

## Vegetable Industry Development Program

# Post Harvest Management for Vegetables

## Facts on preventing losses

### What does 'post harvest' mean?

Post harvest activities include cooling, curing, handling, storage, processing, packaging, transport and the market phase. Post harvest management is about maintaining quality from production in the paddock to the vegetables being placed on a plate for consumption. Maintaining vegetable quality requires good systems and communication throughout the supply chain as each step is influenced by the previous; it is a chain of interdependent activities.

### Why is it important?

An estimated 10 to 40% of the food that is grown is never eaten because of damage, rotting, pests, and the consumers' demand for "perfect" produce. Generally, fresh produce losses are higher than those of processed food. These losses are often higher in warmer, more humid climates as in Northern Australia. The climate makes it more difficult to control diseases in the field, and take out field heat. Long transport distances also make it more challenging to maintain an adequate cool chain.

Post harvest losses mean that production resources such as land, water, energy, fertilisers, labour and effort are wasted, and ultimately, profitability for growers is reduced.



### How do vegetables get wasted after harvest?

Minimising wastage requires a focus on quality throughout the supply chain.

Many post harvest losses are a direct result of production management. Vegetables that are affected by weeds, pests and diseases, inappropriately irrigated and fertilised, generally of poor quality before harvesting, or harvested past optimum maturity can never be improved by post harvest treatments.

Vegetables are living, breathing parts of plants and contain 65 to 95% water. Once harvested their internal food and water reserves decline over time and vegetables deteriorate and rot. Anything that increases the rate at which food and water reserves are used up increases the rate of deterioration. Acceleration of deterioration can be due to high temperature, low humidity, incorrect atmosphere and/or physical damage.

The table on the following page lists causes for losses and how to prevent them.

## Key Messages

- Keep a focus on quality throughout the supply chain
- Keep it healthy: at harvest and from there on
- Keep it cool: check optimum temperature requirements
- Keep it gentle: no rough handling/bumpy rides
- Keep it clean: storage rooms, equipment, sanitation tanks, packaging materials and people
- Keep it breathing: vegetables are alive, airflow and ventilation are vital in storage, transport and packaging



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ISSUE	WHERE IT OCCURS	RESULT	PREVENTION
Misshapen, split product	Production in field	Low pack out and potential rejections from market	Good soil, irrigation and nutrition management. Variety selection to suit growing conditions, and careful harvesting.
Wrong harvest maturity	Harvest	Poor flavour and storage life. Mixed qualities in the same packaging and associated quality problems.	Maturity assessments before harvest and no mixing of different maturities in the same packaging.
Water loss after harvest	Throughout the supply chain	Shrinkage, loss of weight, increased susceptibility to diseases.	Maintain adequate humidity during storage. Avoid stresses due to handling, damage, or incorrect storage temperatures.
Mechanical damage	Harvesting, grading, re-packing, stacking of boxes, shipping, retail handling	Careless handling of vegetables and containers causing splitting, internal bruising, superficial grazing, and crushing of soft produce leading to entry points for diseases, increased water loss and increased respiration.	Adequate harvest method, no over or under trimming. Grading line design with minimum drop heights, no sharp corners or points. Adhering to recommended pallet and container stacking patterns.
Increased respiration	Throughout the supply chain	Increased use of stored energy resources (starch, sugars) leading to ageing and death when reserves are exhausted. Stress due to mechanical injury, diseases or temperature fluctuations can increase respiration rates and cause faster use of stored energy and increased water loss.	Adhere to temperature requirements for each vegetable type throughout the supply chain. Take field heat out as soon as possible after harvest.
Wrong temperatures, temperature fluctuations	Throughout the supply chain	Cold damage (browning, mushiness). Freezing at temperatures between 0 and -2°C. Rots following low temperature injuries.	Check and maintain cooling equipment for stores, shipping containers and trucks. Do not store vegetables that need higher temperatures e.g. beans, cucumbers, tomatoes or eggplants with those requiring low temperatures.
Low oxygen, high carbon dioxide in storage atmosphere	In store rooms, containers and packaging	Poorly ventilated, controlled atmosphere/ modified atmosphere storage reduces oxygen supply and can lead to accumulation of damaging carbon dioxide, 'suffocating' vegetables. This leads to stress that increases respiration and water loss. Stressed vegetables may release more ethylene and carbon dioxide into the storage atmosphere, which promotes ageing.	Good atmosphere control in controlled atmosphere rooms if used. Good ventilation in normal storage (including leaving gaps between pallets and walls for sufficient ventilation/head space in packaging). Correct use of modified atmosphere packaging and maintenance of the cool chain.
Diseases	Throughout the supply chain	Rotting and contamination of surrounding produce	Do not use dirty, contaminated field boxes or insufficiently sanitised washing water. Do not pack damaged, over mature or diseased produce in the same packaging as healthy produce.
Ethylene (a ripening agent) produced by fruits or from fuel exhausts	Packing sheds, stores, transport containers, depots	Pre-mature ageing (senescence), loss of colour and firmness, vegetables susceptible to decay.	Do not store or transport fruit emitting ethylene with vegetables that are sensitive to it. Do not use gas or diesel forklifts and vehicles in or near packing and storage facilities.



