

Developing the potential of Composite Cross Populations: Wheat

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Increasing Environmental Variability

Pressures from the past:

Soil degradation, loss of biodiversity and degradation of ecosystem services, water restriction and pollution etc.

Pressures from the future:

Post Peak Oil, Global Climate Change

Current solutions for variability

- **NON-ORGANIC AGRICULTURE:**

Fossil energy based synthetic inputs, for example, fertilisers, fungicides, herbicides, insecticides, molluscicides, growth regulators

- **ORGANIC AGRICULTURE:**

Rotations, increased diversity, organic matter, manufactured inputs

What do we need to do in the future?

Natural ecosystems depend on spatial and temporal diversity

Agricultural ecosystems need to mimic these as far as possible – maximise spatial and temporal diversity

These principles should apply to human activity including marketing (Agrarian Renaissance)

Diversity

As environmental variation increases, we need diversity, at all levels:

- **Annual plants (mixtures, intercropping, populations)**
- **Animals (within and among species)**
- **Perennial plants (agroforestry systems)**
- **Non-crop environment**
- **Farmers (small farmers more resilient and flexible)**

Wheat: should we use mixtures or populations?

MIXTURES

- Components interact, but relatively little genetic variation
- Some resilience, less than populations
- Legal for trading

POPULATIONS

- Components interact, massive genetic variation
- Outstanding resilience
- Not legal – but there are practical approaches

- BOTH?

Two Parent Model Y1 and Q1

Gene difference	MIXTURE		POPULATION	
	No. of components	No. of genotypes	No. of components	No. of genotypes
2 genes AAbb and aaBB	2	2	4	4
3 genes AAbbCC and aaBBcc	2	2	8	8
32 genes AA..... and aa.....	2	2	4 billion possible!!	4 billion possible!!

Segregating populations

An assembly of genetically different individuals offers:

Capacity: many more characters than a pure stand

Complementation: different genotypes may complement each other (dry/wet; deep/shallow)

Compensation: if some fail, others take their place

Competition: may be positive or negative in effect.

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	Bezostaya	Cadenza	Hereward	Maris Widgeon	Mercia	Monopol	Pastiche	Renan	Renesansa	Soissons	Spark	Thatcher	Buchan	Claire	Deben	HTL	Norman	Option	Tanker	Wembely
Bezostaya		yq	yq	yq	yq	yq	yq	yq	yq	yq	yq	yq	Y	Y	Y	Y	Y	Y	Y	Y
Wembely	yq	YQ	YQ	YQ	YQ	YQ	YQ	YQ	YQ	YQ	YQ	YQ	Y	Y	Y	Y	Y	Y	Y	Y
Tanker	yq	YQ	YQ	YQ	YQ	YQ	YQ	YQ	YQ	YQ	YQ	YQ	Y	Y	Y	Y	Y	Y	Y	Y
Option	yq	YQ	YQ	YQ	YQ	YQ	YQ	YQ	YQ	YQ	YQ	YQ	Y	Y	Y	Y	Y	Y	Y	Y
Norman	yq	YQ	YQ	YQ	YQ	YQ	YQ	YQ	YQ	YQ	YQ	YQ	Y	Y	Y	Y	Y	Y	Y	Y
HTL	yq	YQ	YQ	YQ	YQ	YQ	YQ	YQ	YQ	YQ	YQ	YQ	Y	Y	Y	Y	Y	Y	Y	Y
Deben	yq	YQ	YQ	YQ	YQ	YQ	YQ	YQ	YQ	YQ	YQ	YQ	Y	Y	Y	Y	Y	Y	Y	Y
Claire	yq	YQ	YQ	YQ	YQ	YQ	YQ	YQ	YQ	YQ	YQ	YQ	Y	Y	Y	Y	Y	Y	Y	Y
Buchan	yq	YQ	YQ	YQ	YQ	YQ	YQ	YQ	YQ	YQ	YQ	YQ	Y	Y	Y	Y	Y	Y	Y	Y
Thatcher	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
Spark	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
Soissons	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
Renesansa	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
Renan	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
Pastiche	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
Monopol	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
Mercia	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
Maris Widgeon	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
Hereward	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
Cadenza	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q

