The Role of Farmer and Research Innovation in Sustainable Agriculture and Horticulture

Oliver Doubleday
Before mid 1800s all innovation was lead by farmers

• Development of Crops
• Development of Crop Rotations
• Domestication & Breeding of Livestock
• Irrigation techniques
• Mechanisation
The Advent of Science

- The Royal Society 1660
- Smallpox Vaccination – Edward Jenner 1796
- The Entomological Society 1833
- Royal Society of Chemistry 1838
- Royal Agricultural Society of England 1840
The Birth of Agricultural & Horticultural Research in the United Kingdom

1843
Agricultural Research

1910
John Innes Centre

1913
East Malling Research
Horticultural Research
Agriculture and Horticulture Development Board

Paid for by a Levy on Farm Sales – meat, grain, horticulture, milk, potatoes, etc.
Applied Research in Horticulture

Hortlink – sponsored by Defra with matched funds from Industry, i.e. Growers, Supermarkets and other stakeholders

Horticultural Development Company – funded by a levy on Growers’ sales
My Family’s Fruit Farm

• 85 ha Pears (Conference)
• 28 ha Apples (16 Gala, 10 Braeburn, 2 Bramley)
• 17 ha Cherries
• 2 ha Plums
• Fruit is sold in Bulk – no Packhouse
My Family’s Fruit Farm

- 2,700 Tonnes of Cold Storage
- 3 Full-time Employees (but sometimes use men from the 1,200 ha arable unit)
- Independent Agronomy Advice
- Pruning by Independent Contractors
- Planting by Independent Contractors
- We employ up to 90 seasonal fruit pickers in the summer, mainly from Eastern Europe. Housed in hostel accommodation
Early Cropping of Apple Trees

- Advanced Planting Material
- High Planting Density
- Root Pruning to Control Vigour
- Compost/Irrigation
- 50+ Tonnes/ha target yield
Advanced Planting Material

• Basic & Applied Research into Rootstocks

• Advances in Nursery Propagation Techniques (innovation from nurserymen)
High Density Planting

• Late planting into warm soil gives better growth & fruit bud formation on new growth (Dutch Adviser) – must have WATER!!!

• Depth of planting in compost determines tree vigour, shallow gives less growth (Dutch Adviser)
Root Pruning

- Root Pruning controls growth and can increase fruit size – but timing is critical !!

Farmer & Adviser Observation, with Levy Board Support
Conference Pears

Non-Root Pruned

Root Pruned
Compost
Compost
<table>
<thead>
<tr>
<th></th>
<th>Cox</th>
<th>Braeburn</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fruit Weight</strong></td>
<td>120 gm</td>
<td>128.8 gm</td>
</tr>
<tr>
<td></td>
<td>117.4 gm</td>
<td>116.2 gm</td>
</tr>
<tr>
<td><strong>Fruit Size</strong></td>
<td>62.3 mm</td>
<td>64.4 mm</td>
</tr>
<tr>
<td></td>
<td>61.7 mm</td>
<td>64.7 mm</td>
</tr>
<tr>
<td><strong>Fruits per Tree</strong></td>
<td>257.5</td>
<td>112.9</td>
</tr>
<tr>
<td></td>
<td>176.8</td>
<td>83.4</td>
</tr>
<tr>
<td><strong>With Compost</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Without Compost</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Apple & Pear Fertiliser

• Nitrogen
  Up to 200 kg of N per ha of orchard (i.e. excludes grass strip) annually

• Phosphate, Potassium & pH
  Soil Analysis every 3 years.
  No application if not required.
  50 kg P or K per ha of orchard annually if required
  Lime as required to correct pH
Partial rootzone drying: delivering water saving and sustained high quality yield into horticulture

Dr Mark Else
Matching demand with supply...

Effective irrigation scheduling saves water
Exploiting the plants' signalling system

Regulated Deficit Irrigation (RDI)  Partial Rootzone Drying (PRD)

Success depends on estimating water loss, delivering correct volumes, knowing when to switch...
Successful for Vines, Pistachios, Almonds in California
## Saving water and improving taste

<table>
<thead>
<tr>
<th>Scheduling regime</th>
<th>Volume of irrigation water used (L)</th>
<th>Water saving (% of control)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial control</td>
<td>2835</td>
<td>46</td>
</tr>
<tr>
<td>Evaposensor</td>
<td>1539</td>
<td>9</td>
</tr>
<tr>
<td>EnviroSCAN</td>
<td>2592</td>
<td>9</td>
</tr>
<tr>
<td>Closed loop</td>
<td>1944</td>
<td>31</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Scheduling regime</th>
<th>BRIX</th>
<th>Taste test (% sweetness)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial control</td>
<td>8.2</td>
<td>31</td>
</tr>
<tr>
<td>Evaposensor</td>
<td>9.9</td>
<td>48</td>
</tr>
<tr>
<td>EnviroSCAN</td>
<td>10.4</td>
<td>59</td>
</tr>
<tr>
<td>Closed loop</td>
<td>9.0</td>
<td>45</td>
</tr>
</tbody>
</table>
Stress can be Good!

