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

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emr
east malling
research

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

1913

Horticultural Research

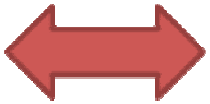
Basic Research

Universities & BBSRC

Innovation

Strategic Research

Defra



Innovation

Applied Research

Defra & Industry (esp. Levy Boards)

Innovation

Advisers

Demonstration

Farms

Innovation

Agriculture and Horticulture Development Board

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

Applied Research in Horticulture

Horticultural Development Company

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

Two-Year Trees

Advanced Planting Material

- Basic & Applied Research into Rootstocks

Horticultural Development Company

- 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)

Dutch Orchard

Root Pruning

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

Farmer & Adviser Observation, with Levy Board Support

HDC Horticultural Development Company

Conference Pears

Non-Root Pruned

Root Pruned

Compost

Material change for a better environment

Compost


RICHARD WESTERN
(TRAILERS) LTD

Table Fruit yields 2007

	Cox		Braeburn	
Fruit Weight				
	120 gm	117.4 gm	128.8 gm	116.2 gm
Fruit Size				
	62.3 mm	61.7 mm	64.4 mm	64.7 mm
Fruits per Tree				
	257.5	176.8	112.9	83.4
	With Compost		Without Compost	

wrap

Material change for a better environment

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

defra
Department for Environment Food and Rural Affairs

emr
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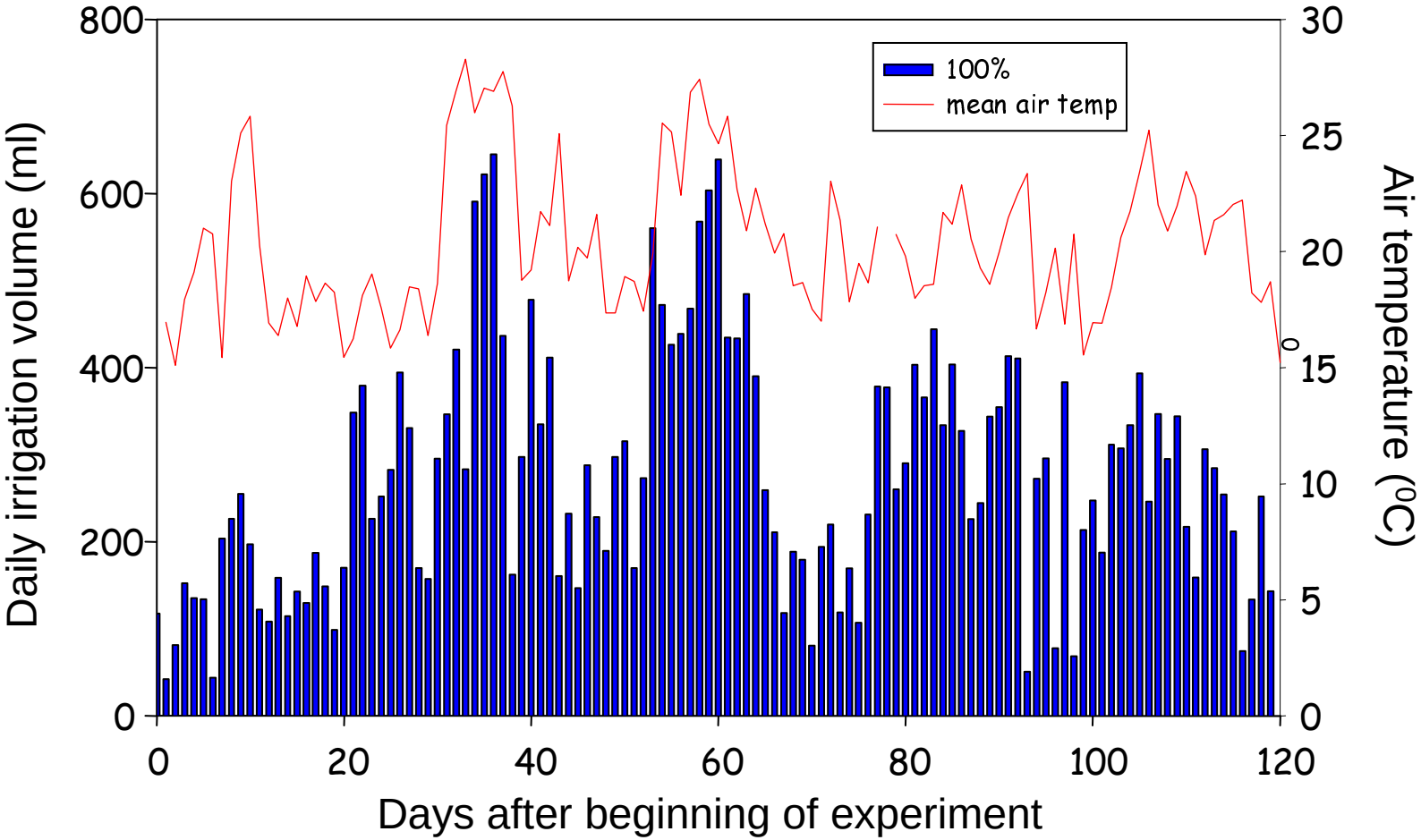
Partial rootzone drying: delivering water saving and sustained high quality yield into horticulture