Y - 36 crosses; Q – 66 crosses; YQ – 107 crosses
 (Total crosses – 190 rather than 210 because of Bezostaya)
 (NB Mixtures have only 9 (Y), 12 (Q) or 20 (YQ) fixed components)

The population trials

- **Six populations, three mixtures, 20 parents**
- **Two non-organic sites: Metfield, Morley, both in east of England**
- **Two organic sites: Wakelyns (east), Sheepdrove (west)**
- **Three years (F4 to F6): 2005-7**
- **Three blocks, randomised block design**

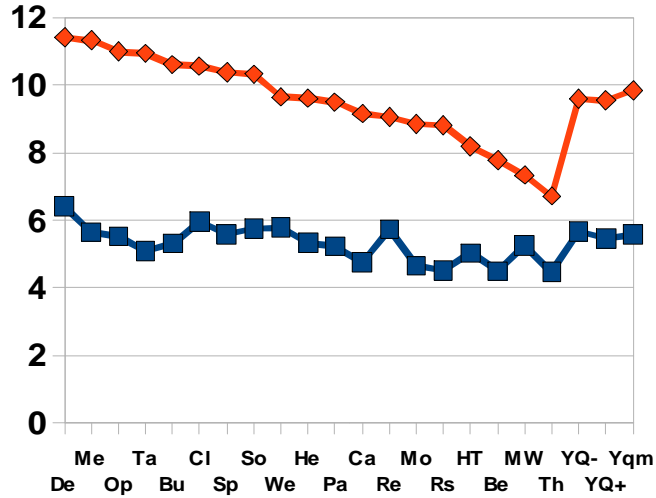
Variety Superiority (= stable at high level)

Based on the cultivar-superiority measure of Lin & Binns (1988):

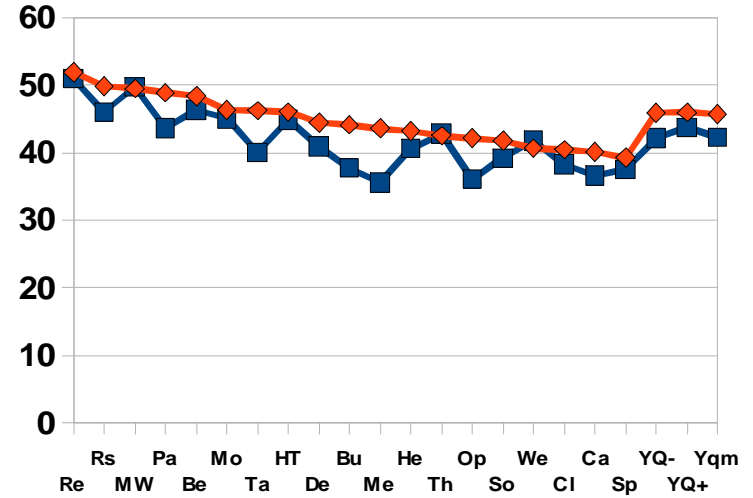
For each variety, this is the sum of the squares of the differences between its mean in each environment and the mean of the best variety there, divided by twice the number of environments.



