Breeding New Pears for the Modern Consumer
Breeding Pears for the Modern Consumer

1. What are we breeding for?
2. What are we breeding with?
3. How are we breeding?
4. Progress
1. What are we breeding for?
Intense Competition for Consumer Dollar
Pear Offerings in a NZ Supermarket
Wide Variability in Pear Consumption

(from O’Rourke et al, 2016)
Static or Falling Pear Consumption

Change in yearly consumption per capita (kg) (1997-2015)

(from O’Rourke et al, 2016)
Convenience in the New Pear

Convenient fruit to eat from harvest to after cold storage

‘Ready-to-eat, anytime anywhere’

Fruits that are ready to eat at time of purchase

No chill induction, no ripening

Extended storage and shelf life

A **consistently** great eating experience
What is Your Ideal Pear?

<table>
<thead>
<tr>
<th>Eating sensory attribute</th>
<th>Consumers (%)</th>
<th>NZ-Chinese</th>
<th>NZ-European¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Most frequently</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mentioned</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Juicy</td>
<td></td>
<td>100</td>
<td>43</td>
</tr>
<tr>
<td>Crisp</td>
<td></td>
<td>80</td>
<td>15</td>
</tr>
<tr>
<td>Soft</td>
<td></td>
<td>-</td>
<td>17</td>
</tr>
<tr>
<td>Firm</td>
<td></td>
<td>31</td>
<td>24</td>
</tr>
<tr>
<td>Sweet</td>
<td></td>
<td>96</td>
<td>38</td>
</tr>
<tr>
<td>Floral</td>
<td></td>
<td>45</td>
<td>-</td>
</tr>
<tr>
<td>Tropical</td>
<td></td>
<td>29</td>
<td>-</td>
</tr>
</tbody>
</table>

2. What are we breeding with?
Most Apple and Pear Germplasm are Low Quality

Cultivar breeding programmes based on a few high quality accessions
High Quality Cultivars Available for Breeding Within Each Pear Species

Cultivar breeding material
- High quality
- Pears often distantly related

Germplasm collection
- High degree of genetic diversity
- Low to high quality
- Source of new traits

New cultivar (interspecific)

European pear
Chinese pear
Japanese pear

Quality

Biodiversity
Several Large Fruited Pear Species are Compatible

*P. communis* L. (European pear)
- Requires postharvest chilling
- Rapid ripening, narrow eating window
- Soft, buttery textures
- **Diverse strong aromatic flavours**

*P. pyrifolia* (Bur.) Nak (Chinese sand pear, Japanese pear)
- Eaten off tree or after storage
- Very slow ripening, wide eating window
- Fine, crisp juicy textures (Japanese)
- Coarse textures, stone cells (Chinese)
- Light sweet flavours, little aroma

*P. x bretschneideri* Rehd (Chinese white pear)
- Very long storage and slow ripening
- **Crisp and juicy** but coarse and some stone cells
- Lightly sweet
The Start of Interspecific Pear Breeding

- 1983 – Appointment of full time apple and pear breeder by DSIR
- Vision to create a new type of pear fulfilling consumers’ needs
- 1984 – First Japanese x Asian pear crosses
- European x European
- Asian x Asian

Allan White
Sources of Pear Germplasm for the New Zealand Pear Breeding Programme

- *P. communis*
- *P. pyrifolia* x *P. communis* x *P. pyrifolia*
- *P. ussuriensis* x *P. pyrifolia* x *P. pyrifolia*
- *P. x bretschneideri*
Collecting Pear Germplasm in Yunnan, China – 1995
# Accessions by Species used in Interspecific Crosses

- **P. communis**
- **P. pyrifolia (Japanese)**
- **P. pyrifolia (Chinese)**
- **P. x bretschneideri**
- **P. communis x P. pyrifolia**
- **P. ussuriensis x P. pyrifolia**

### Accessions by Year

- **1984-1989**: 16 accessions (P. communis)
- **1990-1994**: 6 accessions (P. pyrifolia (Japanese), P. communis)
- **1995-1999**: 2 accessions (P. pyrifolia (Chinese), P. x bretschneideri)
- **2000-2004**: 2 accessions (P. communis x P. pyrifolia)
- **2004-2008**: 1 accession (P. ussuriensis x P. pyrifolia)
‘PremP009’ Pedigree

- Generation 0:
  - Duchesse d’Angouleme
  - NJ10
  - Meigetsu
  - Okusankichi
  - Josephine de Malines
  - Gorham
  - Bartlett

- Generation 1:
  - Nijisseiki
  - Max Red Bartlett

- Generation 2:
  - 29-52

- Generation 3:
  - P037R048T106

- Generation 4:
  - P04R135T058

- Generation 5:
  - ‘PremP009’

- Generation 6:
  - P128R68T003

- ‘PremP009’ Parents:
  - Xuehuali
  - Maxie

- ‘PremP009’ Offspring:
  - NJ10

- Species:
  - P. communis
  - P. pyrifolia
  - P. × bretschneideri

- Interspecific hybrid
3. How are we breeding?
Conventional Apple/Pear Breeding Cycle

