted chestnuts were also available in bags of 10. The roasting was being done on a converted BBQ just outside the shop. This had been equipped with a perforated cylinder on motorised rotisserie. Approximately 3kg of chestnuts were cooked at a time using the four gas burners (Figure 19). Chestnuts roasted on this were perfectly cooked and practically fell out of their shells – a technique which (according to the shop owner) had been refined over several years experimentation. A designated staff member had the job of preparing and roasting chestnuts then bagging them for sale.

Figure 19 - The BBQ turned into a chestnut roaster at FruitEzy Chatswood.

Unsurprisingly, this retailer was selling several 10kg bags daily. At another nearby store, which does not produce hot roasted chestnuts (although chestnuts still had a prominent display) sales were less than one third those through this main outlet.

This demonstrates the great potential to improve chestnut consumption if they are displayed and marketed effectively. On average, the quality of displays in greengrocers was significantly better than those seen in the supermarkets (Figure 20).

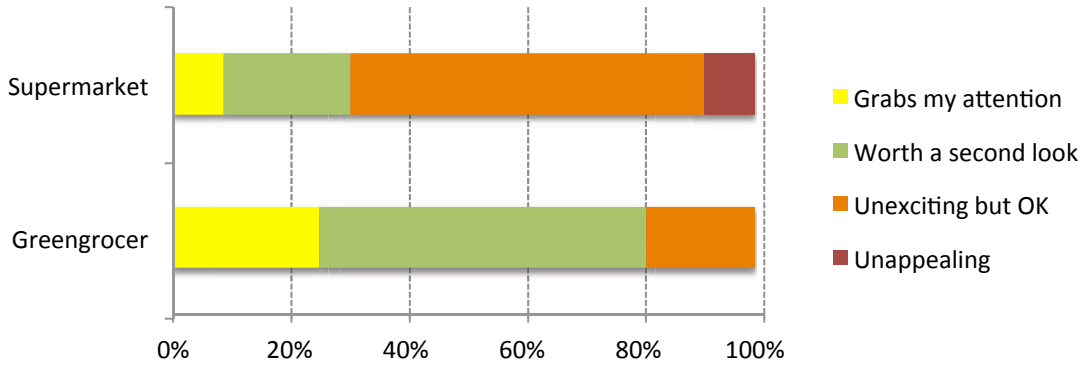


Figure 20 - Attractiveness of chestnut displays in supermarkets compared to those in greengrocer shops.

Quality of chestnuts

In most cases, chestnuts sold through the major retailers were of good appearance, or OK, with only a few recorded as being poor quality.

Independent greengrocers were more variable, providing both better and worse quality than the supermarkets. The larger size of the displays may have meant a lower rate of turnover. Combined with the lack of refrigeration this meant that some of the fruit on display had distinct mould growth on both the hilum and over the surface of the shell (Figure 21).

Figure 21 - Chestnut quality at independent greengrocers varied from excellent (top) to poor (centre and base).

The average quality of chestnuts at both independent retailers and supermarkets was 2.5, indicating Good to OK visual quality. However, such a figure conceals significant variability (Figure 22). The score for greengrocers was reduced by a number of stores that had very low quality fruit. However, it should also be noted that some of this product was also being sold at a very low price, on special. For example, one store had bags of splits for $5/kg – although these were graded as poor, the eating quality of these fruit would likely be as good as any other.

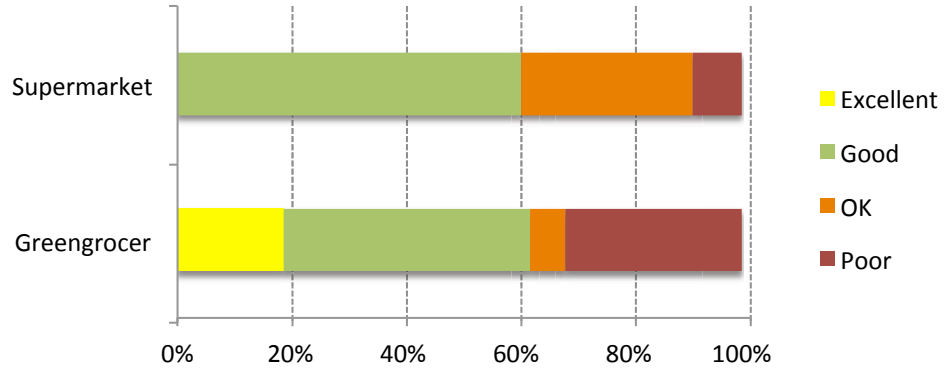


Figure 22 - Quality of chestnuts at supermarkets compared to independent greengrocers.

Price of chestnuts

Over the period of the survey (end of April – June 2015, most surveys conducted 4th to 11th June) retail prices were stable at approximately $9-$10/kg. Many greengrocers matched these prices.

However, as previously noted, there were also a number of stores with low quality but also low priced fruit, on special. Other stores had higher priced fruit, reaching a maximum of $17.99/kg for one particularly well-known store targeting upper income demographics. In some cases price reflected the quality of the chestnuts on offer – as observed for the superb quality Red Spanish at FruitEzy Chatswood, which were selling for $14.99/kg. In other cases, such as grocer C (Figure 21) the link between quality and price was less clear.

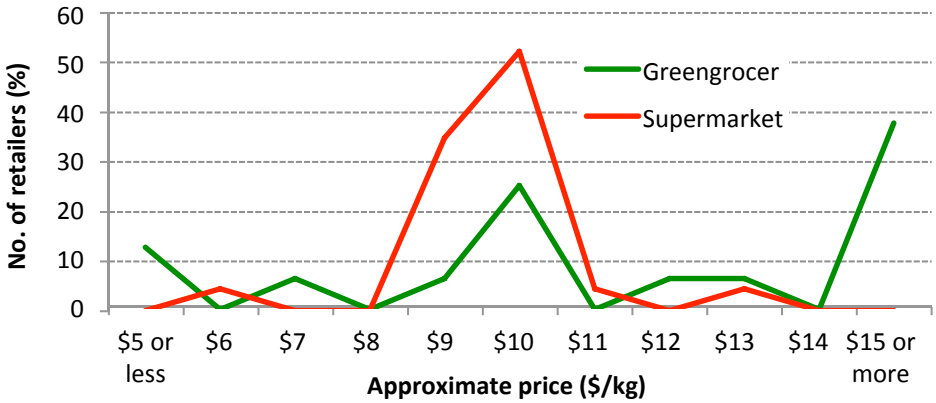


Figure 23 - Prices of chestnuts at supermarkets and greengrocers during May - June 2015

Conclusions

The major retailers proved to be a reliable source of 'good' to 'OK' quality chestnuts. Fruit were kept refrigerated and sold at a reasonable price. However, displays were generally small, with low visual impact. In many cases the consumer would have to search for chestnuts in order to find them within the fresh produce section, as the produce on offer was not clearly or prominently displayed.

Independent greengrocers were highly variable, with chestnut quality ranging from 'excellent' to 'poor', with all qualities in between. Some of their displays were large, elaborate, and showed considerable care and effort. They clearly aimed to attract the consumers' attention to a special, seasonal product. Several were selling chestnuts in 1kg net bags, ready for consumers to take away. Some of the fruit available was lower quality, but in most cases prices had been reduced to reflect this.

It is not known what proportion of chestnuts are sold through independent grocers compared to the major supermarkets. However, it appears that greengrocers are more able to take advantage of a seasonal product than the major retailers, who tend to be locked into a standard pattern of displays and pricing. This suggests that targeting independent greengrocers through offering opportunities to promote chestnuts, display ideas, and even chestnut roasters could significantly increase sales. It is noted that Fresh Produce Group has already started this process, providing chestnut roasters to a number of independent greengrocer customers in suitable areas of Sydney.

The lack of point of sale information on chestnuts remains a concern. The industry has invested in producing attractive leaflets showing how to prepare and cook chestnuts, as well as recipe ideas. However, these are often not reaching consumers. Moreover, it was rare to find information describing whether the chestnuts were an easy peel variety – critical information if the consumer is to be satisfied with their experience.

Packaging chestnuts in net bags appears to be acceptable to consumers and is already used by some greengrocers. Packaging offers an opportunity to provide information on variety, preparation and cooking method directly on every pack. Using this method could be particularly relevant for the major retailers, who may lack the flexibility and specialised attention needed to increase sales of a seasonal and possibly unfamiliar produce category. Packing into 500g or 1kg units may also help increase the volume of individual sales.

It is strongly recommended that the chestnut industry investigate opportunities to package chestnuts for retail sale. Some chestnut grower / packers pack for a number of different growers, or have the potential ability to do so. These larger packing operations, operating independently or as part of a co-operative system, could set up a pre-packing operation for chestnuts. While new equipment would likely be needed, this could be offset against improved retail prices.

Alternatively, the industry could investigate options for market agents to pack for them. Many fresh produce businesses already have equipment that could be used to pack

chestnuts into punnets or nets. Using owned equipment would appear an economical alternative, at least in the early stages of product development. This would also help the industry access direct marketing linkages, particularly with the major retailers.

It seems unlikely that packaging would negatively impact on chestnut quality compared to the open displays currently used. However, trials should test the effect of packaging system on chestnut quality – particularly if punnets are to be used, as this could possibly increase mould growth. Conversely, packing into punnets could help protect chestnuts from poor handling and/or display conditions by keeping humidity high and allowing ventilation of packed fruit.

It would also be useful to test different types of packaging with consumers, to ensure that instructions are clear and easily understood, and the packaging used adds value to the product.

Appendice 2

A recent research project investigating the impact of postharvest cooling practices on chestnuts has uncovered some surprising results.

Chestnut growers usually refer to their product as fruits, not nuts. This is because chestnuts, unlike dry stored tree nuts are kept moist after harvest and eaten fresh. To retain this moisture until they are eaten chestnuts are usually chilled after harvest and kept cold through the supply chain.

Horticultural researcher Dr Jenny Ekman (Applied Horticultural Research) has been testing the most efficient way of cooling chestnuts for storage, to ensure quality is maintained.

"At the beginning of the project, growers were routinely storing their harvested nuts in bins, with cool rooms set as low as -3°C in order to optimise storage quality. From the outset, I felt that the storage temperature seemed very low, so we set about to find out what the optimal conditions for postharvest storage should be."

A series of trials were conducted in the 2014 season testing three key areas: the effect of chilling method on how quickly chestnuts cooled, , identifying the freezing point of chestnuts, and understanding the impact of storage temperature during long term storage.

"For the first part of the research, we wanted to understand how efficient existing cooling practices were at reducing the temperature of the harvested fruit. We also hoped to identify ways in which the cooling process could be sped up. "

Trials were conducted with three growers (small, medium and large operations), and a variety of different cooling techniques were tested under cool room conditions.

"We compared cooling rates in polypropylene bags, mesh bags, wooden bins and plastic bins, as well as room cooling in a lined bin or a bin with ventilation pipes through the load. Other technologies that can be used to speed up cooling rate were also tested, including hydrocooling and forced air cooling using a fan."

The results were, in some circumstances, quite surprising.

"We found that the mesh bags were quite effective at cooling down the chestnuts, as was the use of ventilation pipes in the bins. The pipe system was particularly effective at reducing the temperature of nuts in the middle of the bin.

"More disappointing was the hydrocooler, which initially cooled the chestnuts very fast. However, once removed from the water the fruit cooled at the same rate as those in a standard bin. We also found that using liners was not a good idea. After three days we found that the chestnuts had hardly cooled at all, and

abandoned the trial. This shows that you must never ever use a liner unless the fruit has already cooled."

To Jenny's surprise, the forced air solution provided one of the more exciting results.

"It was a simple solution that involved stacking three bins on top of each other, with a fan on top, and the cool air was pulled through the bins. It was incredibly efficient, and had the effect of reducing cooling time to an hour and a half. This reduces the risk of mould, and of course moisture loss."

The next stage of the project was a little more complex.

"The problem with chestnuts is that it is very hard to tell when they have been frozen. If you freeze a lettuce or an apple, there are clearly visible signs of damage to the fruit. However, when a chestnut is in its shell, it is almost impossible to tell if it is frozen. Even once it is peeled it can be very difficult to tell. However, freezing has a major impact on taste and aroma, making it quite unpleasant to eat."

According to Jenny, some growers had suspicions that their cooling practices were potentially impacting the quality of their chestnuts, so an investigation of the freezing point was carried out.

"We trialled a number of different temperature combinations to identify the freezing point. Freezing damage appears to be the result of a combination of time and temperature, with the critical temperature around -3°C. As little as two hours at temperatures below -3°C resulted in significant damage to the stored fruit, and as time below that temperature increased, so did weight loss, darkening and rancidity."

Ironically, in their efforts to retain moisture, Jenny believes that growers were inadvertently putting their chestnuts at unnecessary risk of damage. The final part of the project was to determine whether storage temperature was critical to quality during longer term storage.

"We wanted to find out if all this cooling was in fact necessary. A lot of money is spent on electricity to run cool rooms, but is it making a difference to the storage life of the chestnut? Can we raise the temperature, save on power, and still have a good product?

Chestnuts were stored at temperatures of both 0°C and 5°C degrees for periods of up to eight weeks.

"At the end of the trial, we couldn't tell any difference between the fruit. The results suggest that growers can store chestnuts below 5°C for up to several weeks and they will be just fine. We saw some damage at the longer end of the time scale, but most growers only store their fruit for a couple of weeks anyway, so there is no need to store them at sub zero temperatures. Not only are growers

able to save money on electricity, but we also know that at these temperatures, the chestnuts are not sustaining any damage due to freezing."

According to Jenny, a number of growers have started implementing changes to their postharvest storage practices as a result of the research.

"The Chestnut industry has been really responsive to the work that we've done, and it is heartening to know that they are already implementing some of the changes as part of their operations."

Appendice 3

How hot are your nuts?

My Professor at University used to say that the three most important things in postharvest management are temperature, temperature and temperature.

Unlike other tree nuts, chestnuts are still alive when they are harvested. They are still using oxygen, releasing CO_2, losing moisture and keeping their living metabolic processes going. How quickly chestnuts use their stored energy reserves, and how much water they lose, largely depends on temperature.

Cooling chestnuts quickly after harvest, then keeping them cold right up until the consumer toasts them on a hot grill, is definitely the best way to keep them fresh, firm and mould free.

However, just putting something in a cold room doesn't mean it is cold. My professor also used to say that cooling is value adding with electricity. Making sure that chestnuts are not only cooled effectively, but also efficiently, is important to ensure you have a good quality product that will make you money.

In 2014 we conducted a series of trials checking just how quickly chestnuts cool using different methods. We followed those during the 2015 season examining temperatures after packing, during transport and finally during wholesale and retail sale.

The results suggest a number of ways growers can improve both quality, and profitability, for their businesses.

Cooling methods (2014)

We tested a number of different cooling methods:

- Room cooling in a mesh bag
- Room cooling in an onion bag
- Room cooling in a wooden bin
- Room cooling in a lined wooden bin
- Room cooling in a bin with ventilation pipes
- Room cooling in a plastic bin
- Hydrocooling
- Forced air cooling

We measured temperature using data loggers with probes inside the fruit. The dataloggers were placed in different spots inside the bins – the core, the outer edge etc.

When products cool, the temperature comes down quickly at first but then gradually approaches room temperature. It can take a long time to reach the room temperature, so it is easier to talk about ¾ or ⅞ cooling time (Figure 1).

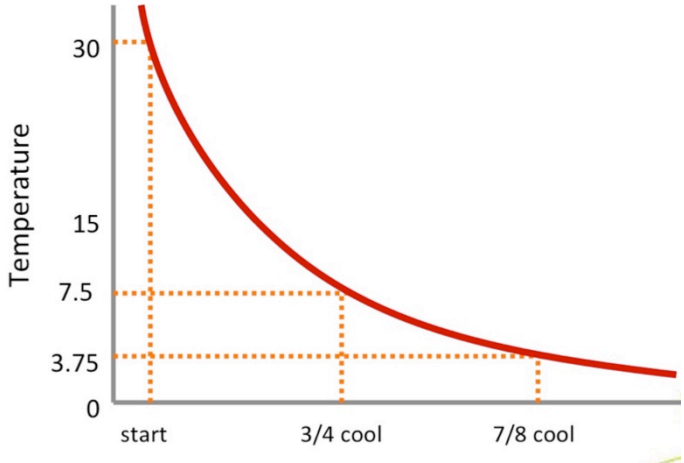


Figure 1 - Example of how a chestnut might cool from 30C to a room temperature of 0C. The fruit is 3/4 cooled when it reaches 7.5C and 7/8 cooled at 3.75C.

As shown in Table 1, there were very large differences between the different cooling methods in the time it took to reduce the temperature of freshly harvested chestnuts by ¾. There were also large differences between the outside of bins and the fruit in the centre.

Key points are:

- Chestnuts packed straight into a lined bin were *extremely* slow to cool, with those in the centre still warm after 3 days. Mould was observed to be starting to grow.
- Although chestnuts near the top of unlined bins cooled OK, especially when they were in plastic rather than wooden bins, chestnuts at the centre were again very slow to cool, taking a day or more to come down to around 4°C.
- Chestnuts packed into polypropylene bags are nearly as slow to cool as those in the centre of a bin, even when placed in a single layer in the cold room. These bags allow very little air movement around the fruit, effectively insulating them from the cold air.
- Chestnuts in a mesh bag cooled quickly but tended to lose moisture (this is likely to relate to the cold room setup as much as the bag).
- The ventilation pipes greatly increased cooling in the middle of the bin – when these were installed chestnuts in the centre cooled just as quickly as those on the outer edges. These therefore represent an excellent, low cost way to improve room cooling in the absence of other methods.
- The hydrocooler worked well, but immersion time is key to success: although the hydrocooler quickly reduced temperature by several degrees, after the fruit were removed they cooled at only the same rate as those in a standard bin.
- The forced air cooling system was the standout success. Chestnuts in the forced air system cooled fast and efficiently right through to the centre of each bin.

