

### Designing Crops for Variable Environments

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# What is special about conventional systems?





### **Conventional systems**

High yields are produced by:

a) High inputs to try to eliminate any limits to production

b) Varieties bred to respond to such high inputs: high HI

But the costs are high.....and increasing



### Are organic systems different?

Small Plot Replicated Trials in 2004 Mean Variety Grain Yield, LSD = 0.66



Small Plot Replicated Trials in 2003 Mean Variety Grain Yield





### **Organic varieties?**

Comparisons of winter wheat trials indicates three classes of variety:

A) Good under conventional AND organic conditions (Claire, Deben)

B) Good under conventional BUT LESS SO under organic conditions (Solstice, Xi19)

C) Poor under conventional BUT GOOD under organic conditions (Hereward, Spark)



 So, wheat varieties respond differently to organic conditions generally, and to the variation in organic conditions

 How are such responses expressed?

• And on what scale?



## DEFRA OF0330 Participatory research: a simple wheat trial on 15 organic farms



There was much variation in yield, due to:

•Variable fertility

 Rotational position

 Variable weed loading

• Other interacting factors



### 'Tall' and 'Short' sites (OF0330)







## Wheat yields at 7 'Tall' sites compared with 8 'Short' sites





#### Straw lengths and numbers of heads at 7 'Tall' and 8 'Short' sites







### Cumulative straw length and the correlation with weed cover









## Varieties clustered by tall/short plant and low/high yield sites





## Varieties clustered by yield (t/ha) and numbers of heads per sq m.





## Dynamics of "Harvest Index" for variety means at the four site clusters



"Harvest Index"	Length per sq m Short sites	Length per sq m Tall sites
Low Yield	1.39	1.45
High Yield	2.33	1.06



### What happened ?

- Distribution of resources among numbers of grains, numbers of heads and length of straw was highly variable among sites
- BUT all varieties followed a similar pattern of variation
- Hereward performed better than Xi19: more plastic genotype
- Environmental effects (4 t/ha) were much greater than genotypic (0.5 t/ha)



# How should we deal with such variation in organic systems?

- By improving fertility amount and dynamics
- By breeding/choosing appropriate varieties with plastic response
- By using heterogeneous crops with built in adaptability such as variety mixtures, species mixtures and crop populations



## High, stable yield from 3-variety wheat mixture









**High Yield Potential** 

1 Bezostaya

- 2 Buchan
- 3 Claire
- 4 Deben
- 5 High Tiller Line
- 6 Norman
- 7 Option
- 8 Tanker
- 9 Wembley

Plus 4 male sterile lines

**High Quality Potential** 

- 1 Bezostaya
- 2 Cadenza
- 3 Hereward
- 4 Maris Widgeon
- 5 Mercia
- 6 Monopol
- 7 Pastiche
- 8 Renan
- 9 Renesansa
- 10 Soissons
- 11 Spark
- 12 Thatcher



# Composite crosses: plant populations under conventional and organic conditions





#### Yield development of composite cross populations under conventional and organic conditions

### Composite Cross F3 under conventional and organic conditions





## Performance of Composite Cross population in first field season







### Conclusions...

 Organic systems are highly variable: they demand fundamentally different varieties from conventional systems

Improvements in the dynamics of soil fertility are needed

• Some conventionally bred varieties can be relatively effective under organic conditions



### Conclusions...

 Inter-cropping with legumes needs further development

• Variety mixtures can be helpful – if the right components are available

 Composite cross populations offer potentials for adaptable crops and for rapid production of adapted genotypes