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## Reducing Waste

### Assessing and avoiding losses

Accurate records of losses at various stages of the marketing chain are rarely kept. Without agreed methods of assessing losses and good data about wastage along the chain, making reliable assessments of the potential cost-effectiveness of interventions is virtually impossible. Quality Assurance systems that cover all supply chain partners can be set up to collect data on losses during each step. They can be used to minimise waste effectively and increase returns, by focusing on the areas where wastage is greatest. Staff training can greatly assist in reducing waste.

### Optimum storage conditions

The more closely optimum storage conditions for vegetables are adhered to throughout the supply chain, the longer is the post harvest life span. Optimum conditions are listed in the table below in relation to temperature (optimum and range) and atmosphere (percentage oxygen, carbon dioxide and relative humidity). Most vegetables listed are more or less ethylene sensitive; e.g. carrots turn bitter when exposed to it.

### Temperature and Modified Atmosphere (MA) requirements for fresh-cut vegetables

FRESH CUT PRODUCT	TEMPERATURE (°C)	ATMOSPHERE <sup>1</sup>		EFFICACY <sup>2</sup>
		%O <sub>2</sub>	%CO <sub>2</sub>	
Beans sprouts	0-2	-	-	-
Beets (Red), Grated, Cubed or Peeled	0-5	5	5	Moderate
Broccoli, Florets	0-5	2-3	6-7	Good
Cabbage, Shredded	0-5	5-7.5	15	Good
Chinese Cabbage, Shredded	0-5	5	5	Moderate
Carrots, Shredded, Sticks or Sliced	0-5	2-5	15-20	Good
Leeks, Sliced	0-5	5	5	Moderate
Lettuce (Butterhead), Chopped	0-5	1-3	5-10	Moderate
Lettuce (Green Leaf) Chopped	0-5	0.5-3	5-10	Good
Lettuce (Iceberg), Chopped or Shredded	0-5	0.5-3	10-15	Good
Lettuce (Red Leaf), Chopped	0-5	0.5-3	5-10	Good
Lettuce (Romaine), Chopped	0-5	0.5-3	5-10	Good
Mushrooms, Sliced	0-5	3	10	Not recommended
Onion, Sliced or Diced	0-5	2-5	10-15	Good
Peppers, Diced	0-5	3	5-10	Moderate
Potato, Sliced or Whole Peeled	0-5	1-3	6-9	Good
Pumpkin, Cubed	0-5	2	15	Moderate
Spinach, Cleaned	0-5	0.8-3	8-10	Moderate
Tomato, Sliced	0-5	3	3	Moderate
Zucchini, Sliced	5	0.25-1	-	Moderate

1 Humidity requirements are 95-100%

2 Efficacy of modified atmosphere packaging

Source: Gorny, J.R. 2001. A summary of CA and MA requirements and recommendations for fresh-cut (minimally processed) fruits and vegetables. pp 95-145. Postharvest Horticulture Series No. 22A, University of California, Davis.