Table 1 - Cooling times in different systems

Cooling method	Time to ¾ cool (hours)	Weight loss (avg %)
Packed in PPE bag	20	0.2
Packed in mesh bag	3.2	1.5
Lined bin (top corner)	68	0.5

Lined bin (centre)	>70	0.1
Unlined wooden bin (top corner)	18	0.6
Unlined wooden bin (centre)	25	0.6
Unlined bin + ventilation pipes	18	0.4
Unlined bin + ventilation pipes	12	0.2
Unlined plastic bin (top corner)	3.9	-2.3 (gain)
Unlined plastic bin (centre)	23	-2.8 (gain)
Hydrocooled system	2.6	-1.1 (gain)
Forced air top bin	1.6	0.3
Forced air middle bin	1.5	0.3
Forced air bottom bin	1.0	0.3

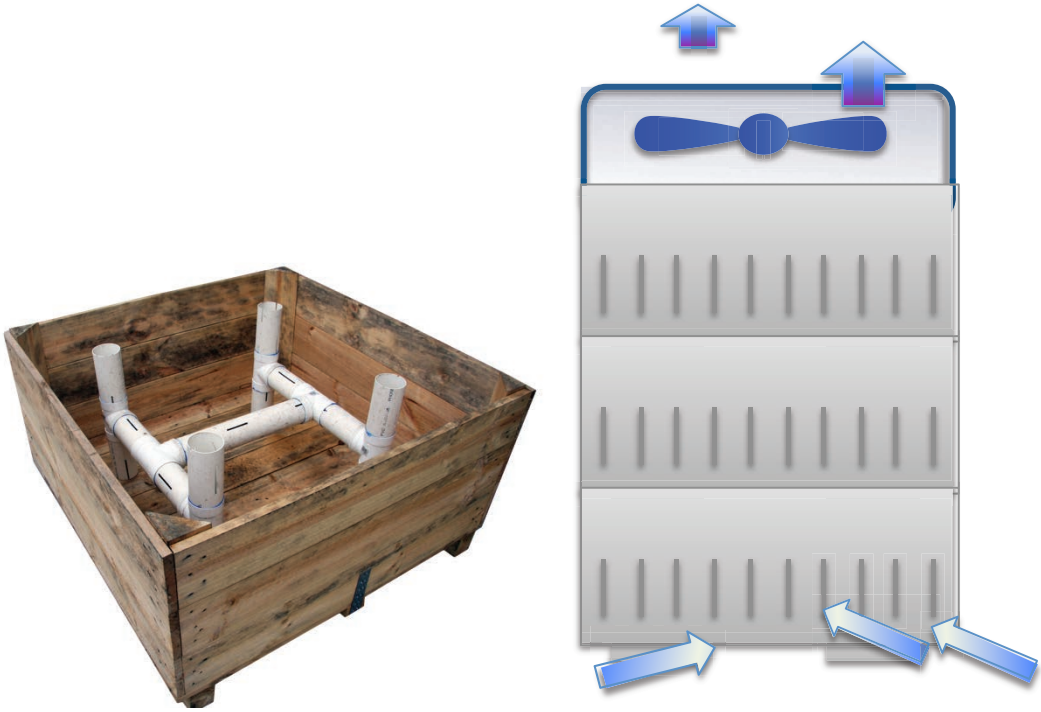


Figure 2 - Two of the cooling methods used were a bin with ventilation pipes (left) and a forced air cooling system that could cool 3 bins at once inside a standard coolroom.

It is clear from the results that warm chestnuts should NEVER be packed into a lined bin in the coolroom, and should preferably not be packed into standard PPE bags either. Packing into onion bags is OK, but it could be important to try to increase humidity inside the coolroom, by wetting it down for example.

If chestnuts are going to be left in bins and placed in the coolroom, then adding ventilation pipes is an easy and inexpensive method to improve cooling, particularly for chestnuts in the middle of the bin.

While I know more than one grower who has aspired to owning a hydrocooler, the results suggest that a forced air system may be not only less expensive but also more effective. All that is needed is a fan, some housing to fit it onto the top of the bin, and plastic or tarping to

wrap around the side vents so that air is forced to come up through the base. Of course, this will not work well with wooden bins, which don't have enough venting to allow the air to be pulled through. Also, the cold room must have enough capacity to cope with the additional heat load. However, if the results are better quality, less weight loss and less mould, the investment could be well worthwhile.

Supply chains (2015)

Having tested the best way to cool chestnuts at the farm, the next step was to see what happened during transport and wholesale.

A total of eight supply chains were monitored, going from farms in Victoria and NSW to destination markets in Sydney, Melbourne, Brisbane and Perth. We also had a couple attempts at Adelaide, but the loggers were lost.

Chestnuts with temperature dataloggers inserted into polypropylene bags at the farms, then palletised ready for transport. Consistent with the results of last season, chestnuts in PPE bags at the middle of the pallet took several days to cool back down after packing. In contrast, bags at the top of the pallet cooled within a few hours. On the positive side, these chestnuts also took longer to warm up if exposed to high temperatures during transport.

Once chestnuts warm it can be difficult to re-cool them in PPE bags. There also appears to be significant 'self-heating' occurring – as chestnuts warm they respire more quickly, causing them to heat up, which increases respiration, and so on and on with a snowballing effect.

While some of the transporters studied kept chestnuts thoroughly cold in transit and even cooled those on the top layer, others did not appear to have turned on the refrigeration units at all, or turned them off at different times – presumably when the driver was taking a break.

As shown in Figure 3, chestnuts increased to 16 or even 22°C during transport, which was warmer than ambient conditions at that time of year.

Once at the markets, the temperature of chestnuts depended on how they were stored and displayed. Wholesalers will often have a small coolstore near the market stand which they use daily. They may also have a larger coolstore to use for more long term storage.

The long term coolstore that we monitored worked extremely well, maintaining chestnuts at a constant 2°C throughout.

The smaller coolstore cooled the chestnuts to around 5°C, and also showed fluctuations as the door was regularly opened and closed.

The predominant pattern was that chestnuts were removed from the onsite coolstore shortly after midnight and placed on display. Despite the cool weather during May they would immediately start to warm, reaching 12 - 16°C by around 9:30, when they were replaced into the coolstore. This zig-zagging of temperature is likely to result in condensation inside the bags and, potentially, mould growth.

Of course, to sell product it must be displayed. However, the amount of product shown on the stand should ideally be minimised. The results also suggest that good stock rotation is essential to avoid too many temperature fluctuations for a single consignment.

Once chestnuts leave wholesale for independent fruit and vegetable stores they are unlikely to be cooled again. This is OK, so long as they sell quickly.

The lack of temperature management within the supply chain emphasises the need to ensure chestnuts are good quality, well cooled and with plenty of storage reserves when

they leave the farm. This is the only way they will survive the inescapable ill-treatment they suffer further down the supply chain, and reach the consumer still good to eat.

For the full report on this project please contact Dr Jenny Ekman: jenny.ekman@ahr.com.au

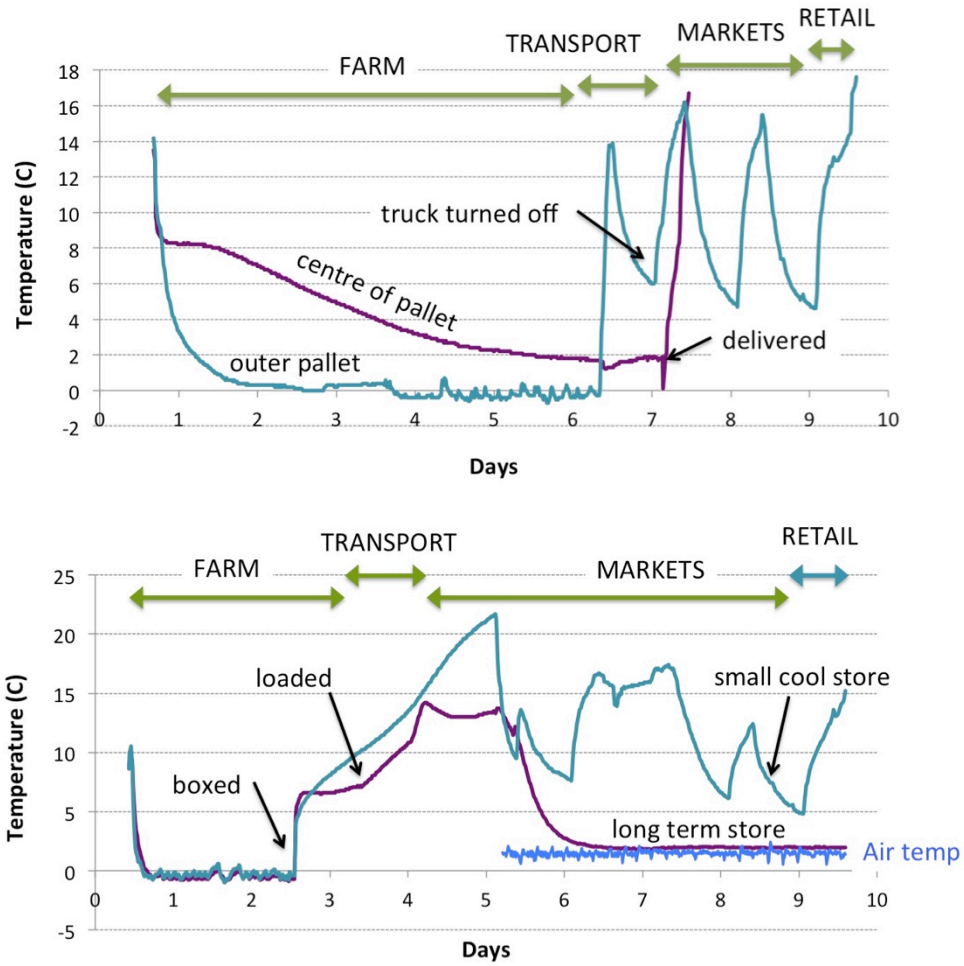


Figure 3 - Temperatures during transport from two different farms in Victoria to the wholesale market in Sydney and finally to a retail store. The blue temperature trace indicates the logger that was tracked to retail, the purple trace was retrieved at the wholesale market.

Appendice 4

Shopping for chestnuts

All the chestnut growers I know take tremendous pride in the quality of their product. This is not just another crop, but a passion, with the harvest the result of a year, or even many years, of effort.

As an annual crop with a short marketing season, chestnuts must be kept fresh and appealing as they move through the supply chain. Only by ensuring that chestnuts are excellent quality at retail can the industry maintain or increase demand.

Previous research has examined ways that growers can optimise harvest, cooling and packing on farms. But what happens when chestnuts reach retail? Is all that hard work undone?

Our survey

We visited 39 retailers to assess chestnut retail displays. These included 16 greengrocers and 23 supermarkets. Most were in Sydney, with a scattering of stores in Melbourne and Brisbane. Other retailers did not appear to be stocking chestnuts at the time.

To make data collection easy, we developed a simple 'app'. This made it easy to record information about the displays, chestnut visual quality and price. We also measured temperature using an infrared gun (Figure 1).

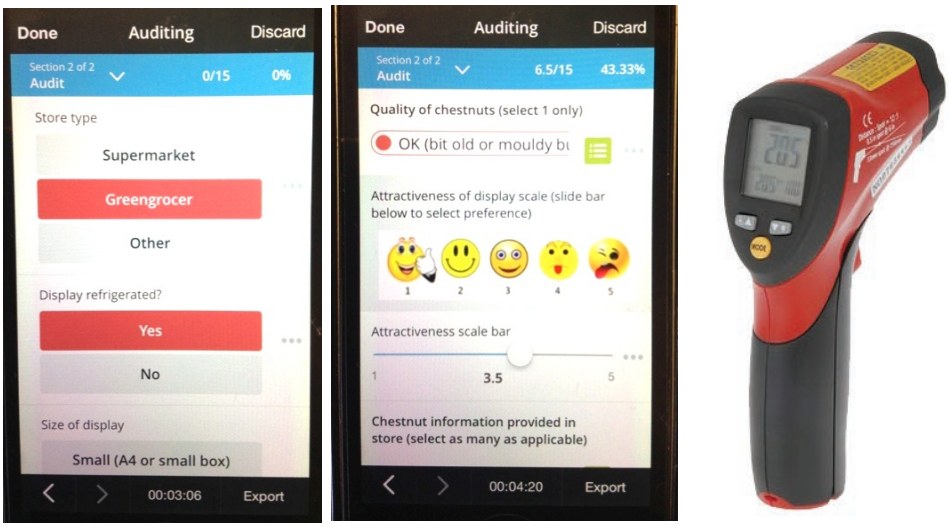


Figure 1 - Screen shots of 'app' used to assess chestnut displays and fruit visual quality, and an IR gun

Using a phone app also made it easy to (surreptitiously) photograph each display.

Results

There were clear differences between supermarkets and specialist greengrocers.

Display temperature

The majority of supermarkets were keeping chestnuts refrigerated, either in a wall cabinet or on a flat but refrigerated shelf display. In contrast, only two of the greengrocer stores surveyed were using refrigerated display units for chestnuts. As a result, chestnut temperatures were higher overall in greengrocer shops compared to supermarkets (Figure 2.

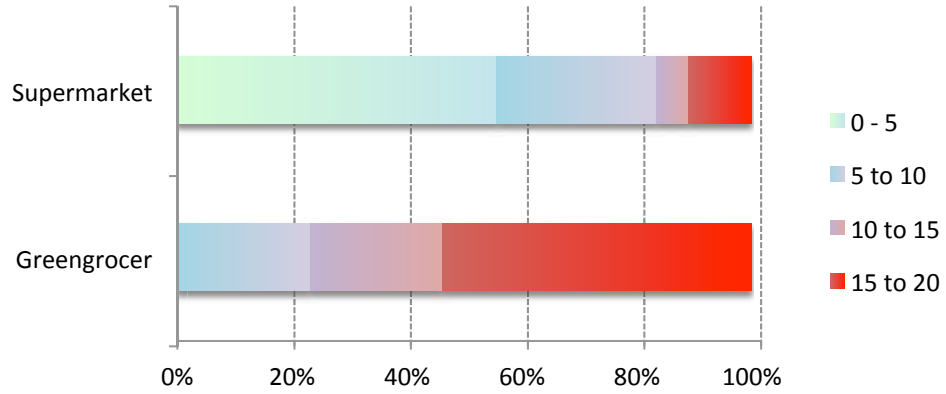


Figure 2 - Percentage of supermarket and greengrocer displays of chestnuts which were between 0-5°C, 5-10°C, 10-15°C or over 15°C.

Overall, average temperature of chestnuts in supermarkets was 5.7°C while in greengrocer shops it was 13.8°C

Display format

Nearly all of the retail displays in supermarkets were a single small box or tray. Greengrocer shops, however, often had much larger displays, with most being medium (A3 size or tray) or even larger (Figure 3).

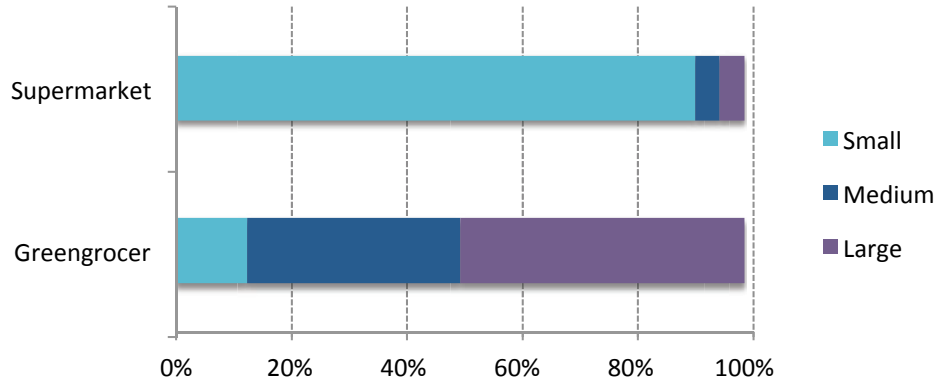


Figure 3 - Size of chestnut displays in supermarkets compared to those in greengrocer shops.

Because the supermarkets were keeping the chestnuts refrigerated, they were often in a box on the wall, so could be hard to find. Likewise, chestnuts inside a box are largely hidden

from view (Figure 4). As a result, supermarkets scored poorly in terms of display attractiveness, even though they were certainly functional.

Figure 4 - Supermarket displays of chestnuts were generally small and often difficult to easily spot on the shelves. Display at right is a mixture of chestnuts and carambola.

Greengrocer stores often made more effort in terms of the display of the fruit. Chestnuts were displayed in barrels, on centre stands or right at the front of the store. Some had handmade signs and were really trying to attract consumers' attention (Figure 5).

Unfortunately, as with the supermarkets, point of sale information was rarely provided. Only two of the 16 stores surveyed had the chestnut industry recipe cards.

Figure 5 - Greengrocer displays of chestnuts were often more distinctive, some clearly seeking to make them a seasonal focus of consumer attention.

One independent greengrocer really stood out. FruitEzy at Chatswood had a large display at front of store of loose L1 size Red Spanish (non easy peel) and bagged 'Ezy peel' chestnuts. The store had gone to a lot of effort, including a "gas fire", lots of signs, and even tastings of hot, freshly roasted chestnuts (Figure 6).

Figure 6 - Chestnut display at FruitEzy, Chatswood.

The roasting was being done on a converted BBQ just outside the shop. The roasted chestnuts were perfectly cooked and practically fell out of their shells – a technique which (according to the shop owner) had been refined over several years.

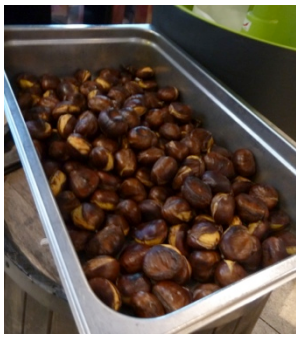


Figure 7 - The BBQ turned into a chestnut roaster at FruitEzy Chatswood.