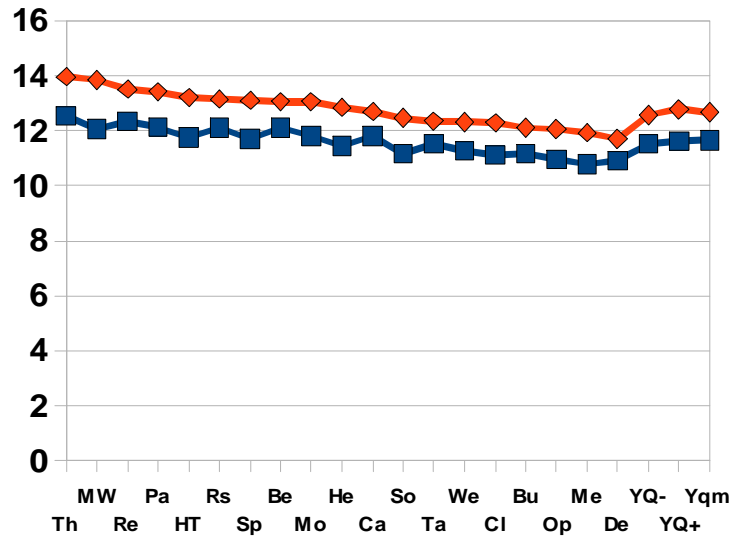
Grain Yield (t/ha)



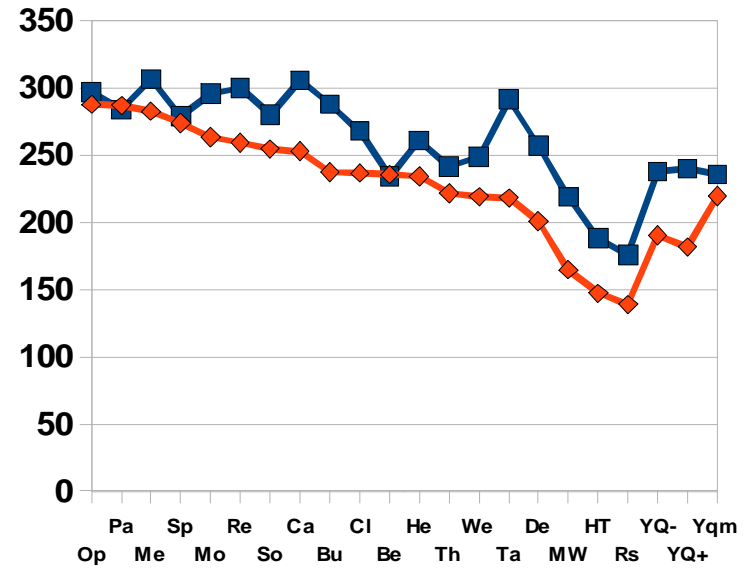
Thousand Gr Wt (gr)



Grain Protein (%)

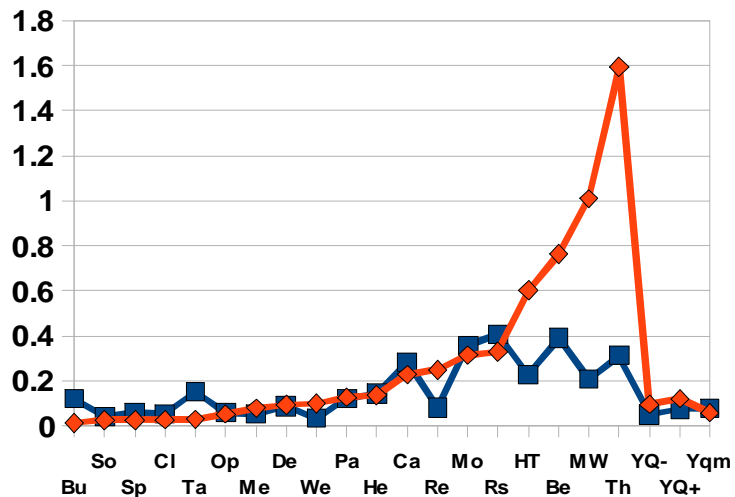


Hagberg FN (sec)