Dr Mark Else

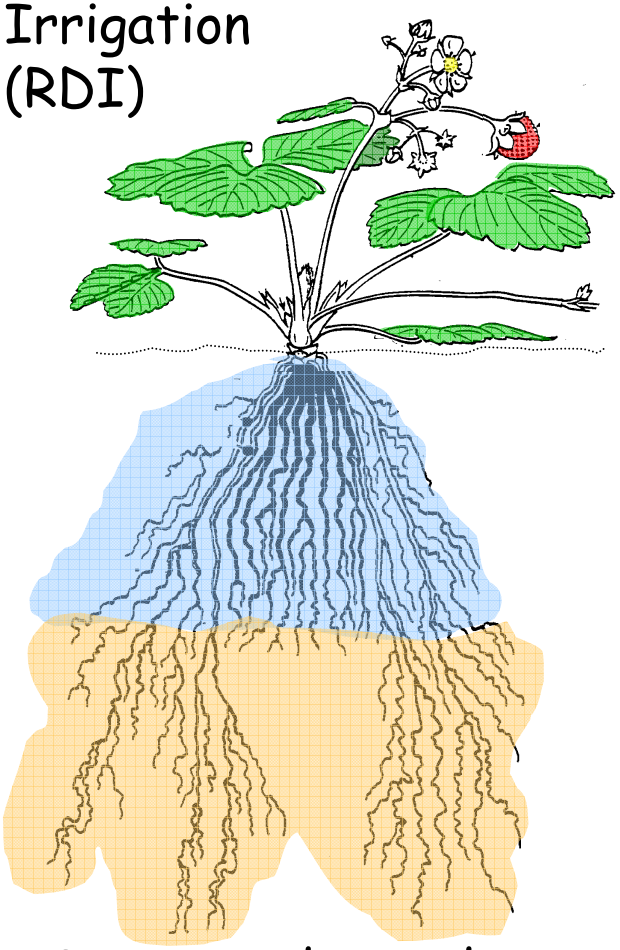
Matching demand with supply…



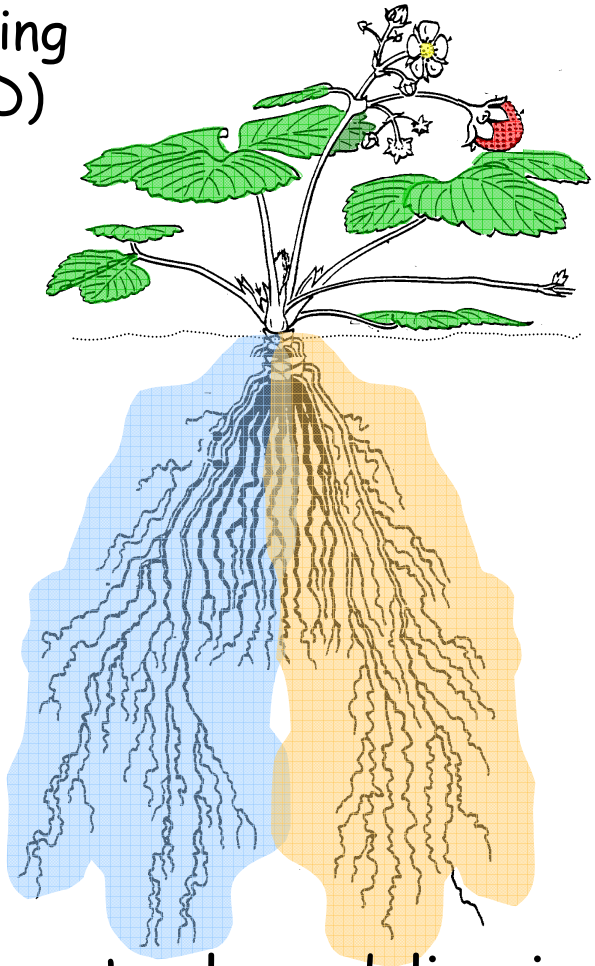
- Effective irrigation scheduling saves water

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

Scheduling regime	Volume of irrigation water used (L)	Water saving (% of control)
Commercial control	2835	
Evaposensor	1539	46
EnviroSCAN	2592	9
Closed loop	1944	31