Unsurprisingly, this store was selling **a lot** of chestnuts! This demonstrates the great potential to improve chestnut sales if they are displayed and marketed effectively.

Quality of chestnuts

In most cases, chestnuts sold through the major retailers were of good appearance, or OK, with only a few recorded as being poor quality.

Independent greengrocers were more variable, providing both better and worse quality than the supermarkets. Large displays with no refrigeration meant some mouldy fruit were on display (Figure 8). Another retailer was selling bags of splits for $5/kg – they didn't look so great but probably eat perfectly well. In many cases price reflected quality – so I guess consumers were getting what they paid for.

Figure 8 - Chestnut quality at independent greengrocers varied from excellent to poor.

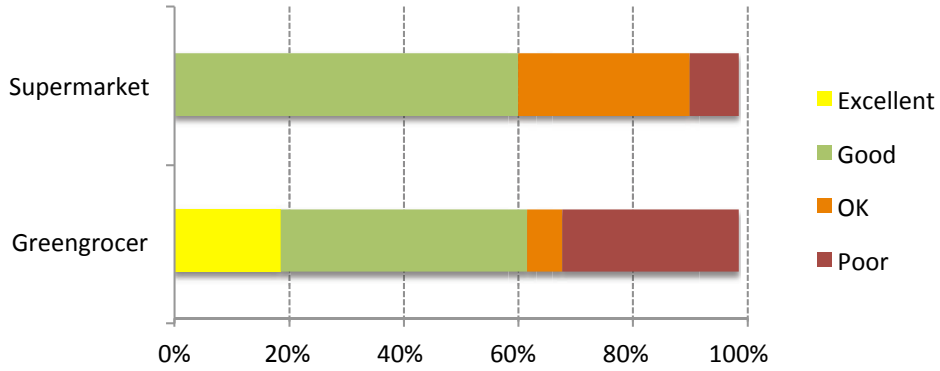


Figure 9 - Quality of chestnuts at supermarkets compared to independent greengrocers.

Price of chestnuts

Over the period of the survey (end of April – June 2015) supermarket prices were stable at approximately $9-$10/kg. Many greengrocers matched these prices.

However, as previously noted, there were also a number of stores with low quality but also low priced fruit, on special. Other stores had higher priced fruit, reaching a maximum of $17.99/kg in one store in an up-market area.

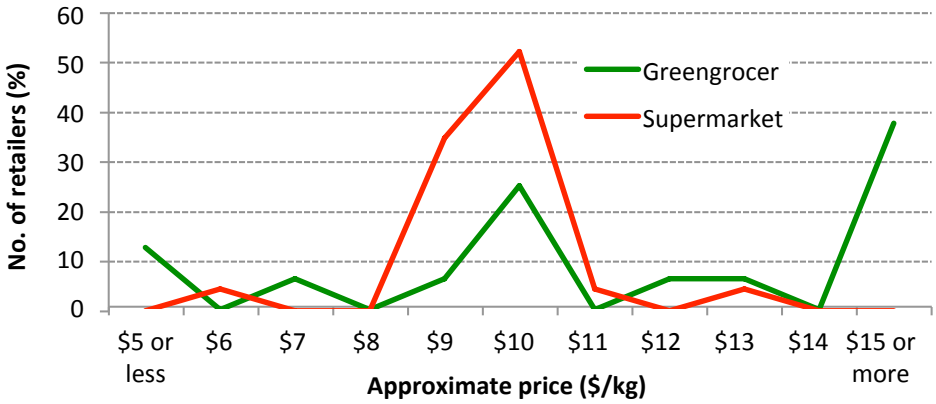


Figure 10 - Prices of chestnuts at supermarkets and greengrocers during May - June 2015

What have we learned?

The major retailers proved to be a reliable source of 'good' to 'OK' quality chestnuts. Fruit were kept refrigerated and sold at a reasonable price. However, displays were generally small, with low visual impact. The consumer would have to search, as chestnuts weren't easy to find.

Independent greengrocers were highly variable, with chestnut quality ranging from 'excellent' to 'poor', and all qualities in between. Some of their displays were large, elaborate, and showed a lot of effort. They clearly aimed to attract the consumers' attention to a special, seasonal product.

It seems likely it is easier for greengrocers to take advantage of a seasonal product like chestnuts than the major retailers, who tend to be locked into a standard pattern of displays and pricing. Targeting independent greengrocers, perhaps through chestnut promotions, display ideas, and even chestnut roasters therefore looks like a good way to increase sales.

Helping consumers eat chestnuts

The industry has invested valuable funds in producing great looking leaflets showing how to prepare and cook chestnuts, as well as recipe ideas. However, in many cases these don't seem to be reaching consumers.

What's more, the vast majority of retailers don't tell their customers whether chestnuts are an easy peel variety – critical information if the purchaser is to be happy with their chestnuts or frustrated trying to peel Red Spanish.

Some greengrocers already package chestnuts in net bags. Packaging offers an opportunity to provide information on variety, preparation and cooking method directly on every pack.

Packaging could also help make chestnuts ‘easy’ for the major retailers to manage. Packaging could help give chestnuts more visual presence, and give consumers the information they need - something the average teenage shop assistant is unlikely to provide!

Obviously, packaging adds work and expense. It needs equipment, which would then sit around gathering dust much of the year. One option could be to get products packaged at wholesale, using equipment that is already there. This would spread risk, and make sure labeling meets legal/commercial requirements.

There are lots of options, and making a few ‘mockups’ to show retailers and consumers might be a good first step. Providing information and instructions on packaging could be exactly what is needed to introduce the pleasure of chestnuts to all those sad, non-chestnut eaters who “just don’t know what to do with them…”.

Chestnut supply chains

Jenny Ekman

or “Do you trust this man with your nuts?”

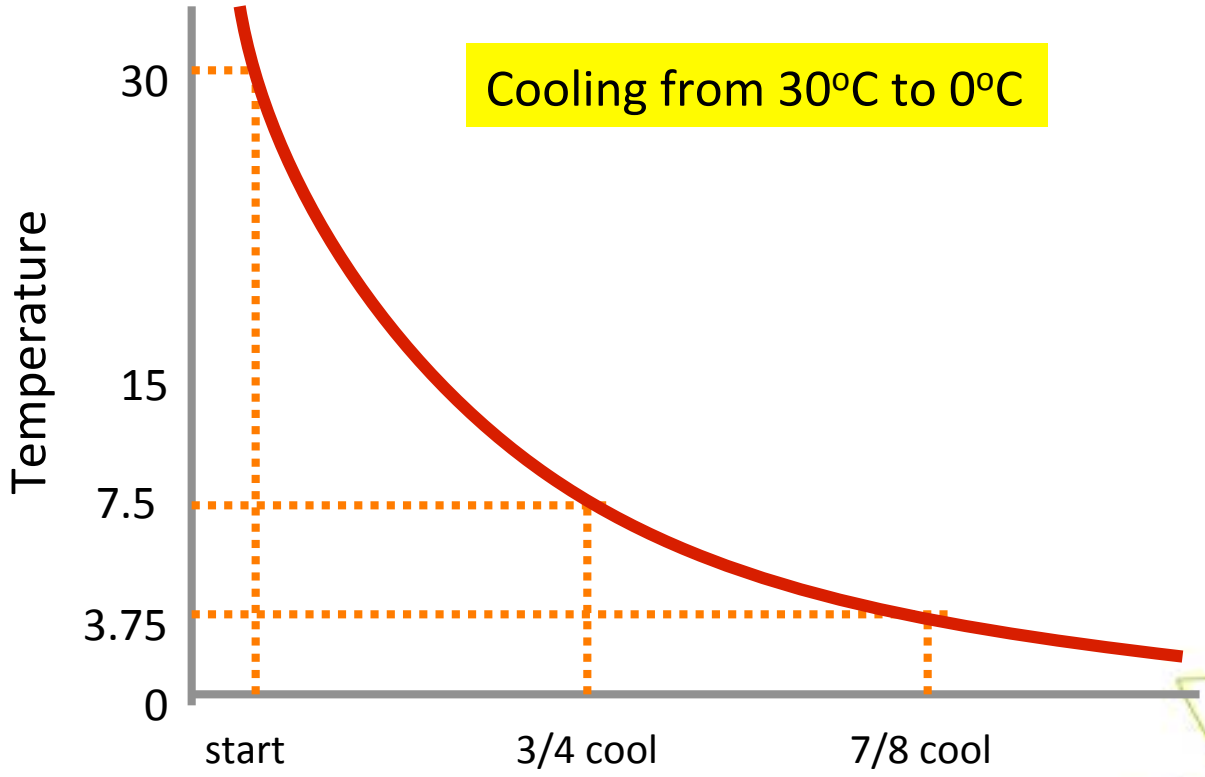
This talk

- 2014 Season Reprise
  - Cooling rates for chestnuts
  - Freezing point of chestnuts
  - Effect of temperature on quality
- 2015 Seasons trials
  - Domestic supply chain
  - Export supply chain
  - Retail survey

The story so far....

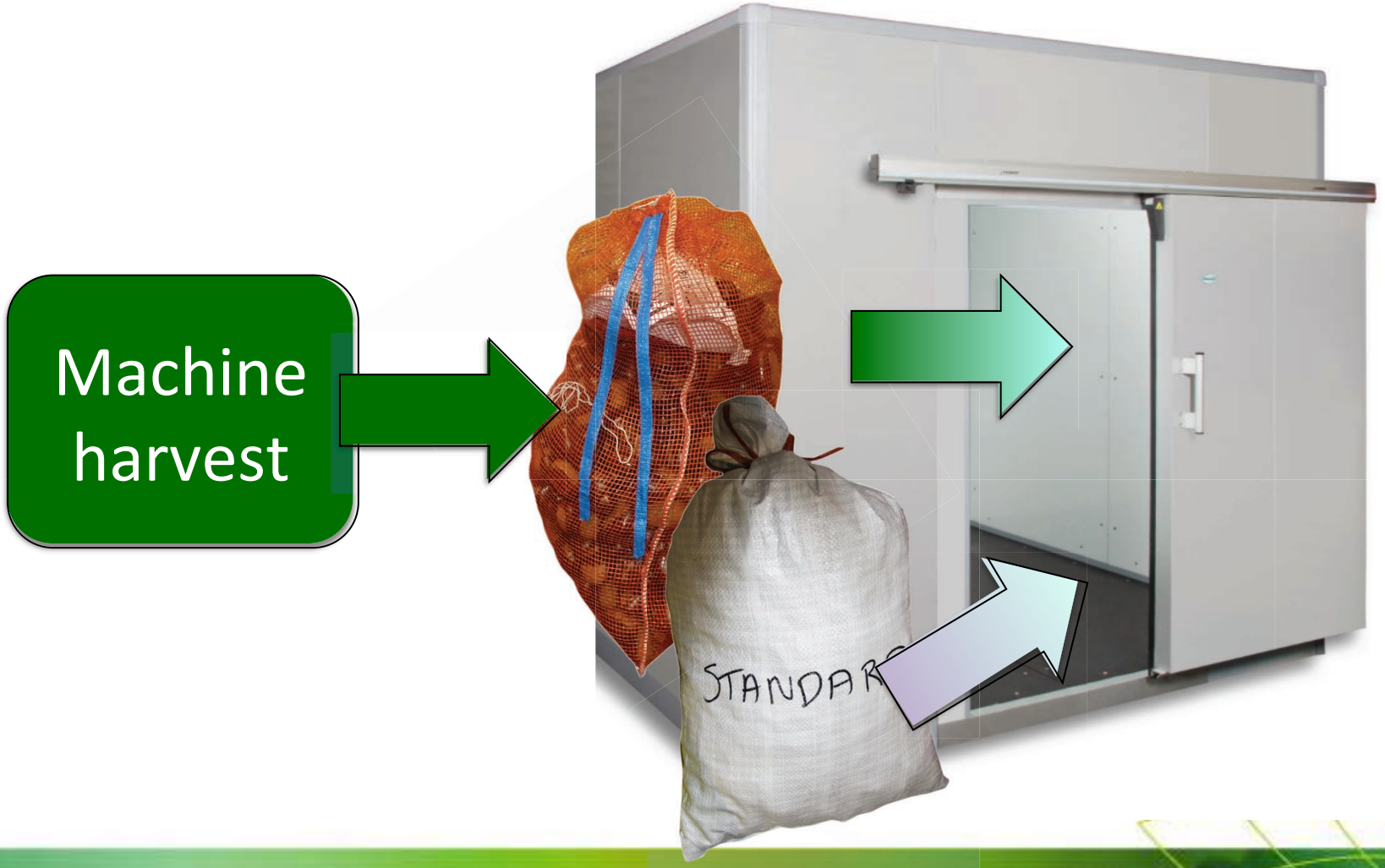
Cooling rates

- 3/4 cooling and 7/8 cooling times



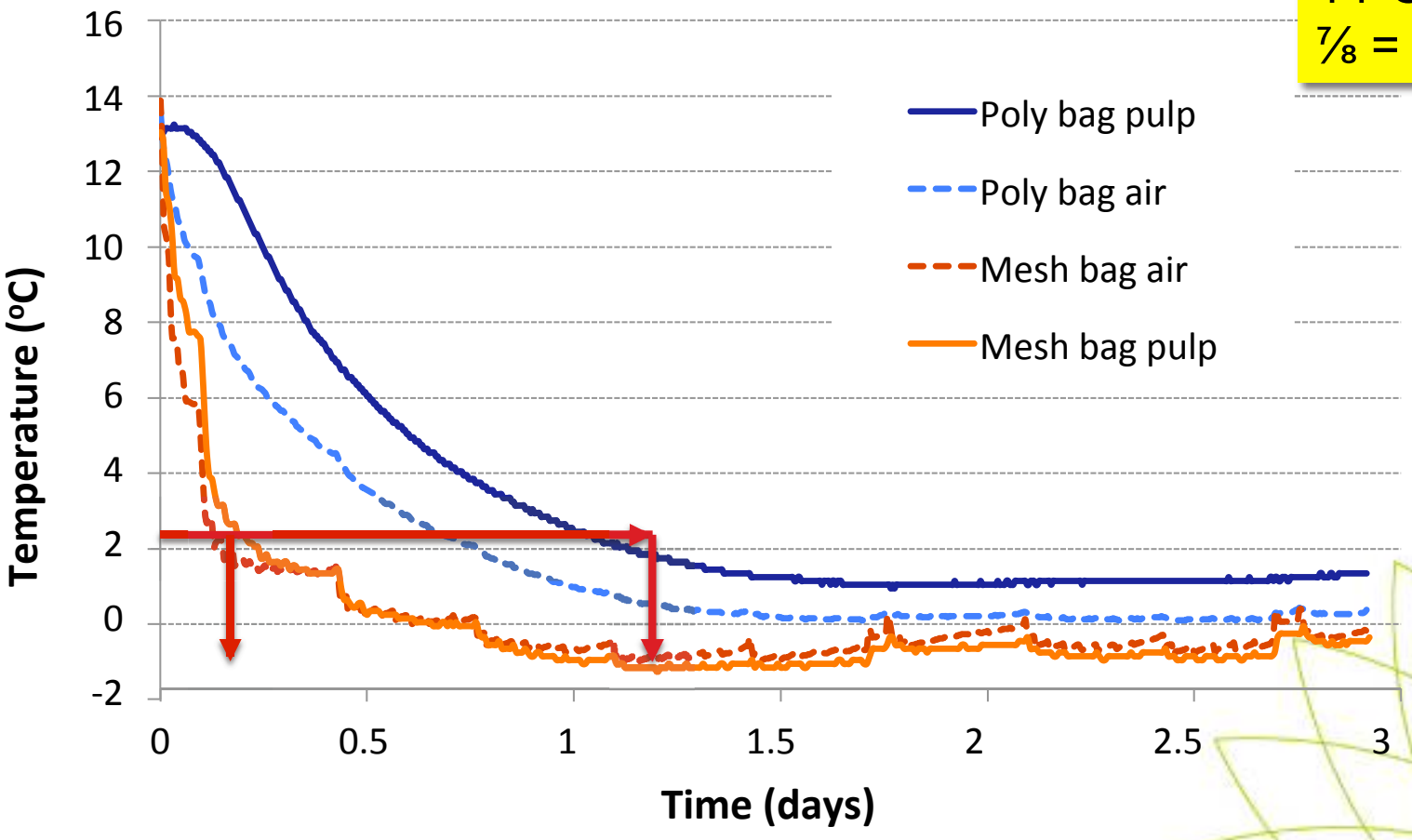
Cooling rates

Cooling rates – small grower



Cooling rates

14°C to 0°C
⅞ = 1.75°C



Cooling rates – medium grower

Machine harvest

Bin + pipes

Bin

Bin + liner

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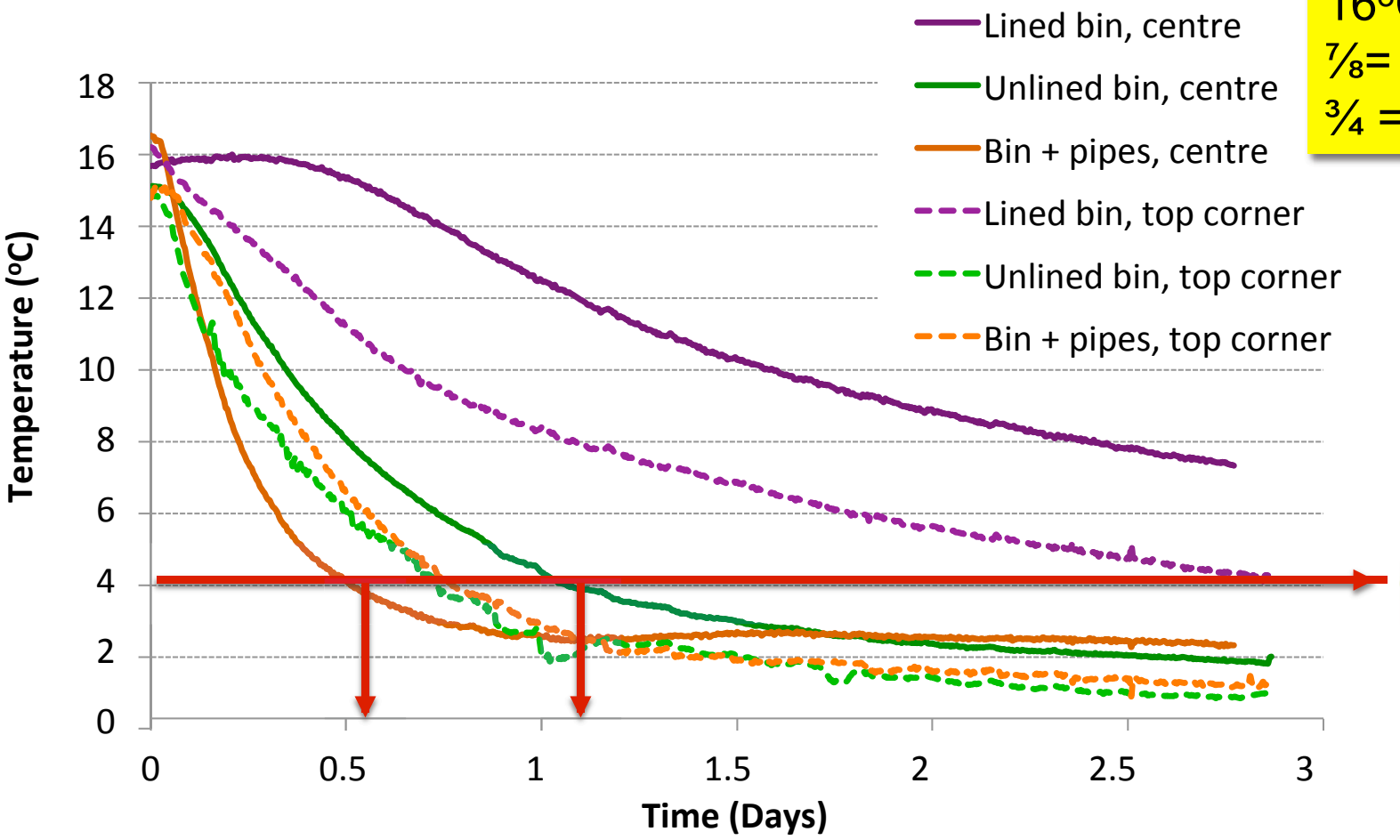
Unlined bin

