Evolutionary breeding in wheat for low input systems

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Composite cross populations or evolutionary breeding

- Composite cross populations are populations of segregating individuals derived from inter-crossing a number of parents.

- Instead of selecting 'promising' individuals in each generation, the whole population is exposed to natural selection in each subsequent generation

Why breed composite cross populations in wheat (evolutionary breeding)?

- Pedigree line breeding is genetically fixed – evolutionary potential is limited

- Breeders currently not interested – market too small; certification system evolved with the breeding system

- Different characters needed: buffering against environmental variation; weed competition; crop nutrition

Why populations?

An assembly of genetically different individuals offers:

Capacity: more characters than a pure stand

Complementation: different genotypes may complement each other

Compensation: if some fail, others take their place

Competition: this is the major factor that may work against the three 'Cs' above.

Populations or Mixtures?

Characteristic	Population	Mixture
Is survival in the community correlated positively with agricultural value?	?	Yes?
How did wheat evolve?	?	Yes?
Able to respond to environmental variation?	Yes	?

Or populations and mixtures??

Composite Cross: Selection of Parent Lines

High Yield Potential	High Quality Potential
1 Bezostaya	1 Bezostaya
2 Buchan	2 Cadenza
3 Claire	3 Hereward
4 Deben	4 Maris Widgeon
5 High Tiller Line	5 Mercia
6 Norman	6 Monopol
7 Option	7 Pastiche
8 Tanker	8 Renan
9 Wembley	9 Renesansa
	10 Soissons
	11 Spark
	12 Thatcher

Plus 4 male sterile lines

Composite Cross breeding process

Parent Lines   **Parent Lines**

X

F$_2$
Composite
Cross
Population

Natural + Directed Mass Selection
(involves all stakeholders – farmers, breeders etc.)

F$_3$
Composite
Cross
Population
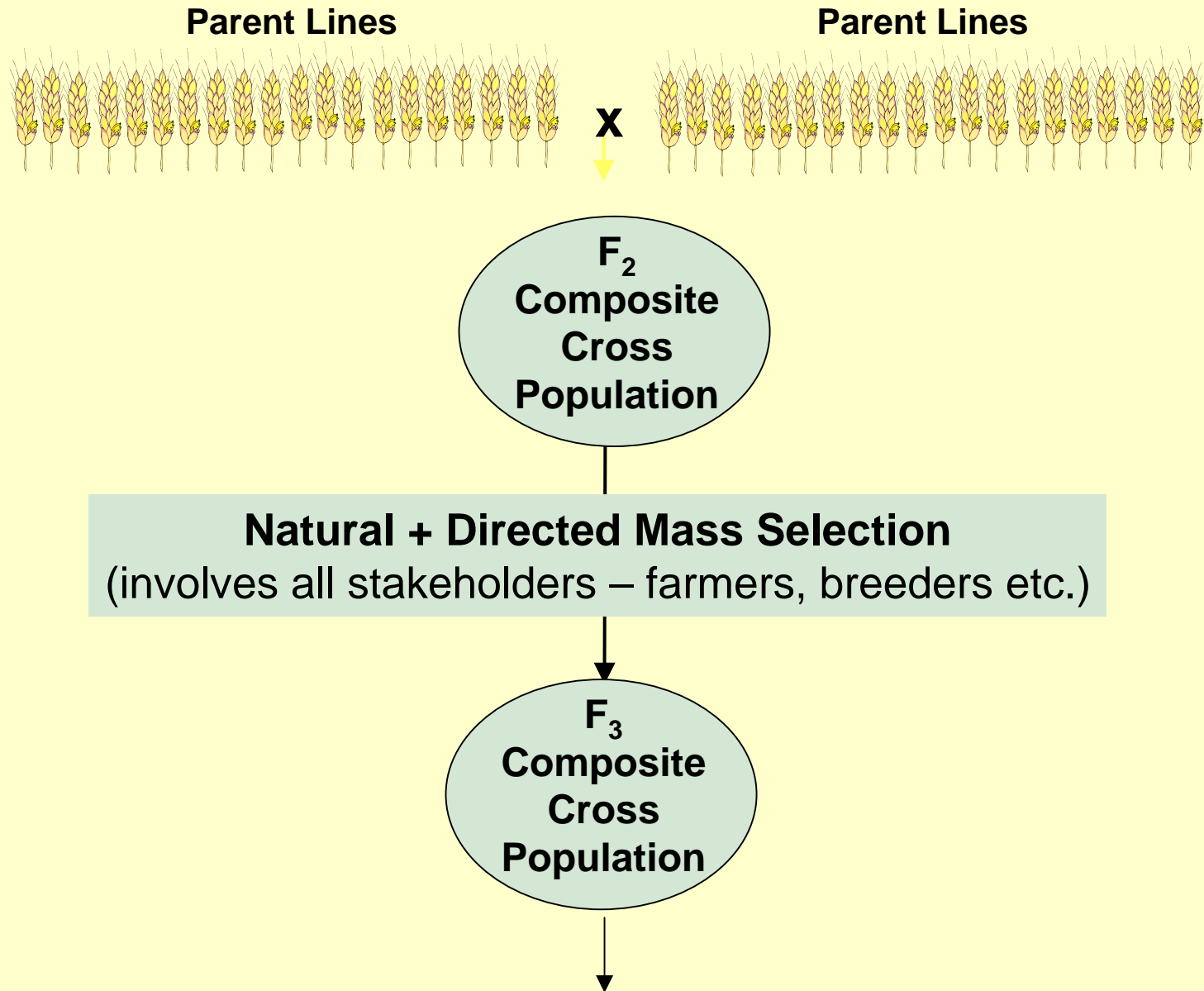
Composite Cross Populations