Information on the storage requirements of other harvested vegetables is available at <http://postharvest.ucdavis.edu/Produce/Storage/CARvegetables.pdf>



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# Vegetable Industry Development Program

## Case Study: Story from the packing shed

Doris Blaesing

Starting a new carrot export business was exciting. There was a lot to learn about growing the new varieties for the Japanese market. Size and quality specifications were tight. Luckily it was a good growing year, not too hot, not too wet and there were no disease issues.

### Getting Ready

The team building the packing shed was working day and night to get everything ready so we could start harvest in ten days. The new forced-air cooling unit was working fine, new bins had arrived, the grading line was coming together and even the new cartons and liners would be on site early. The packing shed would be ready for a Tuesday morning start; we could bring in at least 10 tonnes. The marketing department got excited.

### Harvesting

By lunchtime on Tuesday we were in full swing out in the paddock. The new floating tank and washer worked a dream. So far so good. Bins of clean carrots were put into the cool room for pre-cooling prior to grading and packing. On Monday we had curtains fixed in the cool room doors to keep the cold air inside while the doors were open. The automatic opening and closing mechanism was not fitted yet but all forklift drivers had been worded up to keep the door shut when shifting bins around inside.

### Grading and Packing

Once the carrots had reached the target pre-cooling temperature, we could start up the grading line and adjust the sizers. Something was wrong with one of the motors that we had 'borrowed' from another line so no-go for grading and packing. It could be a day at least to get things fixed which was no problem really as we could continue harvesting and washing, moving the incoming bins to the forced air cooling unit and shift the cold ones to the back of the store.

### Problem!

Getting the grading / packing line up and running properly took a couple of days, then we were ready to roll. By now the high humidity cool room was getting full with bins of washed carrots. I grabbed one from a bin harvested on day one to have a bite – it tasted awful and bitter! What had happened? I knew that the same batch coming in from the field had been very sweet. Then it dawned on me – we had used a gas forklift inside the cool room over the last four days. Our door curtains and policy of keeping the room closed at all times, had allowed enough ethylene to build up to turn the carrots bitter. The first batch was the worst and it had to go to the horses; electric forklifts were hired straight away.

This made me think about other issues we had with some of our lines over the past. Other vegetables do not turn bitter but can deteriorate quickly when exposed to ethylene and we had received complaints about shelf life from the market. I checked with our freight forwarders and found out that they were also using gas forklifts in their rather small cool rooms, which were used to hold all kinds of fresh produce for consolidation to wholesalers. Our lettuce may also have been stored and transported with apples, or other fruit, that produces quite a bit of ethylene.

### Solution

This issue made me talk to everybody handling our vegetables to find out how they were stored and how long for. It was interesting to follow the transport routes, especially for export lines.

The 'bitter carrot issue' looked like a loss to start with however it helped build some great relationships throughout our supply chains, and also streamlined and improved our handling processes. Now there are fewer complaints about product quality and less waste - a good result for the bottom line.

## Further Information

Information on appropriate post harvest management for a range of vegetables can be found on the Postharvest Fresh website at <http://www.postharvest.com.au/storage.htm> or [http://www.postharvest.com.au/Produce\\_Information.htm](http://www.postharvest.com.au/Produce_Information.htm)

Information on the Freshcare Code of Practice is available on the Vegetable Growers Association of Victoria website at <http://www.vgavic.org.au/pdf/VegeNote-Cool-Chain.pdf> or <http://www.vgavic.org.au/pdf/VegeNote-Freshcare.pdf>

Go to the R+D Insights Database (within the log-in section of the AUSVEG website) to search for further information on post harvest management of vegetables.



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