Scheduling regime	BRIX	Taste test (% sweetness)
Commercial control	8.2	31
Evaposensor	9.9	48
EnviroSCAN	10.4	59
Closed loop	9.0	45

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

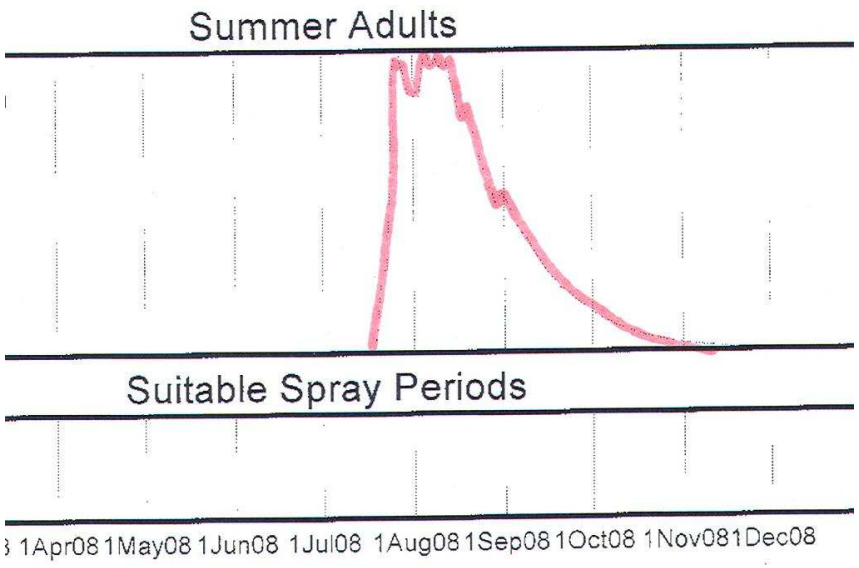
- Especially Ca^{++} to avoid storage problems

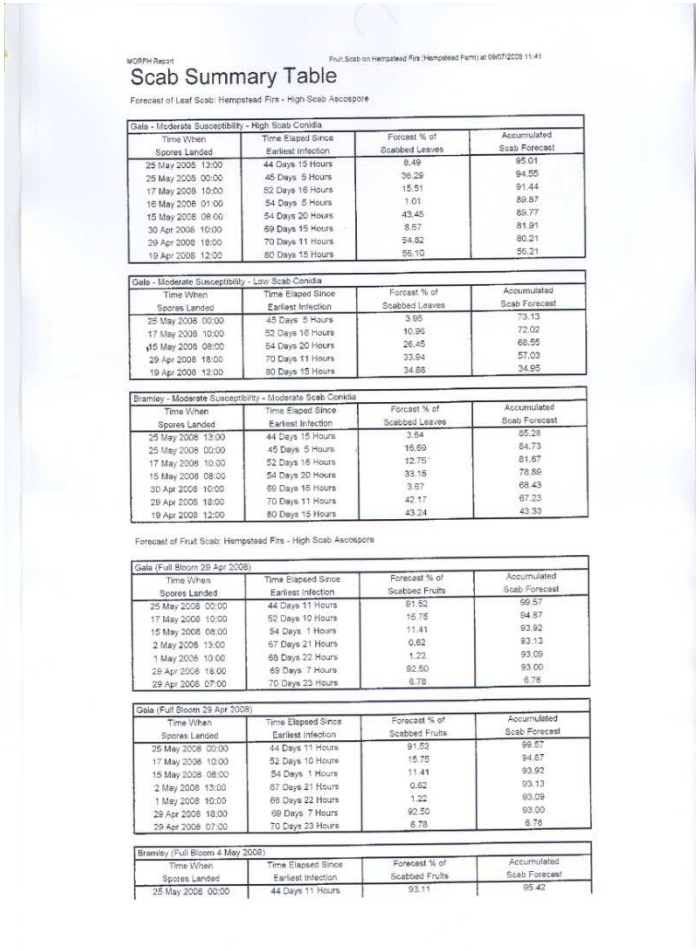
Weather Station

- Temperature
- Rainfall
- Humidity
- Leaf Wetness
- Wind Speed & Direction

Weather Data Drives Pest & Disease Models

Pear Psyllid





MORPH Resort — Fruit Scab on Hempstead Firs (Hempstead Farm) at 09/07/2009 11:41

Scab Summary Table

Forecast of Leaf Scab: Hempstead Firs - High Scab Ascospore

Gala - Moderate Susceptibility - High Scab Conidia

Time When Spores Landed	Time Elaped Since Earliest Infection	Forcast % of Scabbed Leaves	Accumulated Scab Forecast
25 May 2008 13:00	44 Days 15 Hours	8.49	95.01
25 May 2008 00:00	45 Days 5 Hours	36.29	94.55
17 May 2008 10:00	52 Days 16 Hours	15.51	91.44
16 May 2008 01:00	54 Days 5 Hours	1.01	89.87
15 May 2008 08:00	54 Days 20 Hours	43.45	89.77
30 Apr 2008 10:00	69 Days 15 Hours	8.57	81.91
29 Apr 2008 18:00	70 Days 11 Hours	54.82	80.21
19 Apr 2008 12:00	80 Days 15 Hours	56.10	56.21