Bin with pipes

Lined bin

Chestnut temperature

16°C to 0°C
⅞= 2°C
¾ = 4°C



Lined bin

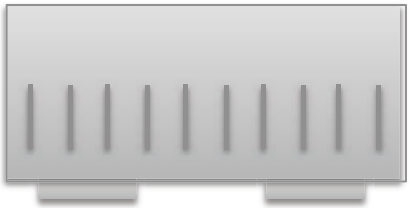
Cooling rates – large grower

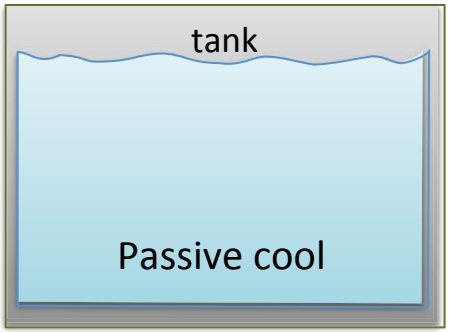
Hand harvest

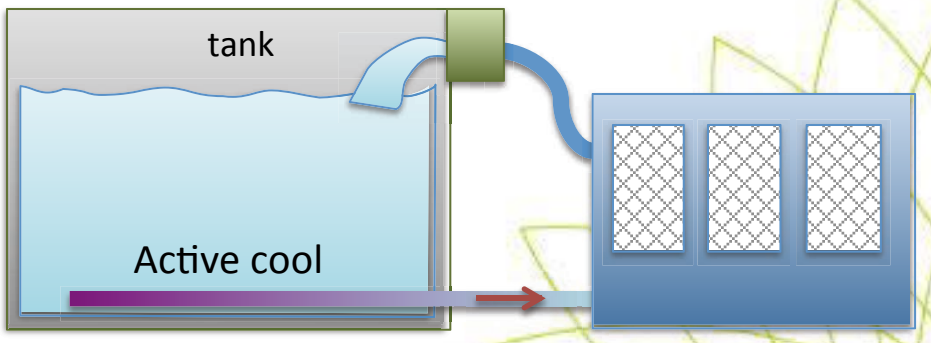
Forced air

Bin

Hydrocool







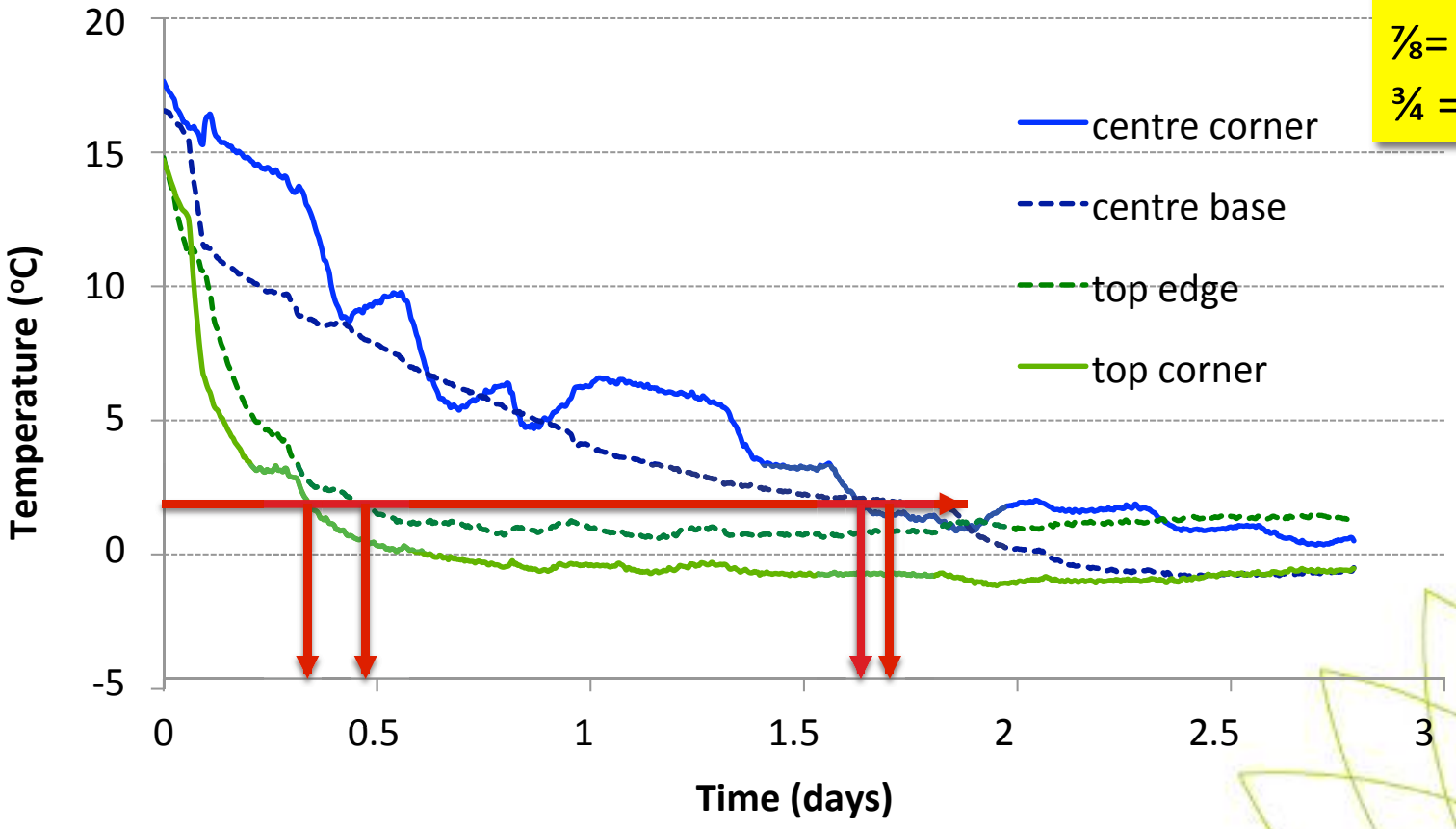
Unlined bin

Hydrocooler

Forced air system

Cooling rate – unlined plastic bin

17°C to 0°C
⅞= 2.1°C
¾ = 4.2°C



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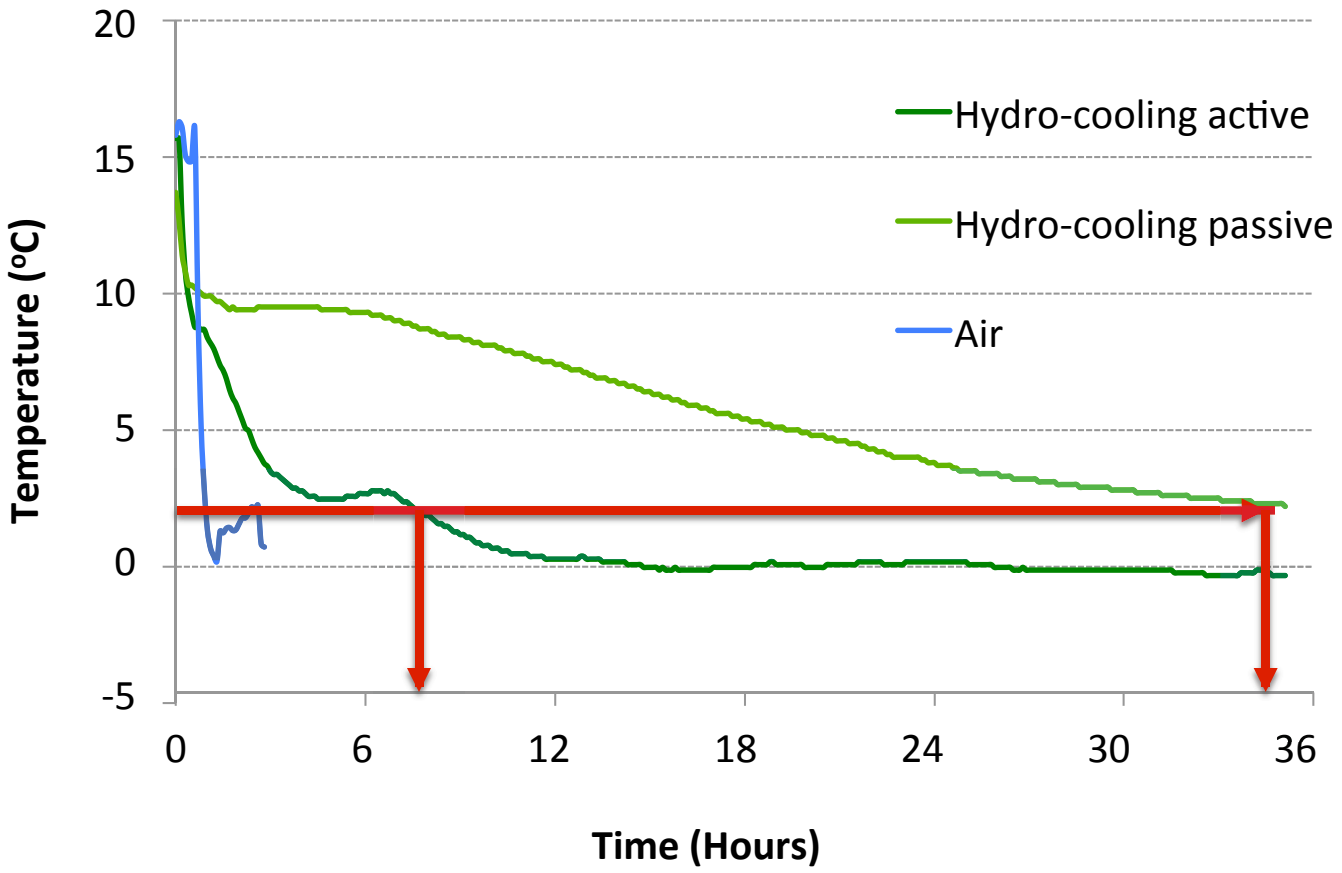
Cooling rate - hydrocooling

17°C to 0°C
⅞= 2.1°C
¾ = 4.2°C



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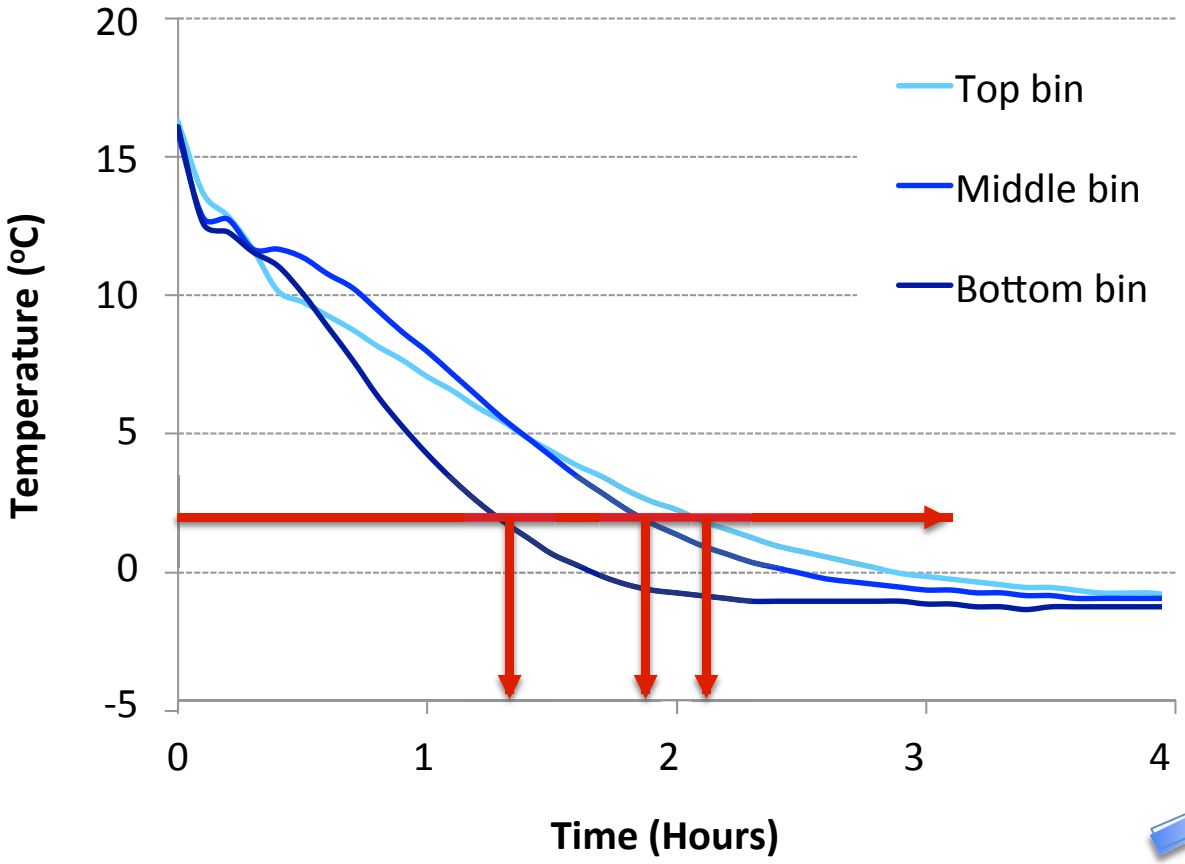
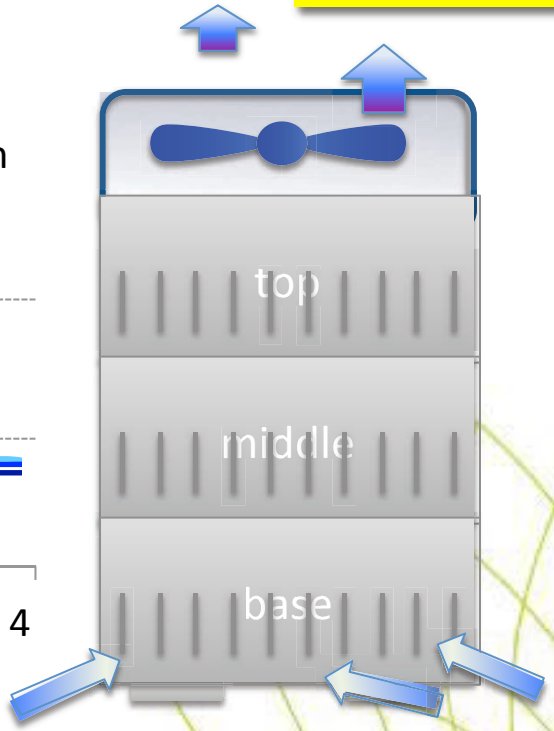
Cooling rate – Forced air