- Partial Rootzone Drying
- Root Pruning

Stress can be Bad!

- Avoid stress during fruit set (first 6 weeks after petal fall) & during fruit bud formation

Easy Living can be Bad!

- Promotes too much vegetative growth

Use foliar Feeds or Fertigation

- Especially Ca++ to avoid storage problems
Weather Station

- Temperature
- Rainfall
- Humidity
- Leaf Wetness
- Wind Speed & Direction
Weather Data Drives Pest & Disease Models

Pear Psyllid

Summer Adults

Suitable Spray Periods
Monitoring Pests with Pheromones
Bio-Control where possible (nb thresholds)

Typhlodromus Pyri eating a Red Spider
Eliminating reportable pesticide Residues from apples

Dr Jerry Cross and Dr Angela Berrie

*East Malling Research*

*Supporting Sustainable Horticulture*
MARKS & SPENCER and Somerfield were "named and shamed" by Friends of the Earth yesterday for the levels of pesticide residues on their fruit and vegetables. The environmental campaign group claimed that M&S was the worst offender, with 63 per cent of its fruit and vegetables containing residues. Somerfield followed with 59 per cent. Waitrose was found to have the lowest result with 29 per cent.
Typical UK pesticide programme - apple

• ~18 spray rounds
• Tank mixing
• > 20 fungicides
• 3 - 4 insecticides
• Plant Growth Regulators
• Pre-harvest spraying
• Post harvest drenching
• Spraying is reduced by use of weather station driven pest & disease models
East Malling Research
Zero residue management system

Key features

• Bud burst to petal fall – full programme
  - No Organo-Phosphates
• Petal fall to harvest
  - Biocontrol for pests - Bt, Granulovirus
  - No fungicides except low dose sulphur for mildew
• Post harvest / dormant period
  - DMI fungicide for late mildew & scab
  - Urea for leaf rotting
  - Copper for canker at leaf fall
  - Copper pre bud burst for scab
  - Insecticides for rosy apple aphid & tortrix
• Cultural control – removal of primary mildew and canker
• Selective picking for storage rot control
### Mildew (% blossoms infected with primary mildew)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Disease susceptible variety Cox</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Untreated</td>
<td>2.3</td>
<td>0</td>
<td>3.5</td>
<td>1.8</td>
<td>2.7</td>
<td>6.5</td>
</tr>
<tr>
<td>Conventional</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Zero residue</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Vf scab resistor Ahra</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Untreated</td>
<td>8.4</td>
<td>3.3</td>
<td>13.5</td>
<td>26.9</td>
<td>16.1</td>
<td>38.3</td>
</tr>
<tr>
<td>Conventional</td>
<td>0.4</td>
<td>0.1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Zero residue</td>
<td>14.5</td>
<td>0.8</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
### Scab incidence on Gala

<table>
<thead>
<tr>
<th>Treatment</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>% shoots infected in July</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Untreated</td>
<td>90</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Conventional</td>
<td>2.5</td>
<td>7.5</td>
<td>0</td>
<td>5</td>
<td>12.5</td>
<td>25</td>
</tr>
<tr>
<td>Zero residue</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>22.5</td>
</tr>
<tr>
<td>% fruits infected at harvest</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Untreated</td>
<td>72</td>
<td>98</td>
<td>51</td>
<td>89</td>
<td>70</td>
<td>92.4</td>
</tr>
<tr>
<td>Conventional</td>
<td>0.5</td>
<td>5.6</td>
<td>0.3</td>
<td>2.4</td>
<td>1.2</td>
<td>6.2</td>
</tr>
<tr>
<td>Zero residue</td>
<td>1</td>
<td>2.7</td>
<td>0.3</td>
<td>0.1</td>
<td>0</td>
<td>5.8</td>
</tr>
</tbody>
</table>
**EMR Zero pesticide residues**

**Conclusions from trials**

- Zero residues program gave good results over 6 years
- Residues eliminated
- As good or better control of scab, even in high risk years
- Acceptable mildew control, but not as good as conventional in grower trials
- Alternative to sulphur needed for mildew control
- Pest control satisfactory, but costs increase
- Storage rot control satisfactory
- Grower trials satisfactory
- Rapid commercial implementation
Picking Trains – Industry Innovation

Improved efficiency of Harvesting, where a great deal of cost is incurred