Gala - Moderate Susceptibility - Low Scab Conidia

Time When Spores Landed	Time Elaped Since Earliest Infection	Forcast % of Scabbed Leaves	Accumulated Scab Forecast
25 May 2008 00:00	45 Days 5 Hours	3.95	73.13
17 May 2008 10:00	52 Days 16 Hours	10.96	72.02
15 May 2008 08:00	54 Days 20 Hours	26.45	68.55
29 Apr 2008 18:00	70 Days 11 Hours	33.94	57.03
19 Apr 2008 12:00	80 Days 15 Hours	34.88	34.95

Bramley - Moderate Susceptibility - Moderate Scab Conidia

Time When Spores Landed	Time Elaped Since Earliest Infection	Forcast % of Scabbed Leaves	Accumulated Scab Forecast
25 May 2008 13:00	44 Days 15 Hours	3.64	85.28
25 May 2008 00:00	45 Days 5 Hours	15.69	84.73
17 May 2008 10:00	52 Days 16 Hours	12.75	81.67
15 May 2008 08:00	54 Days 20 Hours	33.15	78.89
30 Apr 2008 10:00	69 Days 15 Hours	3.67	68.43
29 Apr 2008 18:00	70 Days 11 Hours	42.17	67.23
19 Apr 2008 12:00	80 Days 15 Hours	43.24	43.33

Forecast of Fruit Scab: Hempstead Firs - High Scab Ascospore

Gala (Full Bloom 29 Apr 2008)

Time When Spores Landed	Time Elapsed Since Earliest Infection	Forecast % of Scabbed Fruits	Accumulated Scab Forecast
25 May 2008 00:00	44 Days 11 Hours	91.52	99.57
17 May 2008 10:00	52 Days 10 Hours	15.75	94.87
15 May 2008 08:00	54 Days 1 Hours	11.41	93.92
2 May 2008 13:00	67 Days 21 Hours	0.62	93.13
1 May 2008 10:00	68 Days 22 Hours	1.22	93.09
29 Apr 2008 18:00	69 Days 7 Hours	92.50	93.00
29 Apr 2008 07:00	70 Days 23 Hours	6.78	6.78

Gala (Full Bloom 29 Apr 2008)

Time When Spores Landed	Time Elapsed Since Earliest Infection	Forecast % of Scabbed Fruits	Accumulated Scab Forecast
25 May 2008 00:00	44 Days 11 Hours	91.52	99.57
17 May 2008 10:00	52 Days 10 Hours	15.75	94.87
15 May 2008 08:00	54 Days 1 Hours	11.41	93.92
2 May 2008 13:00	67 Days 21 Hours	0.62	93.13
1 May 2008 10:00	68 Days 22 Hours	1.22	93.09
29 Apr 2008 18:00	69 Days 7 Hours	92.50	93.00
29 Apr 2008 07:00	70 Days 23 Hours	6.78	6.78

Bramley (Full Bloom 4 May 2008)

Time When Spores Landed	Time Elapsed Since Earliest Infection	Forecast % of Scabbed Fruits	Accumulated Scab Forecast
25 May 2008 00:00	44 Days 11 Hours	93.11	95.42

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

Pesticide report “names and shames” superstores

Daily Telegraph 16 August 2001

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)

Treatment	2001	2002	2003	2004	2005	2006
Disease susceptible variety Cox						
Untreated	2.3	0	3.5	1.8	2.7	6.5
Conventional	0	0	0	0	0	0
Zero residue	0	0	0	0	0	0
Vf scab resistor Ahra						
Untreated	8.4	3.3	13.5	26.9	16.1	38.3
Conventional	0.4	0.1	0	0	0	0
Zero residue	14.5	0.8	0	0	0	0

Scab incidence on Gala

Treatment	2001	2002	2003	2004	2005	2006
% shoots infected in July						
Untreated	90	100	100	100	100	100
Conventional	2.5	7.5	0	5	12.5	25
Zero residue	0	0	0	0	0	22.5
% fruits infected at harvest						
Untreated	72	98	51	89	70	92.4
Conventional	0.5	5.6	0.3	2.4	1.2	6.2
Zero residue	1	2.7	0.3	0.1	0	5.8

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