- Generation interval: \(~4\) - \(5\) years
- Commercial cultivar development: \(~13\) years
Conventional Hybridisation in Pear
Features of Early Stage Pear Breeding in 2016

“Better cultivars faster”

- Dwarf Quince rootstock
- Accelerated growth of seedlings and rapid fruiting
- High seed numbers and seedlings in orchard
Post-storage fruit quality

Fruit appearance
Bright colours, even shape, blemish-free, large size

Post-storage eating quality
Crisp & juicy flesh texture, no stone cells, high sweetness/ flavoursome, non-offensive skin, free from disorders

Many traits scored from 0-9 using known standards as anchor points
The New Zealand Institute for Plant & Food Research Limited

Pear Cultivar Breeding System

Pre-commercial testing

Identification of commercial potential

Stage 1. Seedlings on clonal rootstocks in nursery

Stage 1. Seedlings on own roots in glasshouse

Stage 2. Selections on clonal rootstocks in small (PFR) orchard trials in HB and NN

Stage 3. Selections on clonal rootstock in multi-site PFR & commercial orchards in HB and NN

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PFR Pipfruit Cultivar Breeding Locations

Stage 1 Apple
Stage 1 Pear
Stage 2 & 3 Apple/Pear

Havelock North
(Hawke’s Bay region)

Riwaka (Nelson region)
New Breeding Tools to Accelerate Breeding

+/− DNA molecular marker
Plant Breeding and Large Scale DNA Fingerprinting (Genotyping)

DNA profiles mathematically related to each important plant trait
Determine and select the ‘best’ overall seedling profile
= Genomic selection
Conventional Apple/Pear Breeding Cycle

- Generation interval: ~ 4 - 5 years
- Commercial cultivar development: ~ 13 years
New apple/pear breeding cycle based on genotypic selection

- Generation interval: ~ 2 - 3 years
- Commercial cultivar development: ~ 8 years
4. Progress

‘Crispie’

‘Maxie’

Nijisseiki x Max Red Bartlett
Relationship Between Flesh Aroma and Crispness

(from Brewer et al, 2008)
Crispness Response to Selection

![Graph showing crispness response to selection.](attachment:image.png)

**P. communis** families

**P. pyrifolia x P. x bretschneideri**

Interspecific pear generation no.

Score

more

less
Aroma Intensity Response to Selection

Score

more

less

F1

F1

1

2

3

4

Interspecific pear generation no.

P. communis

P. pyrifolia x

P. x bretschneideri

The New Zealand Institute for Plant & Food Research Limited
Interspecific Pear Breeding – Qualitative shift in aroma and flavour profiles

Canned Pear
- Tropical: 6%
- Melon: 2%
- Citrus: 2%
- Nutty: 1%
- Plum: 1%
- Apple: 1%
- Peach: 0%
- 10% = distinctive flavours

Generation 2
- Citrus: 2%
- Melon: 2%
- Apple: 1%
- 25% = distinctive flavours

Generation 3
- Tropical: 6%
- Melon: 2%
- Nutty: 1%
- Plum: 1%
- 12% = distinctive flavours
Red Skin Colour

Attractive: Range of red skin colours

Dominant genes derived from European pear budsports for full block red colour

Less dependent on sunlight, presence easily detected from seedling leaf colour

Bartlett: ‘Max Red Bartlett’, ‘Red Sensation’

D’Anjou: ‘Red d’Anjou’

Generally a purple-brown red
Red Skin Colour

‘Huobali’
‘Yanshan’
‘Winshan’
‘Pinguoli’
‘Hongli’
‘Forelle’
‘Worden’
‘Seckle’

Photo; Robert Lamberts
High diversity + High Quality = Innovation in bright red skin colours
Genetic Diversity in Pear is Huge!
Fruit Scuffing Tolerance

Scuff breeding value (eBV)

P. communis
P. pyrifolia
P. × bretschneideri

(from Brewer et al, 2011)
Other Important Selection Traits

Skin abrasion damage

Fruit Shape

Flesh spot decay: a storage disorder of Asian species
In Greek mythology, Gaia, or Mother Earth, presented a tree with golden apples and the fruit of the Tree of Knowledge of Good and Evil to the serpent Serpent of the Evening Star. These golden apples became involved with many tales of love, betrayal, and knowledge. The golden apples of the Tree of the Golden Apples became the most sought-after fruit on earth. They have taken their rightful place in the pantheon of fruits that require a skilled hand to pluck.
Summary

• Development of a new type of pear through classical breeding approach
  - Novel combinations of colours, shapes, flavours
  - Fruit attributes that meet consumer desires around convenience
  - Use of complementary high-quality diverse breeding parents
  - Takes advantage of unexpected opportunities

• New genomic technologies will allow new pear products to be brought to the table much more rapidly than before
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