17°C to 0°C
⅞= 2.1°C
¾ = 4.2°C





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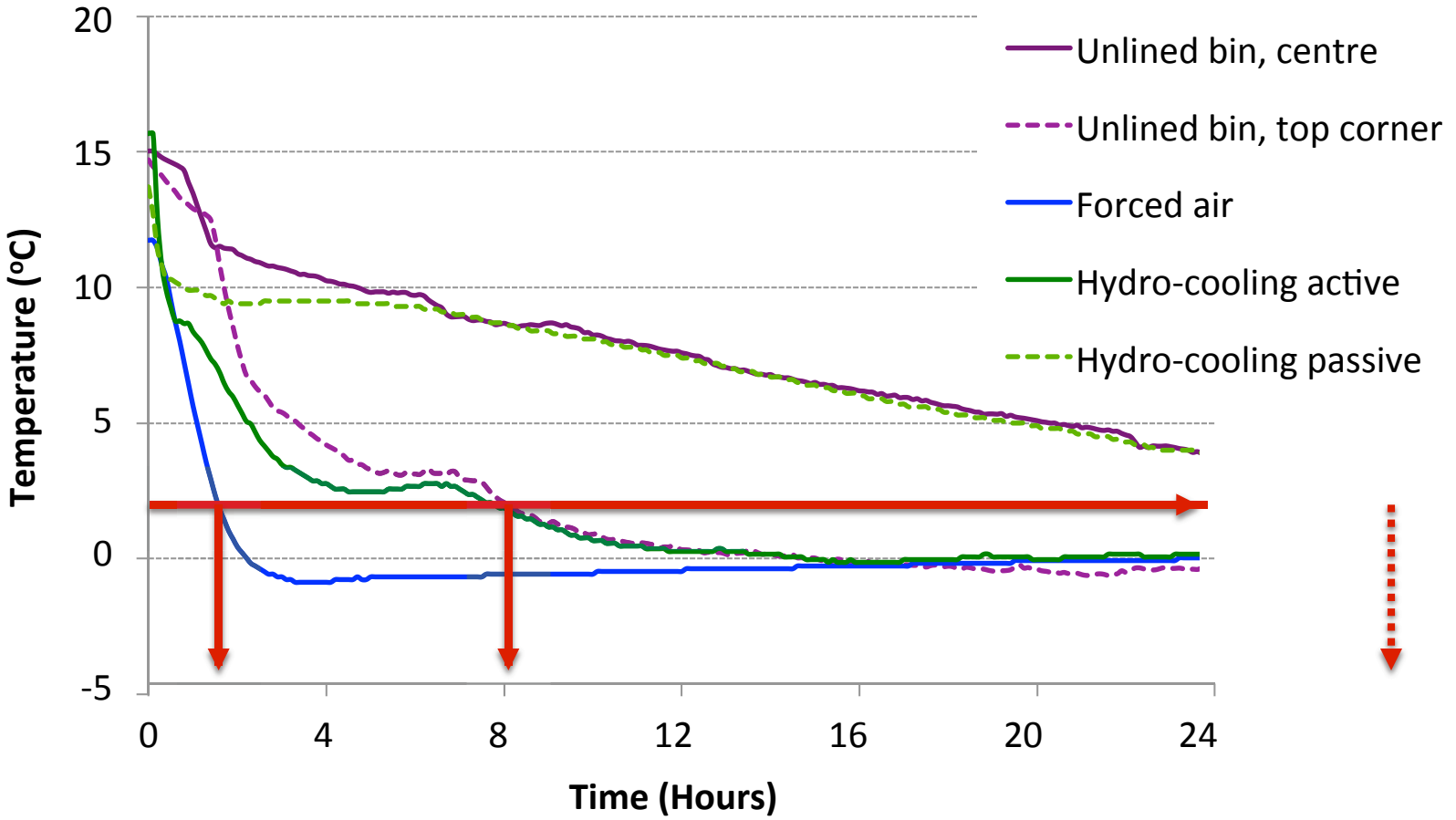
Cooling rates - all



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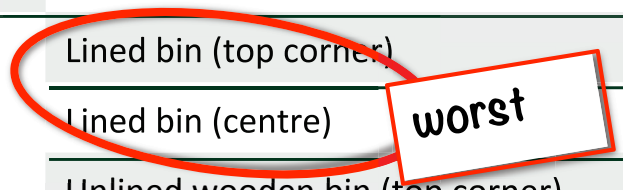
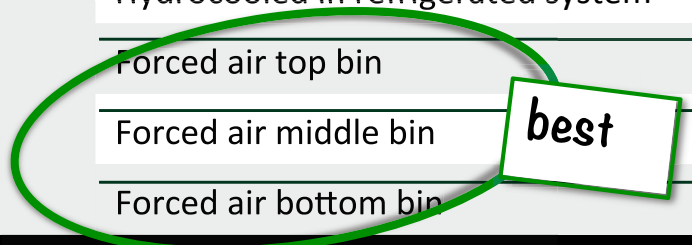
Summary of cooling rates

Farm	Cooling method	Time to ¾ cool (hours)	Time to ⅞ cool (hours)	Weight loss (avg %)
Small	Packed in PPE bag	20	29	0.2
	Packed in mesh bag	3.2	5.7	1.5
Medium	Lined bin (top corner)	68	>70	0.5
	Lined bin (centre)	>70	>70	0.1
	Unlined wooden bin (top corner)	18	24	0.6
	Unlined wooden bin (centre)	25	59	0.6
	Unlined bin + ventilation pipes (top corner)	18	32	0.4
	Unlined bin + ventilation pipes (centre)	12	>70	0.2
Large	Unlined plastic bin (top corner)	3.9	7.9	-2.3 (gain)
	Unlined plastic bin (centre)	23	38	-2.8 (gain)
	Hydrocooled in the cold room	22	35	-0.8 (gain)
	Hydrocooled in refrigerated system	2.6	7.5	-1.1 (gain)
	Forced air top bin	1.6	2.0	0.3
	Forced air middle bin	1.5	1.8	0.3
	Forced air bottom bin	1	1.2	0.3





Conclusion

- Forced air cooling was extremely effective at reducing temperature of chestnuts without increasing moisture loss
- Hydrocooling works OK, but immersion time is important
- Cooling in an unlined bin may be OK, especially if ventilation pipes are added
- Warm chestnuts should NEVER be placed in a lined bin!!

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Freezing damage

- Development of freezing damage is a factor of **TIME** not just **TEMPERATURE**
- Freezing symptoms include:

Rancidity

Discolouration

Weight Loss

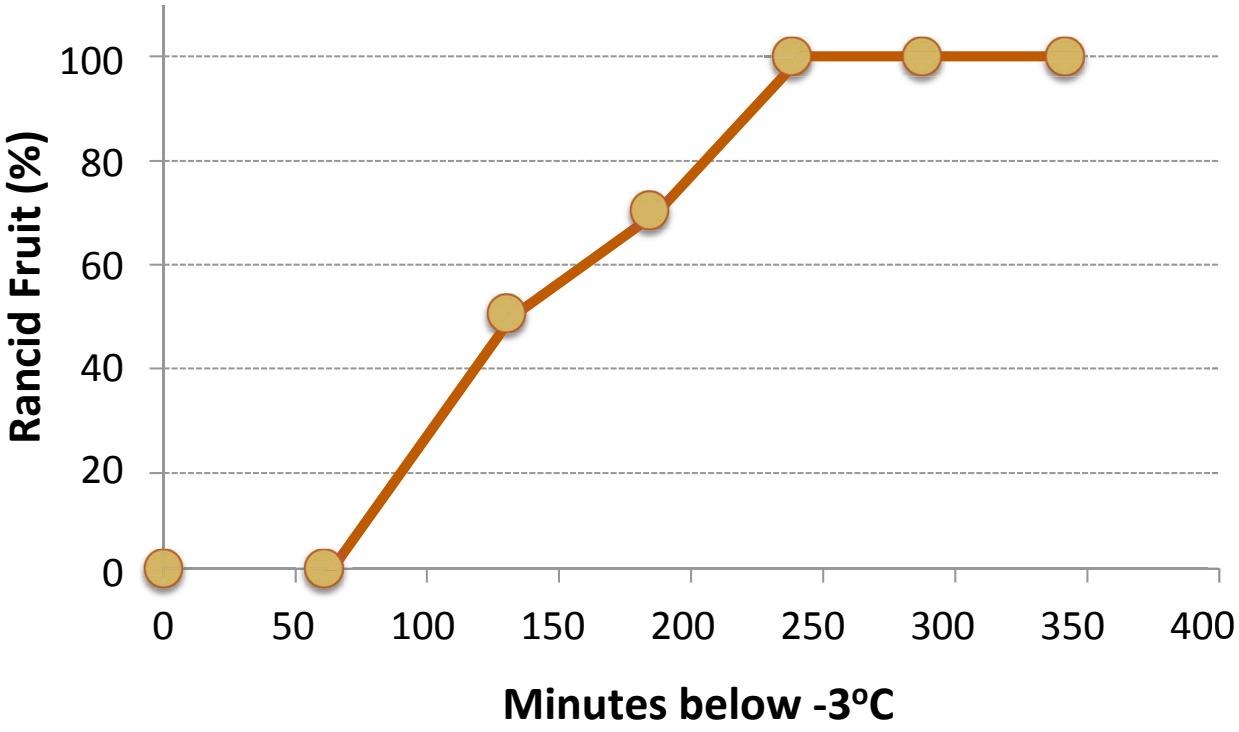
Freezing damage

approx. -2.5°C

approx. -3.5°C

Freezing damage

- Converted into “time below -3°C”



Conclusion

NO damage occurred in chestnuts that went only to **-1°C**

SLIGHT damage occurred to *some* chestnuts that went below **-2°C** (*but these were stored fruit*)

MODERATE damage occurred when chestnuts went below **-3°C**

MOST chestnuts that went below **-4°C** were damaged

ALL chestnuts that went to **-5°C**, even briefly, were damaged

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How much does storage temperature matter?

April Gold

0˚C

5˚C

4 weeks

8 weeks

15 weeks

How much does storage temperature matter?

Red Spanish

0˚C

5˚C

4 weeks

8 weeks

15 weeks

And now…..

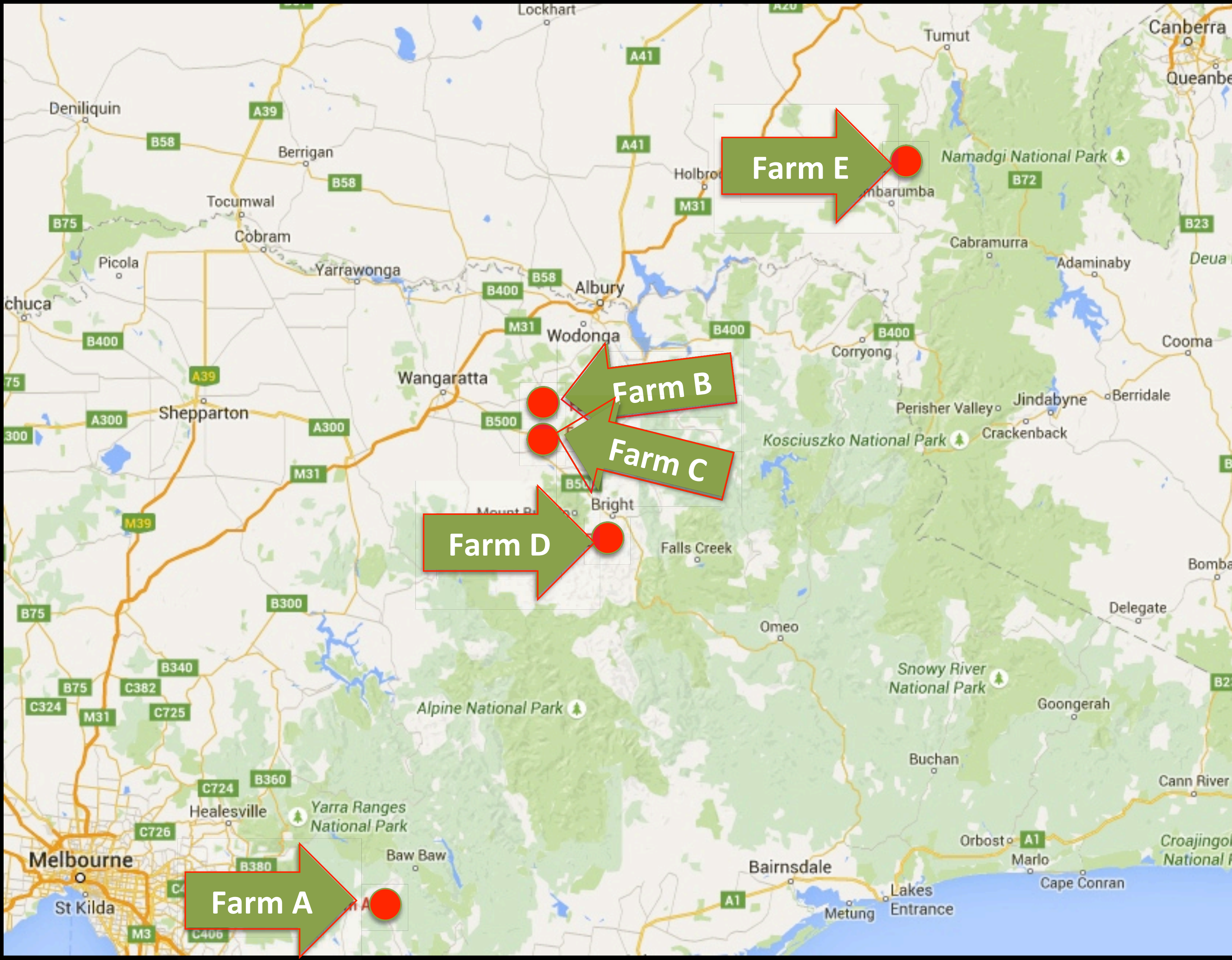
Domestic supply chains

- Cooling on farm – SORTED (*mostly*)
- But what happens once the chestnuts leave the farm?
- Reports of chestnuts arriving at wholesale at >30°C

Aim: Monitor temperatures within a range of supply chains, from farm to retail

Supply chains

Supply chain	Supply chain destination	Farm ID	Farm location	Chestnut cultivar	Date of setup
1	Sydney	A	Yarra Valley, Victoria	Purtons Pride	27/4/15
2	Sydney	D	Alpine Victoria	Red Spanish	29/4/15
3	Sydney	E	Alpine NSW	Purtons Pride	30/4/15
4	Brisbane	A	Yarra Valley, Victoria	Purtons Pride	27/4/15
5	Melbourne	A	Yarra Valley, Victoria	Purtons Pride	27/4/15
6	Perth	B	Alpine Victoria	Red Spanish	28/4/15
7	Adelaide	C	Alpine Victoria	April Gold	28/4/15
8	Adelaide	D	Alpine Victoria	Red Spanish	29/4/15

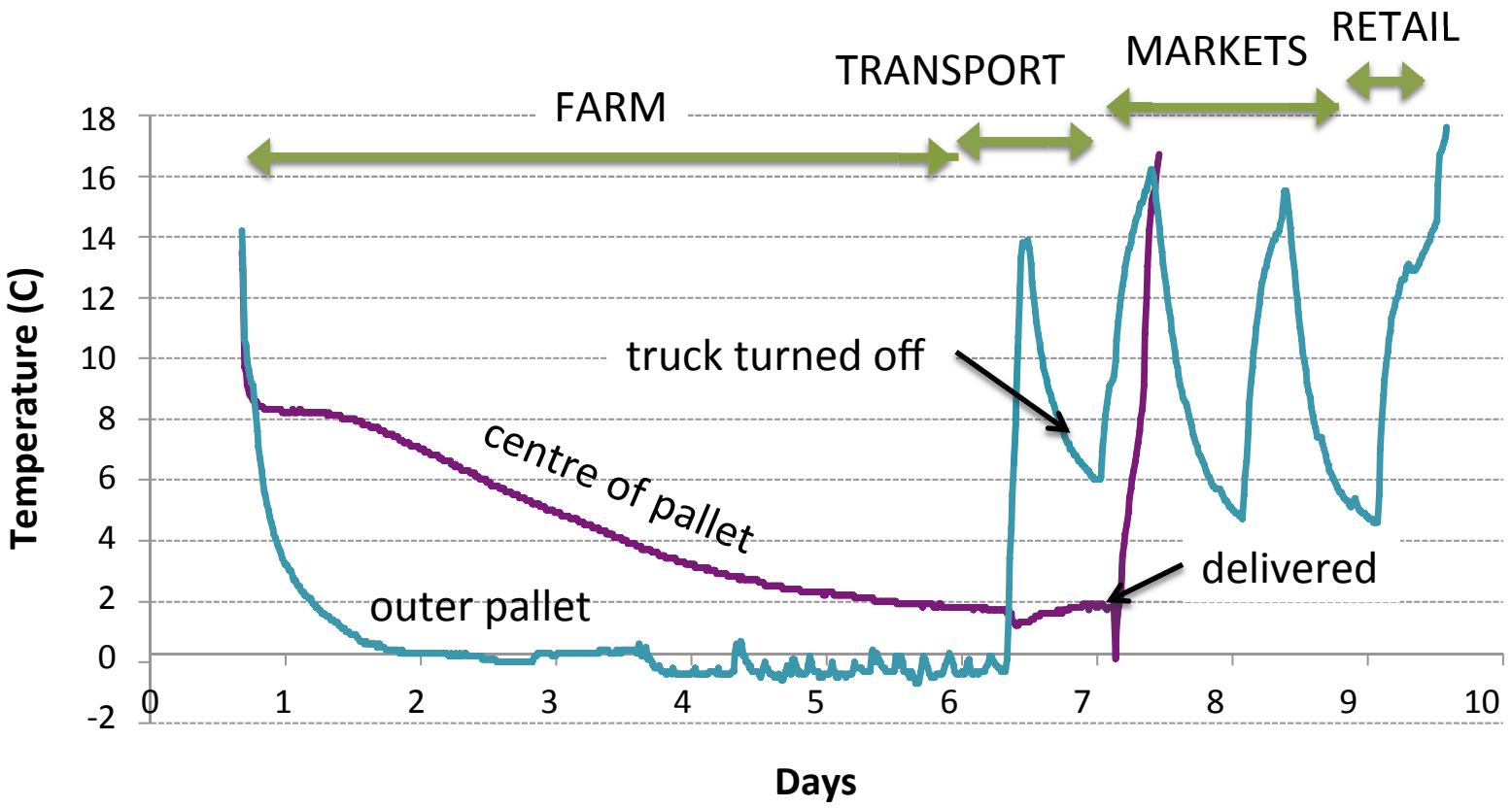

Farm E
Farm B
Farm C
Farm D
Farm A
Canberra
Queanbeyan
Tumut
Namadgi National Park
Holbrook
Deniliquin
Berrigan
Tocumwal
Cobram
Picola
Yarrawonga
Albury
Wodonga
Corryong
Cabramurra
Adaminaby
Cooma
Wangaratta
Shepparton
Perisher Valley
Jindabyne
Berridale
Crackenback
Kosciuszko National Park
Bright
Falls Creek
Omeo
Bombala
Delegate
Snowy River National Park
Goongerah
Alpine National Park
Buchan
Cann River
Healesville
Yarra Ranges National Park
Baw Baw
Melbourne
St Kilda
Bairnsdale
Orbost
Marlo
Cape Conran
Lakes Entrance
Metung

