What the project set out to achieve

1. Develop techniques to increase the shelf life destined for use in fresh-cut mixes.
2. Understand environmental effects on yield and quality
Lettuce 3 days before end of shelf life
How to Improve?
Some key learning's:

- Influence of location x time of year
  - Yield
  - Quality
  - Plant development (days to maturity)
- Promising New varieties
- Planting Density
- Optimum harvest
- Irrigation Type
- Cool Chain management
Natural Variations in shelf life and yield over seasons have been quantified.

For example
- Gatton 10 → 14 days for Cos
- Gatton 9 → 12 days for Iceberg

Yield follows the same trend as shelf life
Winter Cos Yields x Shelf Life

R² = 0.72

R² = 0.98

Grow winter Cos July - September

Gatton Yield

Gatton Shelf Life
Winter Iceberg Yield x Shelf Life

\[ R^2 = 0.9942 \]

\[ R^2 = 0.7601 \]

Harvest date (Julian days where 1st March = 1)

Yield (t/ha)

Shelf-life (days)

Gatton yield

Gatton Shelf Life

Grow winter Iceberg July-September
Summer Lettuce

Yield
Shelf life
Cos yields lowest mid summer in both regions. Higher in autumn and spring.
Best shelf life autumn and spring – worst in summer

Same trend as yield
Same Yield pattern as for Cos: Low yield in summer – especially in Toowoomba.
Summer Iceberg Shelf-Life

Shelf life follows the same trend as yield – best quality in SPRING

Toowoomba

Bairnsdale

R² ≈ 0.725

Harvest date (Julian days where 1st July = 1)
Effect of Temperature on Days to maturity – critical for supply

- Bairnsdale example
- Compare to Salinas Valley, CA.
Days to Harvest Iceberg - Bairnsdale

90 Days for October harvest to 50 days for February harvest – Growth inverse of temperature

Days from Transplanting to Harvest

R² = 0.82

Temperature (ºC)

Daily Maximum

Daily Minimum

Harvest date (Julian days where 1st July = 1)

OCT | NOV | DEC | JAN | FEB | MAR | APR

0 10 20 30 40 50 60 70 80 90 100

100 120 140 160 180 200 220 240 260 280 300
Bairnsdale Maximum > 24°C

Salinas Maximum < 24°C

Salinas Minimum < 12°C

Bairnsdale Minimum > 12°C

Temperature Bairnsdale & Salinas

Optimal Maximum Temperature Lettuce

Optimal Minimum Temperature Lettuce

Bairnsdale can be too hot in summer – also more variable than Salinas
New Varieties

- Cyclone (3/4 Cos)
- Challenger (Cos)
- Patagonia (Iceberg)
- Cartagenas (Iceberg)
- Lettuce Aphid Resistant (Nr)
Introduced Cos -‘Cyclone’

Gatton August 2005

- Whole head weight- 1100 g
- Trimmed weight- 900 g
- Tipburn external & internal- nil
- Days to harvest- 69 days
- Holding ability- excellent
Introduced Cos - ‘Challenger’

- East Gippsland April 2004
- Whole head weight-1445 g
- Trimmed weight- 1060 g
- Tipburn external & internal -nil
- Days to harvest – 49 days
- Holding ability – as for Verdi
Introduced Iceberg - ‘Patagonia’

Robinvale October 2004 harvest

- Whole head weight - 925g
- Trimmed weight - 739 g
- Tipburn external & internal - nil
- Days to harvest – 103 days
- Holding ability – excellent against Marksman/Greenway
Introduced Iceberg- ‘Cartagenas’ (Nr)

Example Gatton May 2004-05

- Whole head weight- 825 g
- Trimmed weight- 611 g
- Tipburn external & internal-nil
- Days to harvest – 50 days
- Holding ability – excellent against Raider: possible replacement
Correct harvest maturities is critical for maximizing yield. Growers harvesting too early?
Iceberg - Harvesting a week later increased Iceberg yield by up to 63%, with no effect on the 11 day shelf life.
Cos (Cyclone)

61 days best maturity for cyclone (Gatton late April transplant)

Later $\rightarrow$ long core

Shelf Life OK at 61 days
Planting Density

What is the best planting density to maximize yield of processed lettuce?
Example: Cos (Cyclone)
The Effect of Planting Density on the Average Head Weight of Cos Lettuce (Cyclone) Gatton, 2004

Increasing density reduces head size.
The Effect of Planting Density and Fertiliser Management on the Yield of Cos Lettuce (Cyclone) Gatton, 2004

Optimum density x nutrition for maximum yield = 80,000 plants and 46:51:43 NPK = 20% yield increase over standard practice

Yield (t/ha)

Plants per hectare

Basal Fertiliser (N-P-K) (kg/ha): 26-28-24 46-51-43

- 66 000
- 80 000
- 100 000
Trickle irrigation in Gatton 2004
Trickle vs. overhead sprinkler irrigation
Cos

Generally sprinkler better
Rain during head filling

Irrigation method on Cos Gatton 2004

Irrigation method on Cos Gatton 2005

Sprinkler  Trickle
Iceberg not so sensitive to irrigation type

Rain during head filling

Trickle vs. overhead irrigation on Iceberg

Irrigation method on Iceberg Gatton 2004

Irrigation method on Iceberg Gatton 2005

- Trickle irrigation
- Overhead irrigation

Sprinkler

Trickle
Irrigation method and Shelf Life (Cos)

Irrigation type did not affect shelf life

<table>
<thead>
<tr>
<th>Month</th>
<th>Overhead Irrigation</th>
<th>Trickle Irrigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>May</td>
<td>9</td>
<td>9.5</td>
</tr>
<tr>
<td>June</td>
<td>9.5</td>
<td>10</td>
</tr>
<tr>
<td>July</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>August</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>September</td>
<td>13</td>
<td>13</td>
</tr>
</tbody>
</table>

Irrigation type did not affect shelf life
Irrigation method - results

- Overhead sprinklers result in better yield than trickle, especially for Cos
- Possible solution: Establish with sprinkler, then switch to trickle to reduce water use by 60%
- Shelf life not influenced
Temperature Management

Vacuum cooling or not?
Postharvest Temperature Management

Trialed Vacuum cooling at:

- 0.5 h of harvest
- 2 hrs from harvest
- 4 hrs from harvest
- Forced air cooling only
Vacuum cooling within 30 minutes

Vacuum cool after 4 hours

Forced air cooling only
Vacuum cooling extends shelf life but needs to be done within 0.5 h of harvest

Gained extra 2.5 days shelf life by rapid vac cooling. Vac cooling after 2 or 4 hours no better than Forced air cooling.

Vac-cooled after 0.5 hours
Vac-cooled after 2 hours
Vac-cooled after 4 hours
Immediate forced-air cooling, not vac-cooled
Vac-cooled within 0.5 h

End of shelf life

Days at 7°C

Quality Score

0 5 10 15 20 25 30 35

10 Days 12.5 Days
Acknowledgements

- OneHarvest
- Horticulture Australia Ltd. (HAL)
- Co-operating supplies- Nelson Cox, Bill Taylor, Andrew Young, Max Durham, Jay Parchert/Ian Thorne, Lester Hamblin, Withcott Seedlings, Boomaroo Seedlings
- AHR staff Brad Giggins & Bart Bauer
- Numerous Vegetable Seed companies
- Kim Martin (ex. Vegco P/L) initial project concept with Vegco & HFC staff