High Yield Population

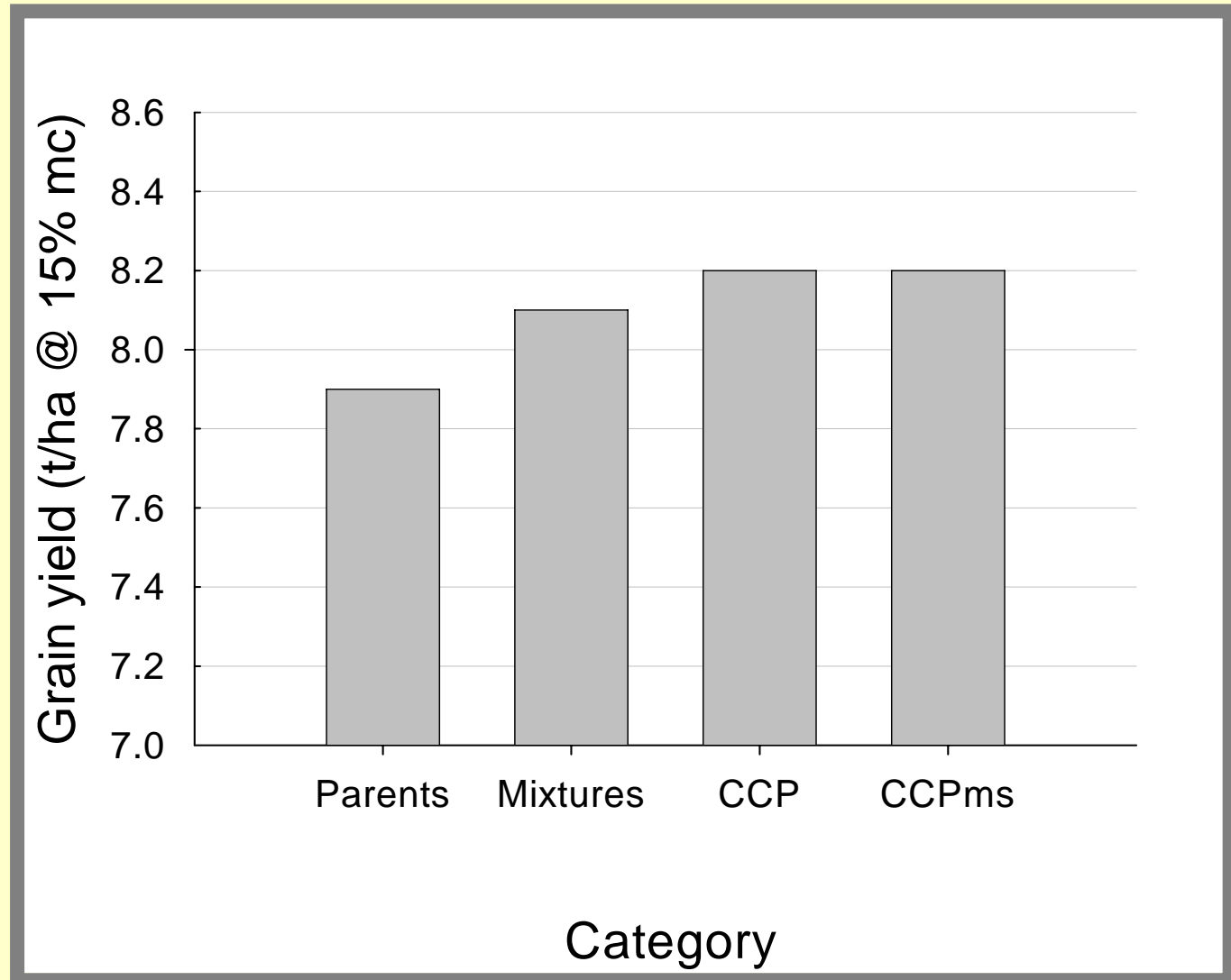High Quality Population

High Yield & Quality Population

High Yield Population + HMS

High Quality Population + HMS
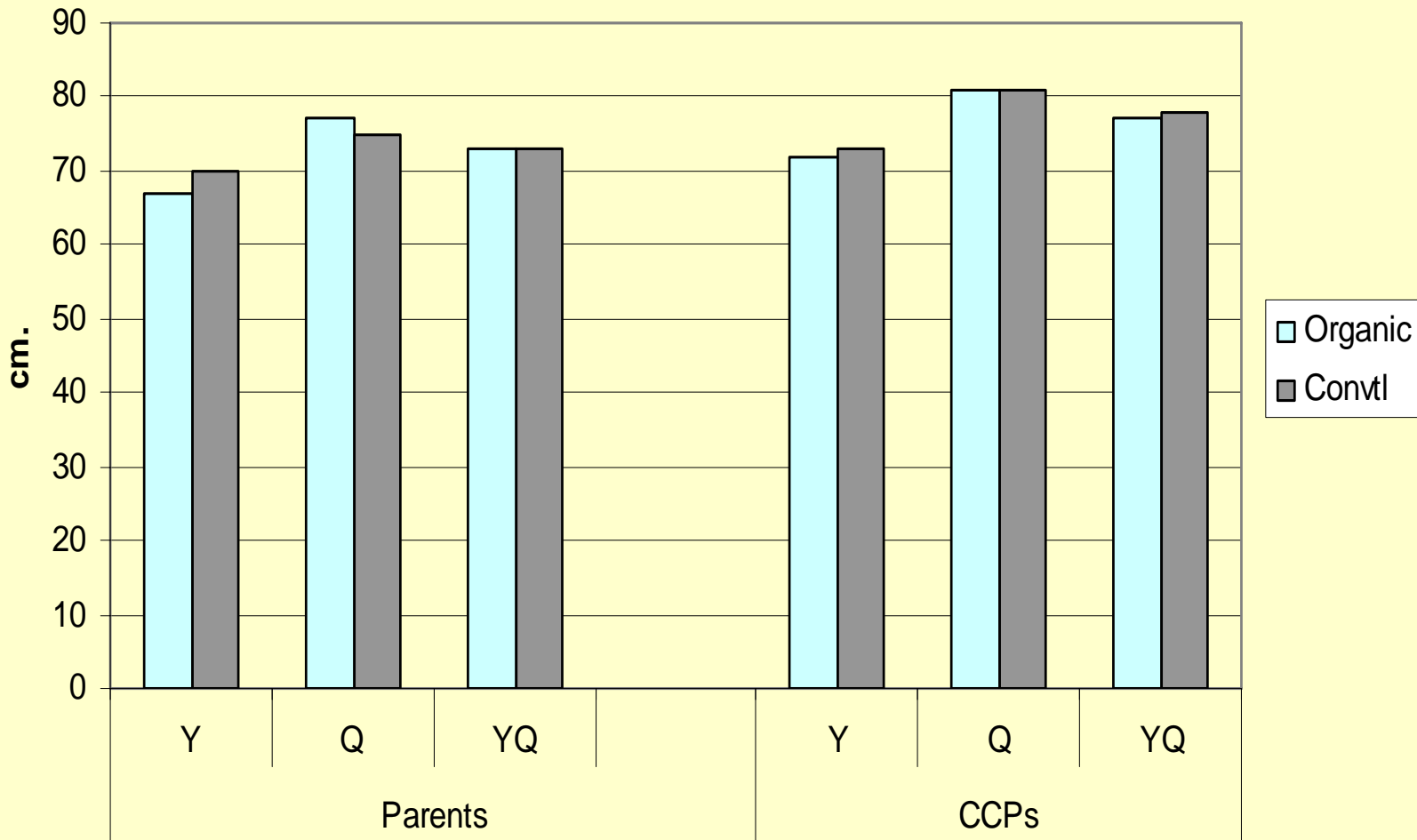
High Yield & Quality Population + HMS

Overall yield data: four sites x two years
(s.e.d.=0.157)

Average plant heights comparing systems, and parents versus populations

Heights (cm) across four sites, two years

Grain Quality

a) Quality was low in both years.

b) There was little difference in quality between organic and conventional.

c) Quality parents, mixtures and populations had better quality than, respectively, their Yield and Yield/Quality counterparts.

Geographical expansion

- Currently four comprehensive trials in east and west of England

- Participatory farm observations at further sites in England

- Second year trials in France, Germany and Hungary

Development dynamics

- Adding new parental material

- Adding more male steriles

- Mass selection – different characters and environments

- Combining different populations with different histories

Exploitation of populations

- Direct exploitation:
    - Using the rye model
    - Closed loop production
    - Farmer clubs
    - On-farm production and use

- Synthetic varieties (rye model)

- Pedigree line breeding