Temperature monitoring

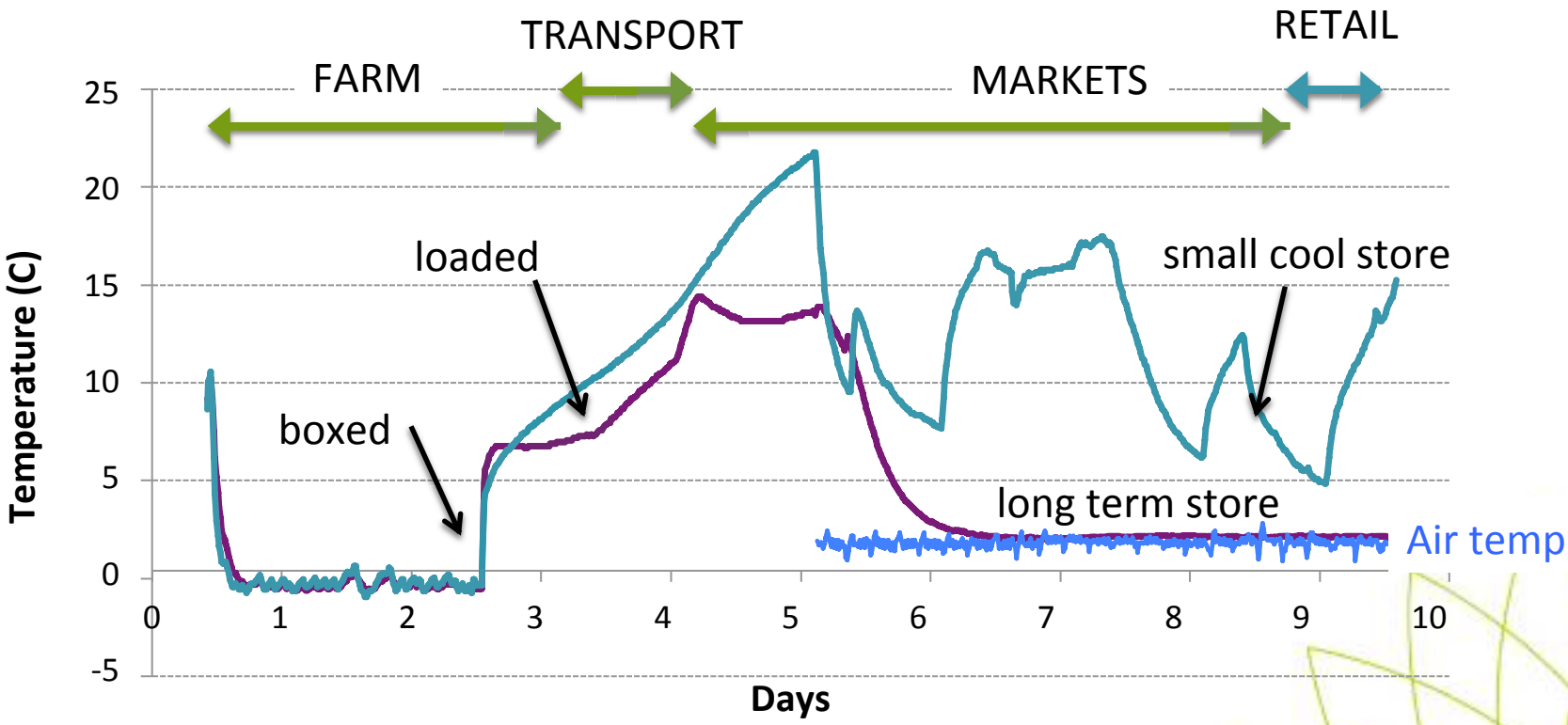
LogTag

i-button

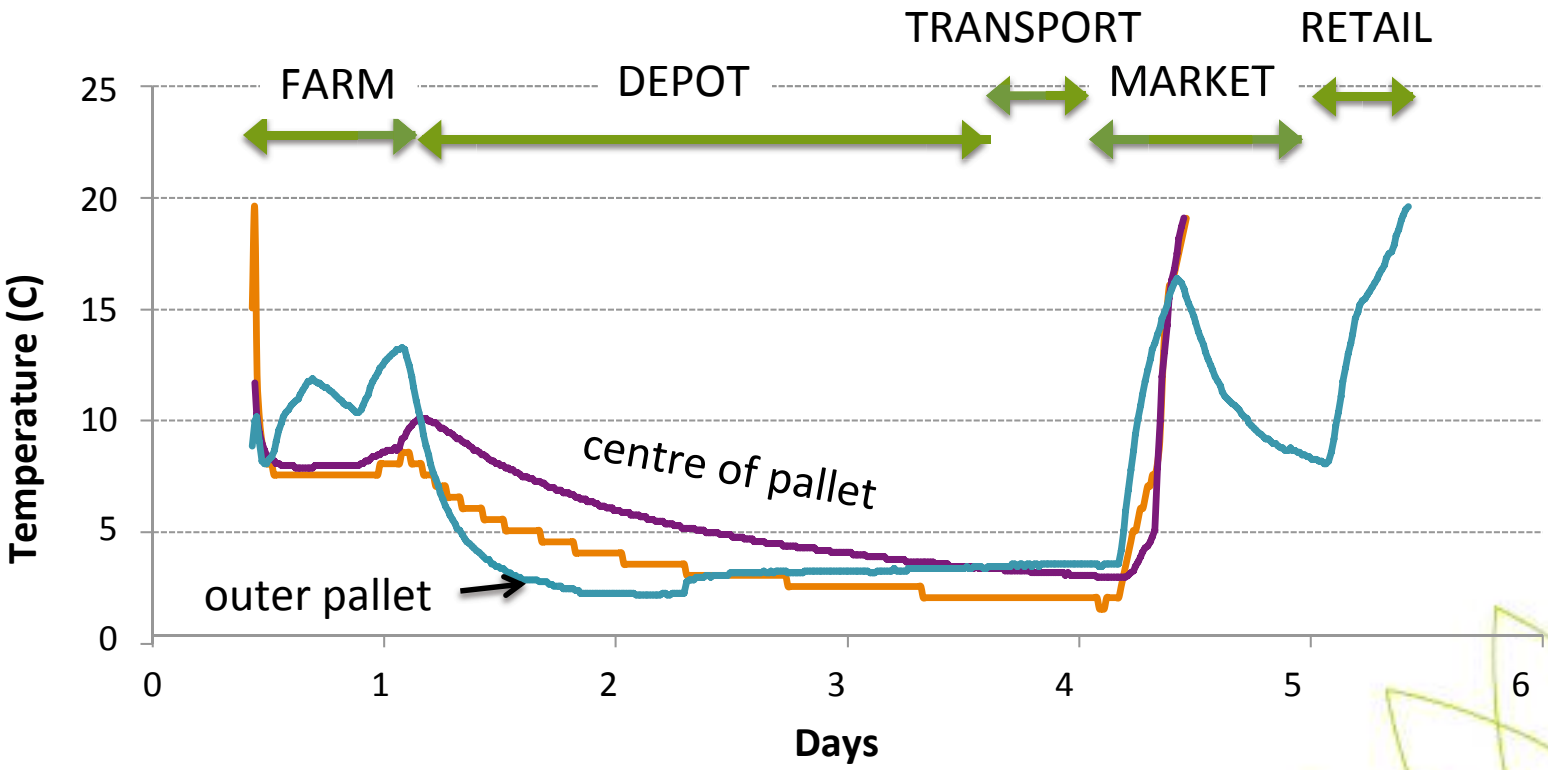
Supply chains to Sydney - 1



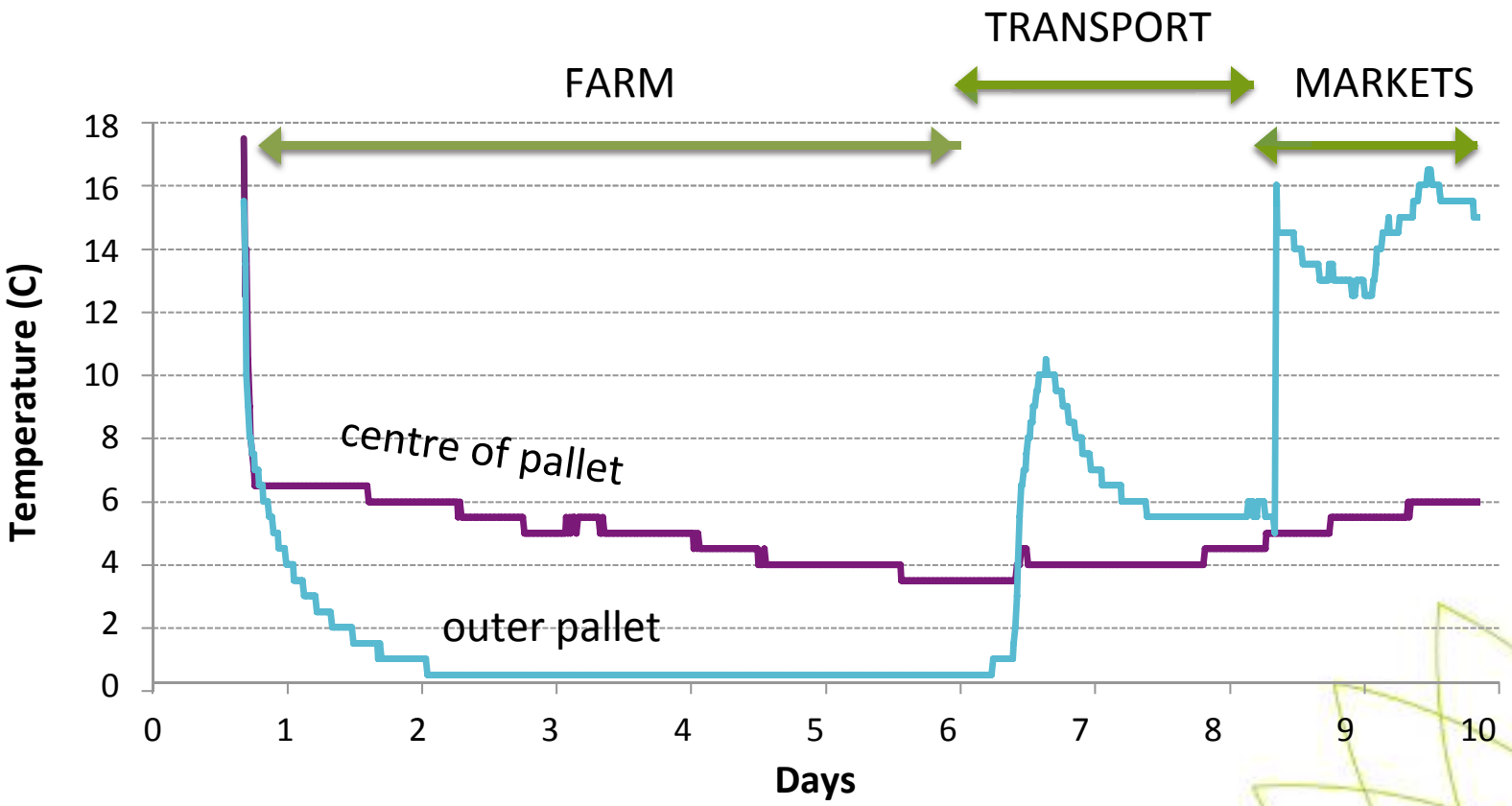
Supply chains to Sydney - 2



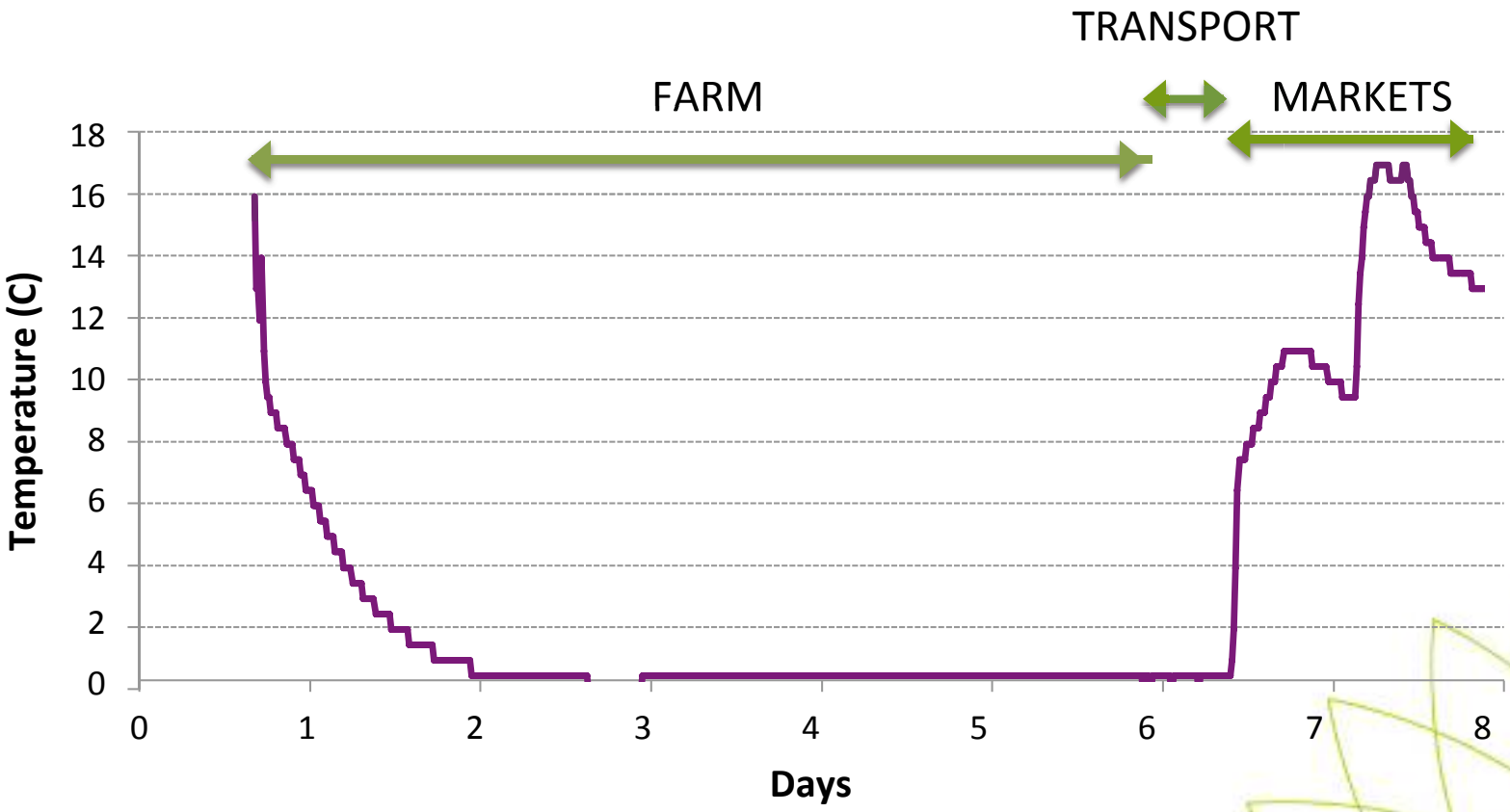
Supply chains to Sydney - 3



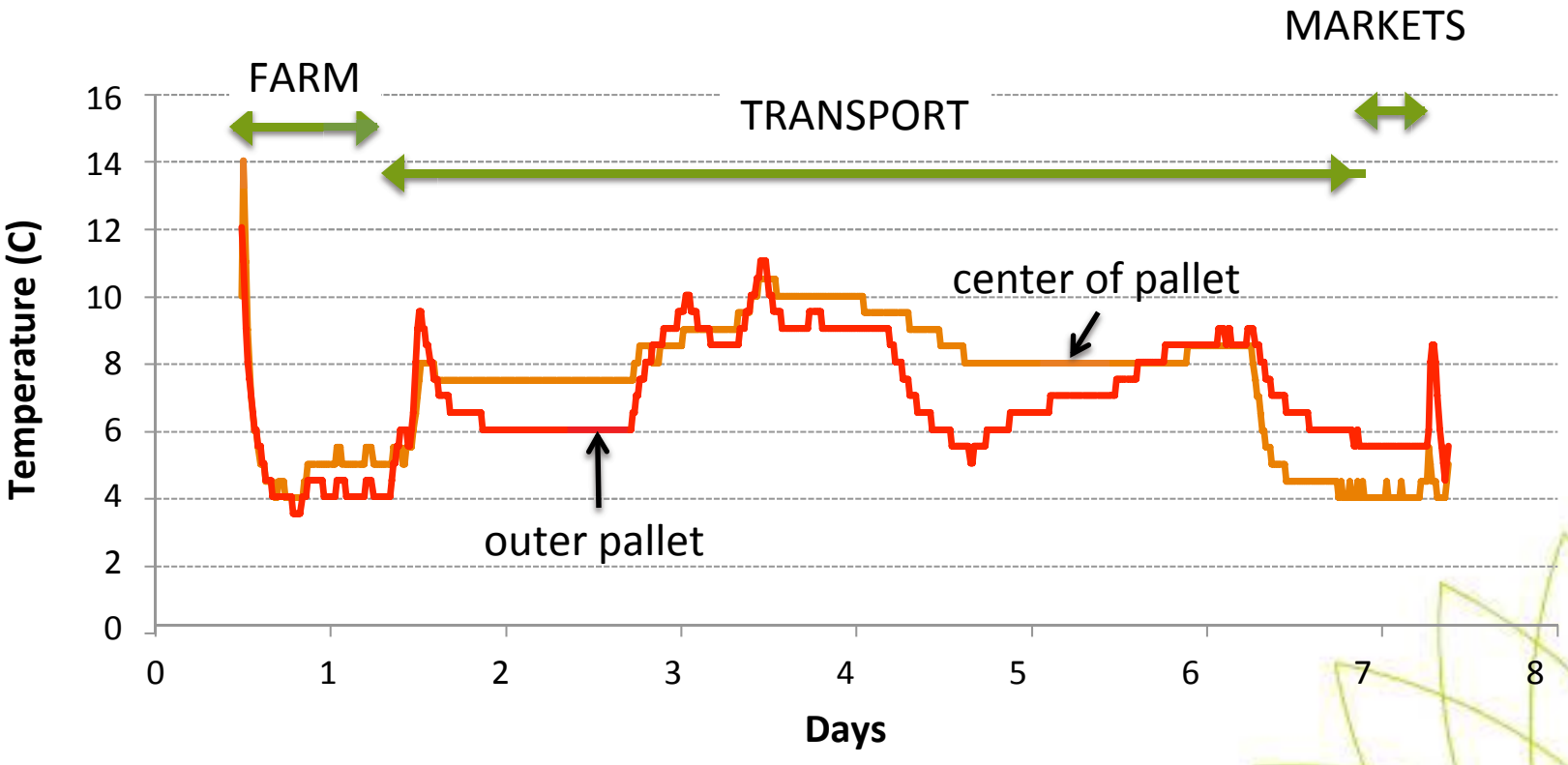
Supply chain to Brisbane - 4



Supply chain to Melbourne - 5



Supply chain to Perth - 6



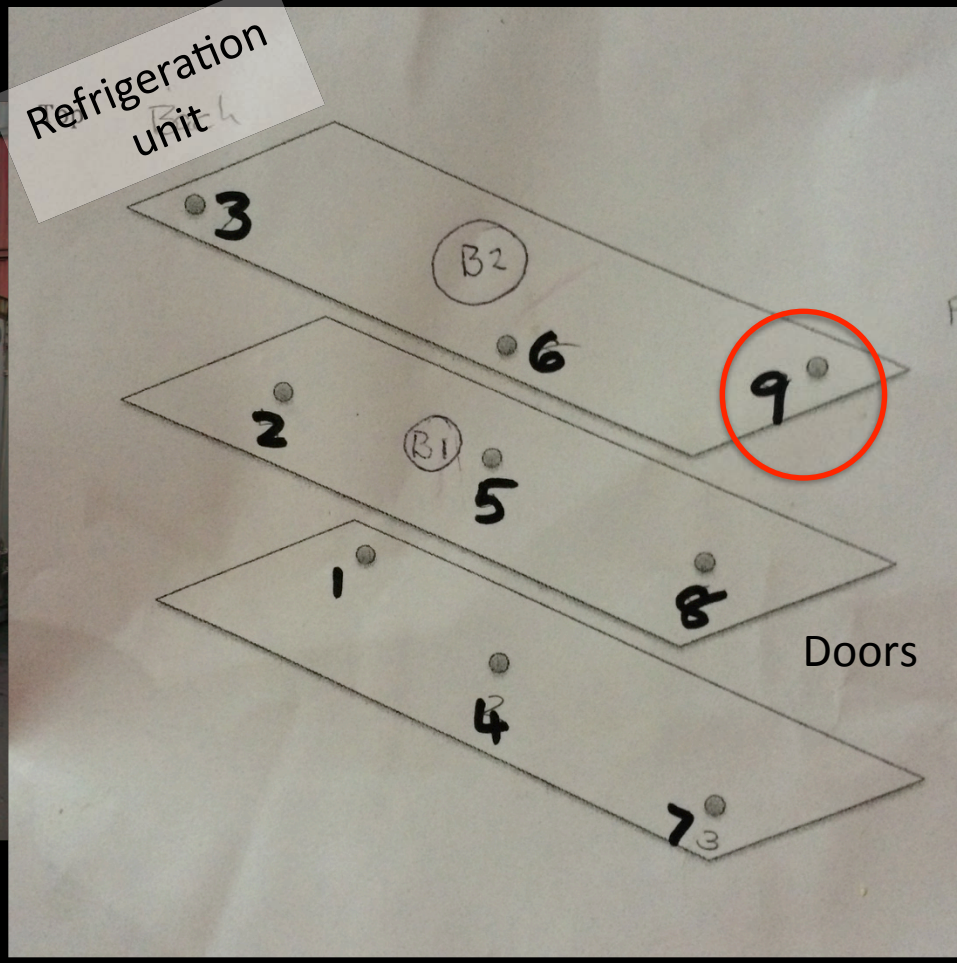
Conclusions

- On farm
  - Chestnuts can take several days to fully re-cool after packing if inside a bag at the centre of a pallet
- Transport
  - Temperatures were highly variable depending on position in the truck
  - Temperatures during transport generally **5 - 12°C** BUT one sack increased to **22°C**
- Markets
  - Long term storage in cool store optimised and stable conditions
  - Chestnuts not always placed straight into cold room on arrival
  - Market stand to cold room fluctuations >10°C

Supply chain Melbourne to China

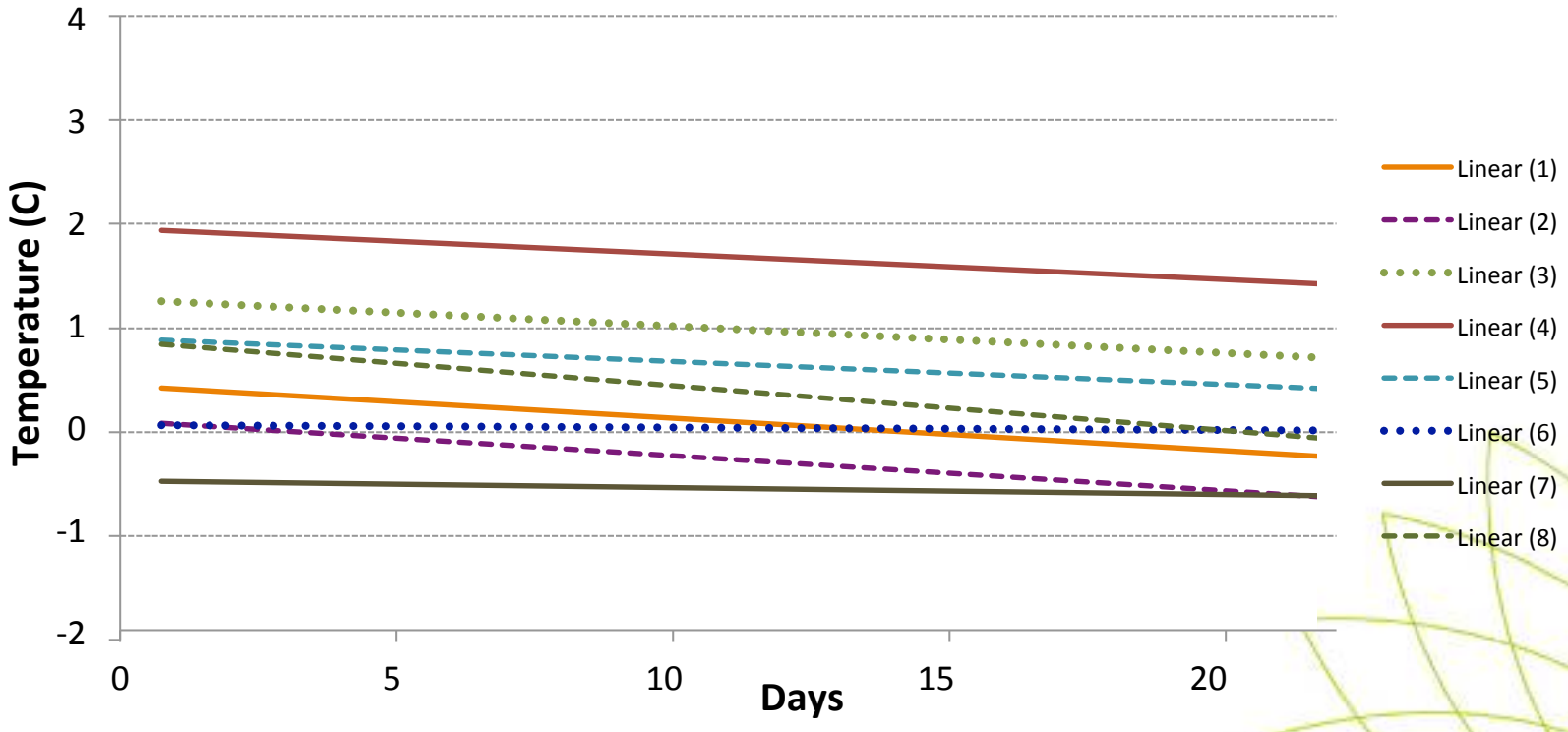
- Chestnuts exported from Australia to China for processing, then returned as processed, ready to eat product