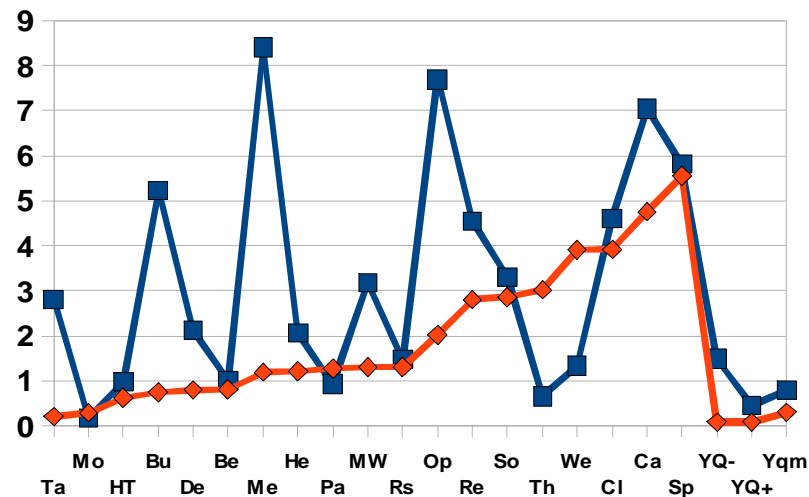




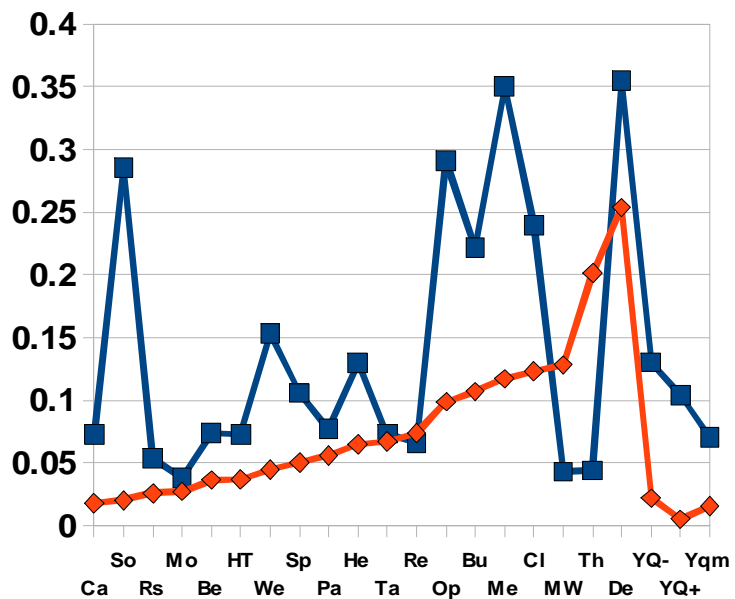
Grn Yld Superiorities



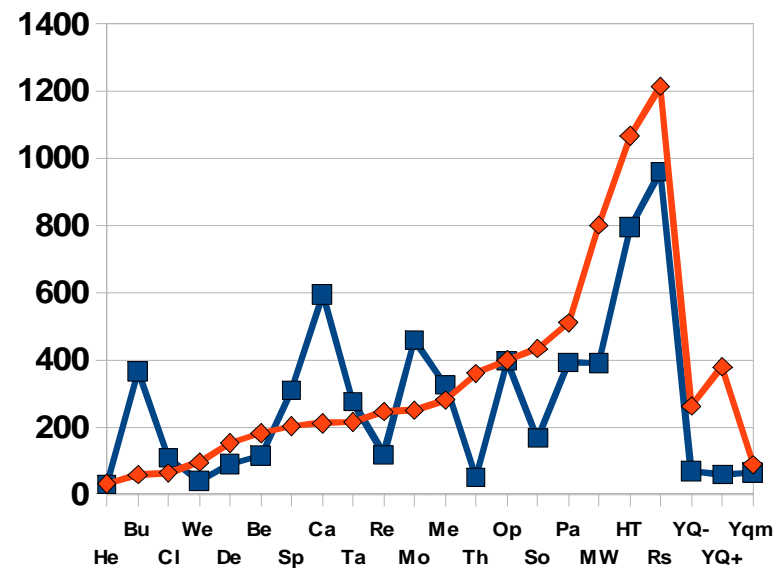
Th Gr Wt Superiorities



Grn Prtn Superiorities

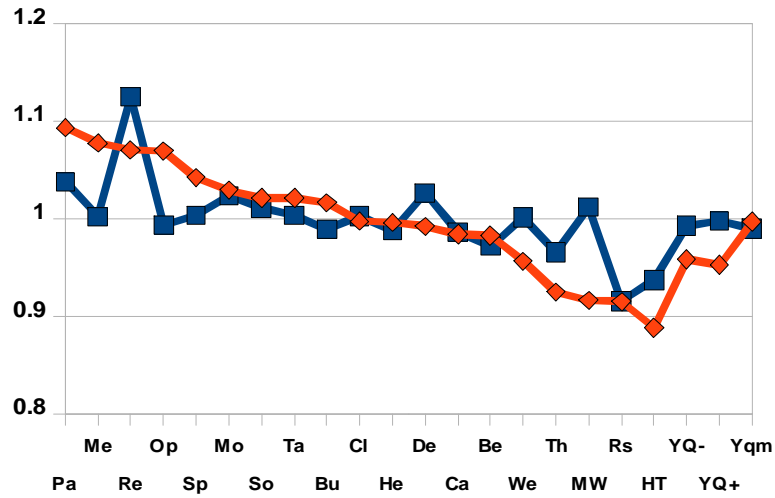


HFN Superiorities

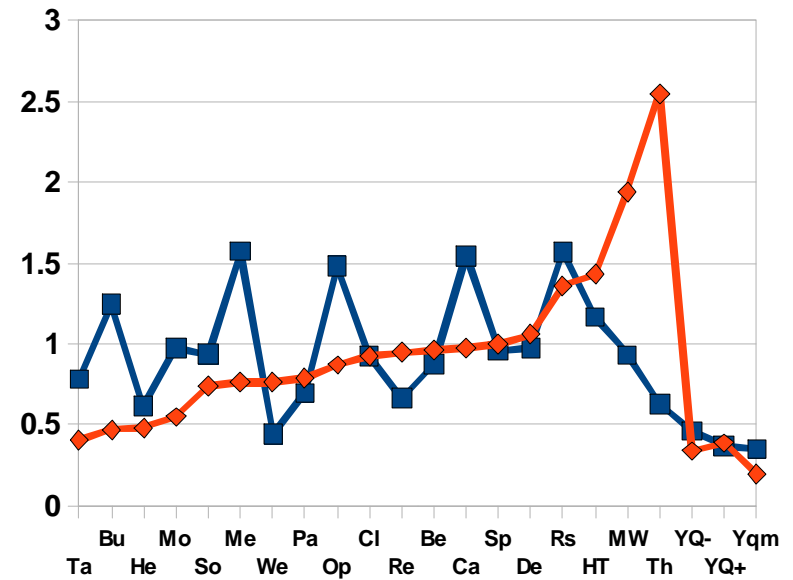




Means of four scaled values



Means of four Superiorities



Comparing superiority performance of all varieties between non-organic and organic systems

Same	Non-org	Org	Non-org +	Non-org	Org
YQ CCP	1	1	Soissons	3	10
YQ mix	2	3	Buchan	4	22
YQ CCPMS	5	2	Mercia	6	17
Spark	7	6	Option	8	18
Monopol	9	5	Tanker	10	20
HTL	11	8	Bezostaya	13	19
Pastiche	12	12			
Hereward	14	16			
Renesansa	15	14	Org+	Non-org	Org
Deben	16	15	Renan	17	4
Cadenza	20	21	Claire	18	13
			Wembley	19	7
			Maris Widgeon	21	11
			Thatcher	22	9

Many other potentials.....

- Different wheat populations
- Adding pure lines and mixtures into populations
- Developing populations in barley, oats and other crops
- Extending the principle to parents and relatives of wheat (G Kovacs)
- Selecting for inter-cropping and other agronomic variants

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