- Previous issue with colour variation:
  - CO2 damage?
  - Freezing damage?

- Loggers inserted into chestnuts, bags loaded into container

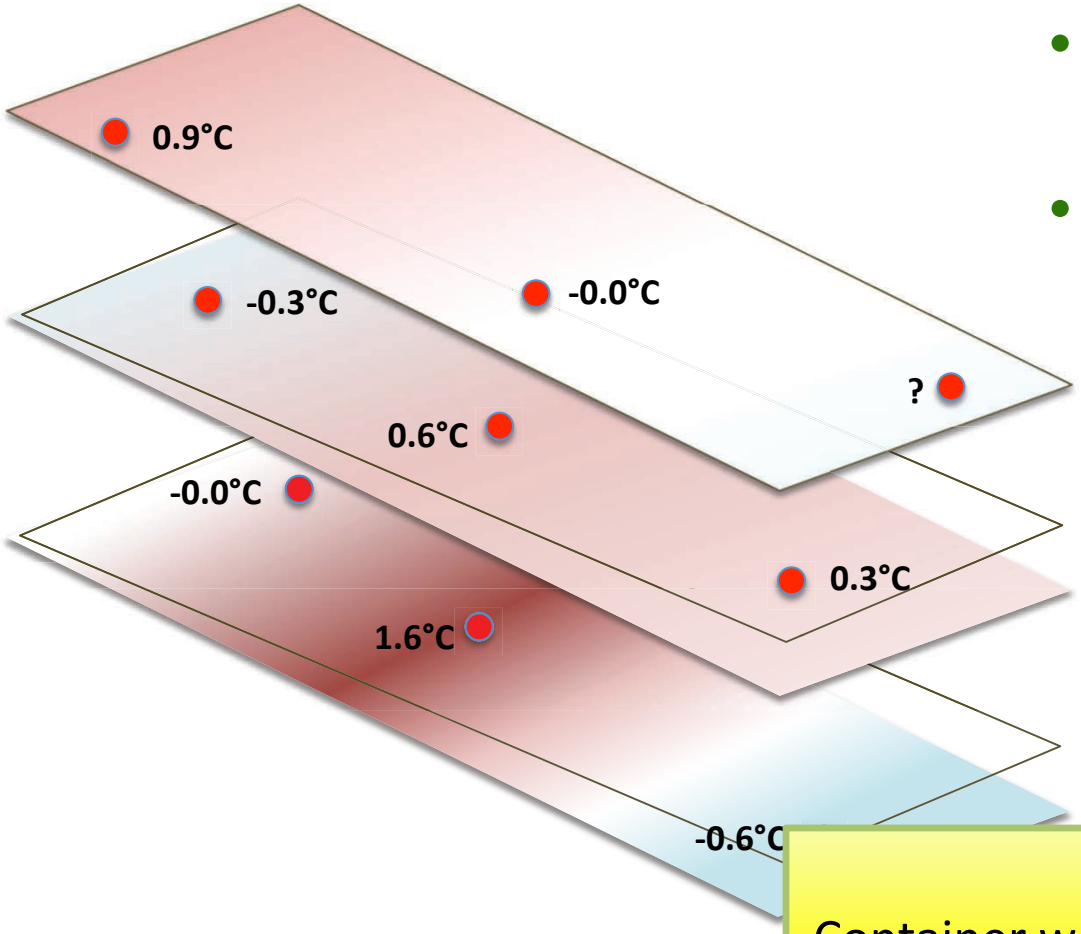

Refrigeration unit
3
B2
6
9
2
B1
5
1
8
Doors
4
7

Temperatures

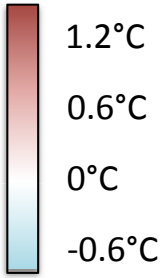
- Temperatures were very stable at each point, tending to fall slightly during shipping



Temperatures



- Temperature ranged from min -1°C to max 2°C
- Outturn quality good



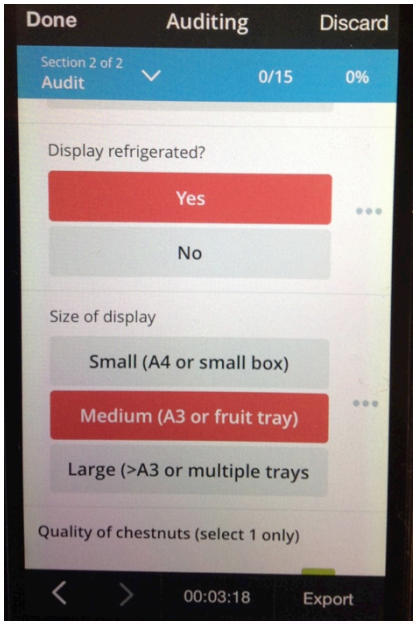
Summary:
Container worked well, ventilation rate OK

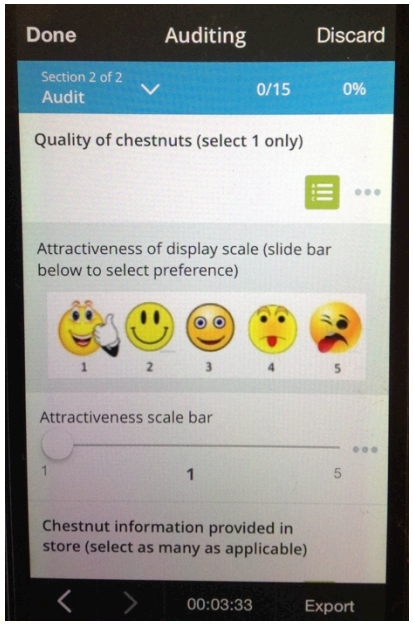
Retail survey

- Aim: *To assess the type and quality of displays used for chestnuts and price and visual quality of chestnuts sold*
- 39 retailers visited
  - 16 greengrocers, 23 supermarkets
  - Display refrigerated or not, size and attractiveness
  - Chestnut visual quality
  - Information provided?
  - Price $/kg
  - Display temperature

Retail survey

- App developed to make data collection easier
- Includes a photograph of each display
- Temperature with IR temperature gun

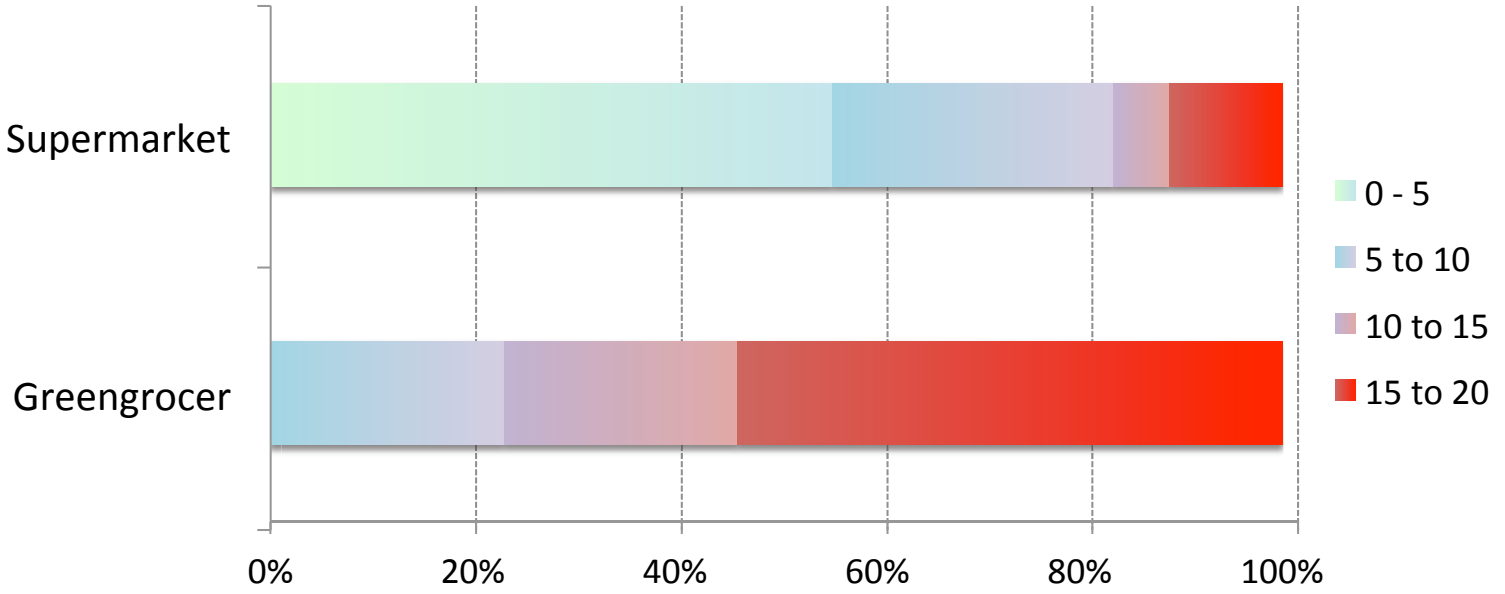




Retail survey – refrigerated?

- Supermarkets use refrigeration, most fruit and veg shops don't

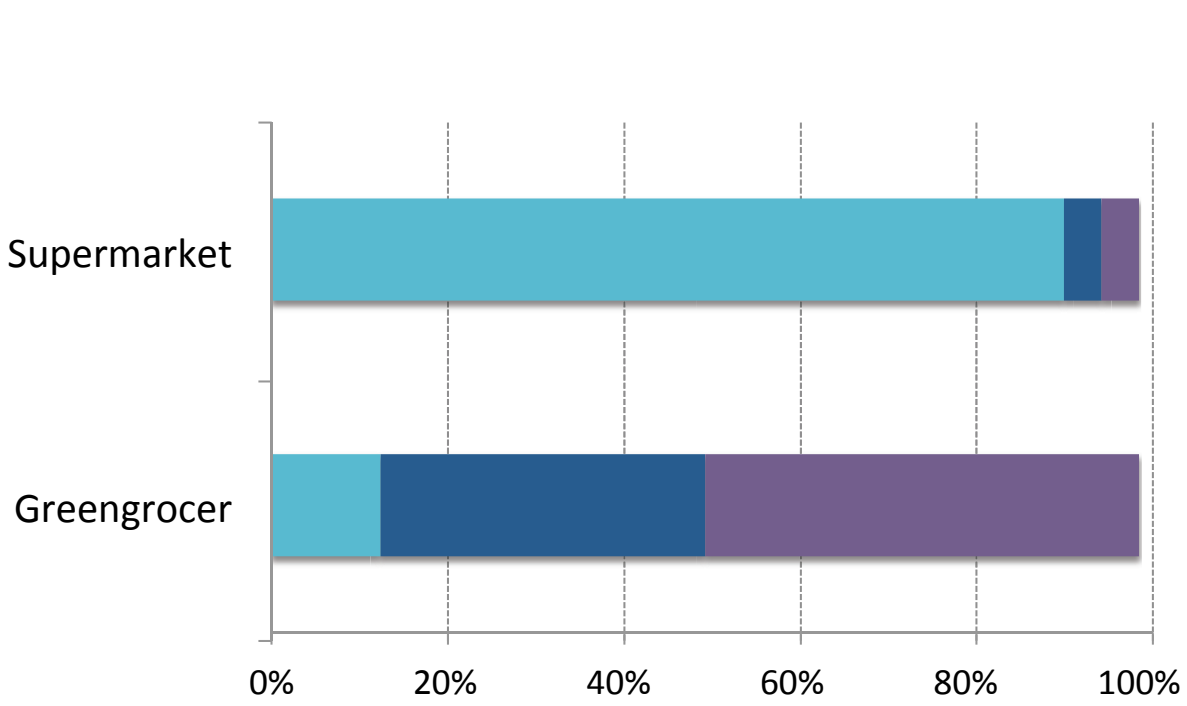
….so temperatures are higher in supermarkets



average temperature: supermarket = 5.7°C, greengrocer = 13.8°C

Display format

- Supermarkets had smaller displays than greengrocers



Small = A4 or small box

Medium = A3 or fruit tray

Large = >A3

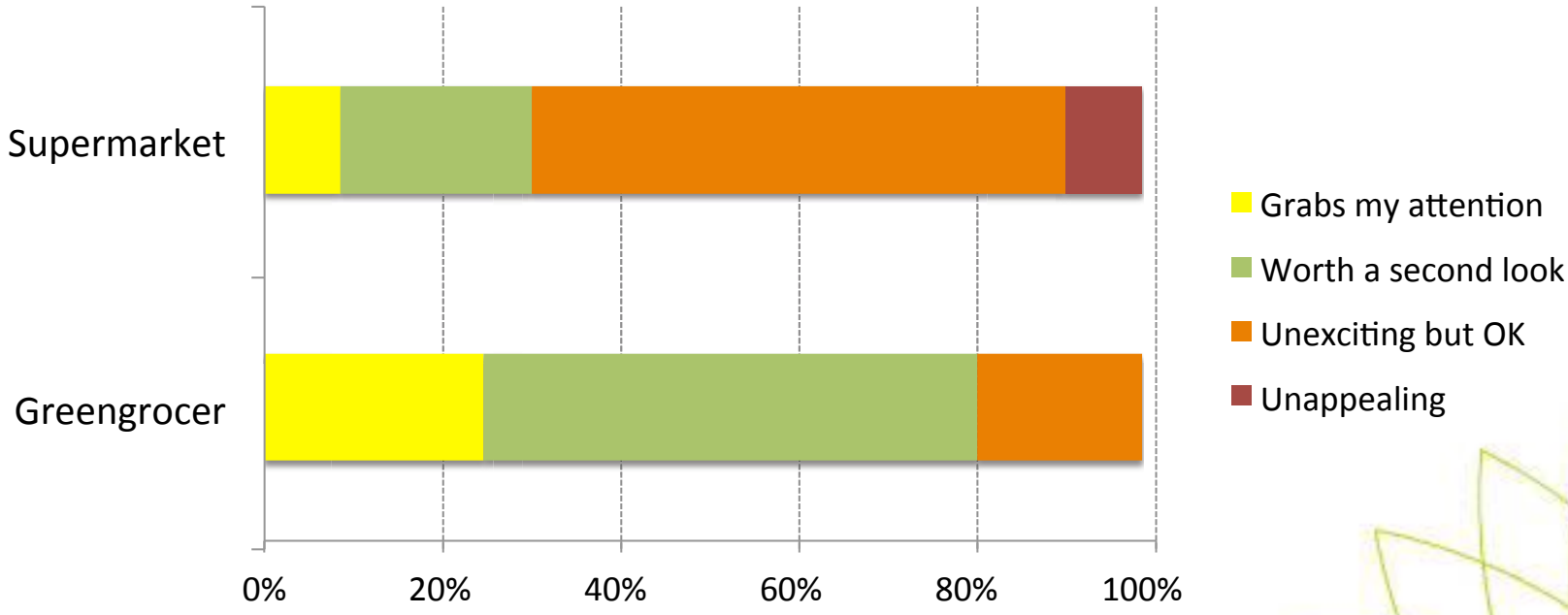

NATURAL
Any 2 for
SAVE
Caramel Dip Sauce


$13 kg

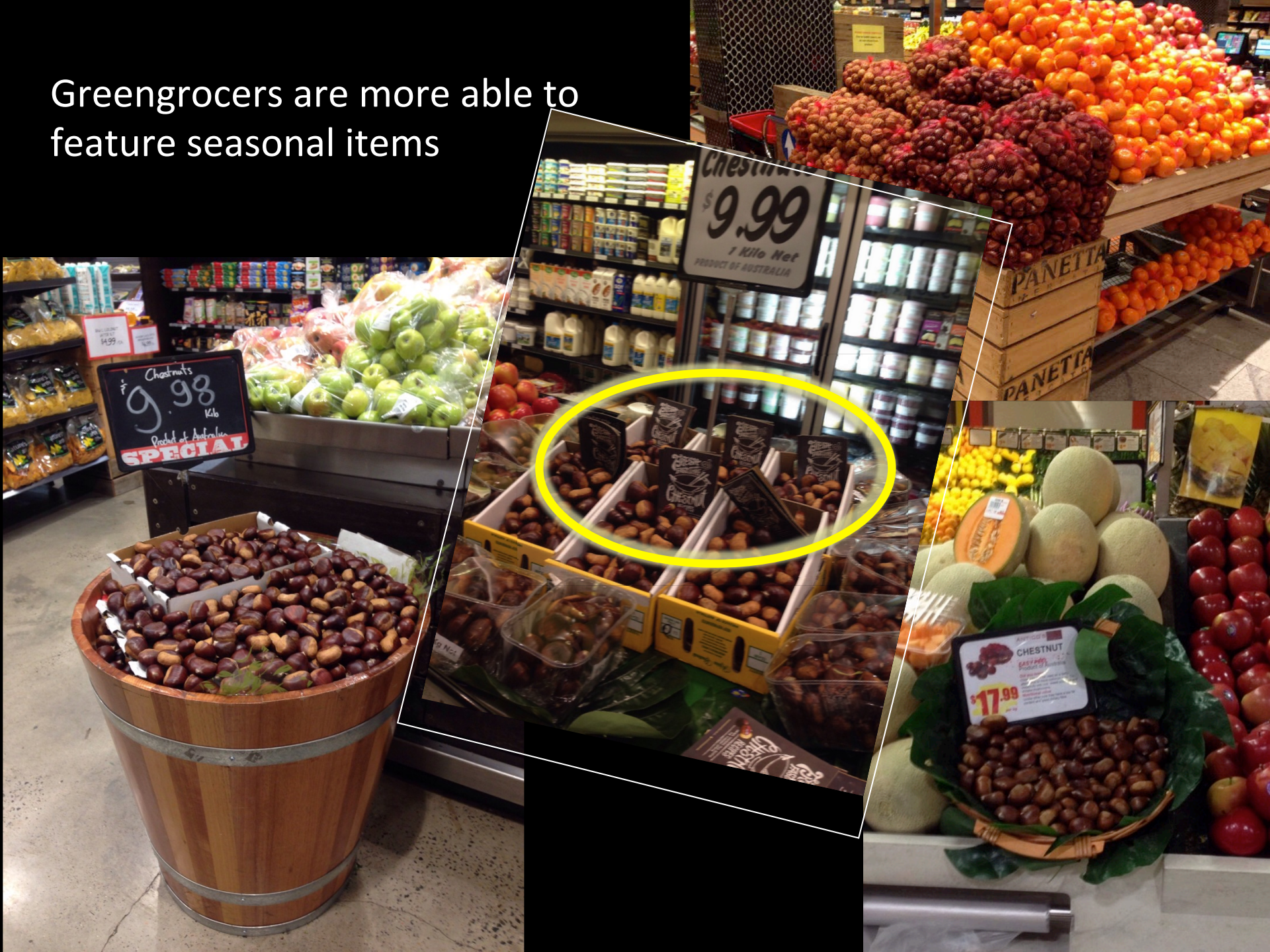
Chestnuts are lost amongst other, larger displays

Display attractiveness

- Greengrocer displays were often more attention grabbing



Greengrocers are more able to feature seasonal items



FruitEzy Chatswood

Definitely the Best!

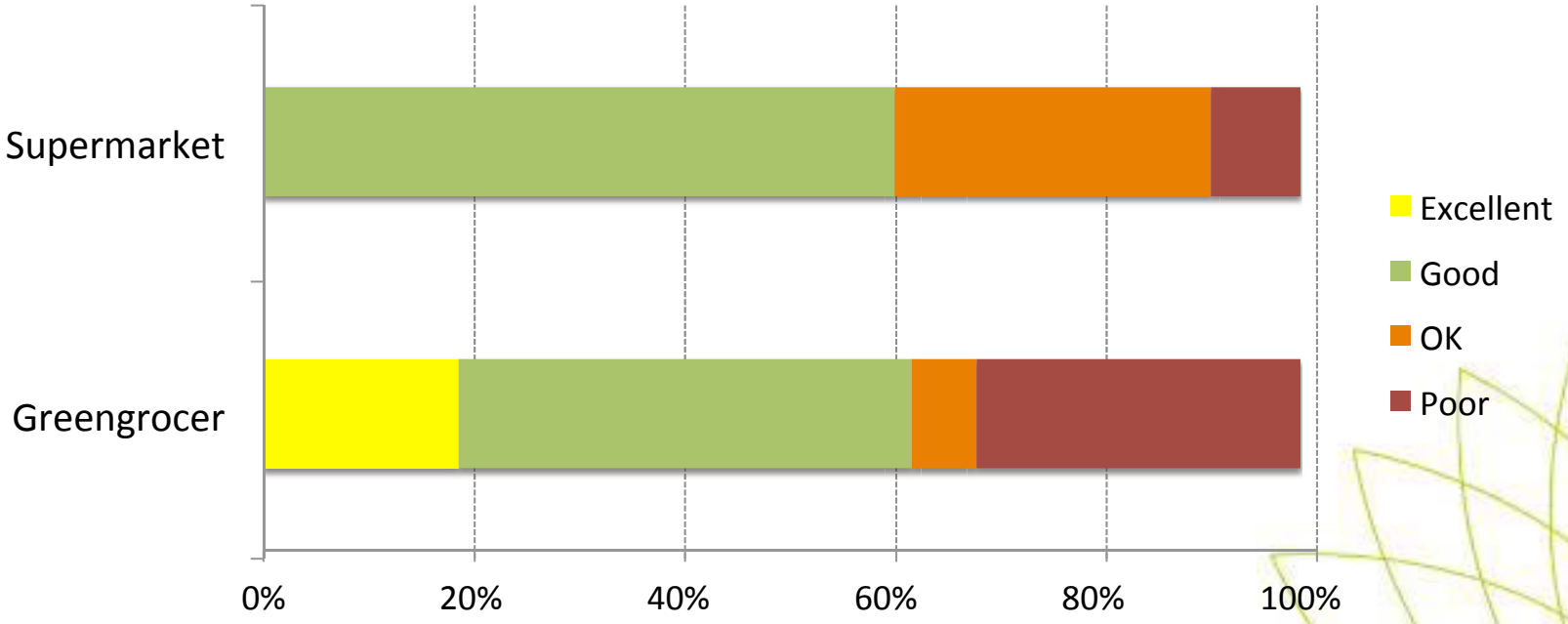

$3.60
CAUTION
HOT SURFACE
CORDON BLEU


CORDON BLEU
CAUTION


CORDON BLEU

Quality of chestnuts

- Major retailers generally Good – OK quality
- Greengrocers variable



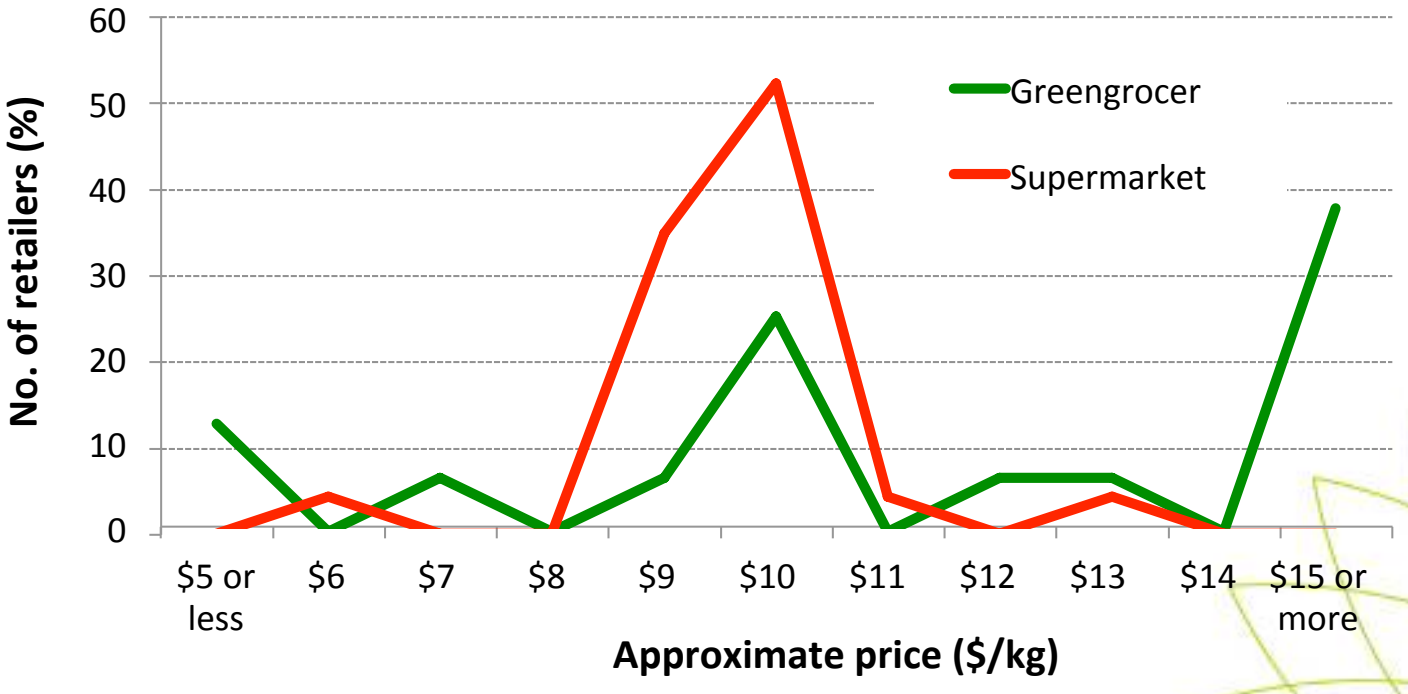

CHESTNUT
$12.99
KG
PRODUCT OF AUSTRALIA
PLU 6801


STRAWBERRIES
$ 3.48
STRAWBERRIES
$ 3.48
CHESTNUTS
$ 6.78


Fresh
Chestnuts
$12.99
$8.99
KG

Price of chestnuts

- Retail prices generally $9 - $10/kg
- Greengrocers often matched, but more stores with higher or lower prices



Conclusions

- Major retailers are a reliable source of chestnuts
  - Good / OK quality
  - Refrigerated
  - Displays small, little visual impact
- Independent greengrocers more variable
  - Displays sometimes large, elaborate, but unrefrigerated
  - Chestnuts in 1kg net bags
  - Poor quality = low price
- Lack of point of sale material a continuing concern


Thanks!