

# Optimising organic and low-input Agriculture: needs for plant breeding

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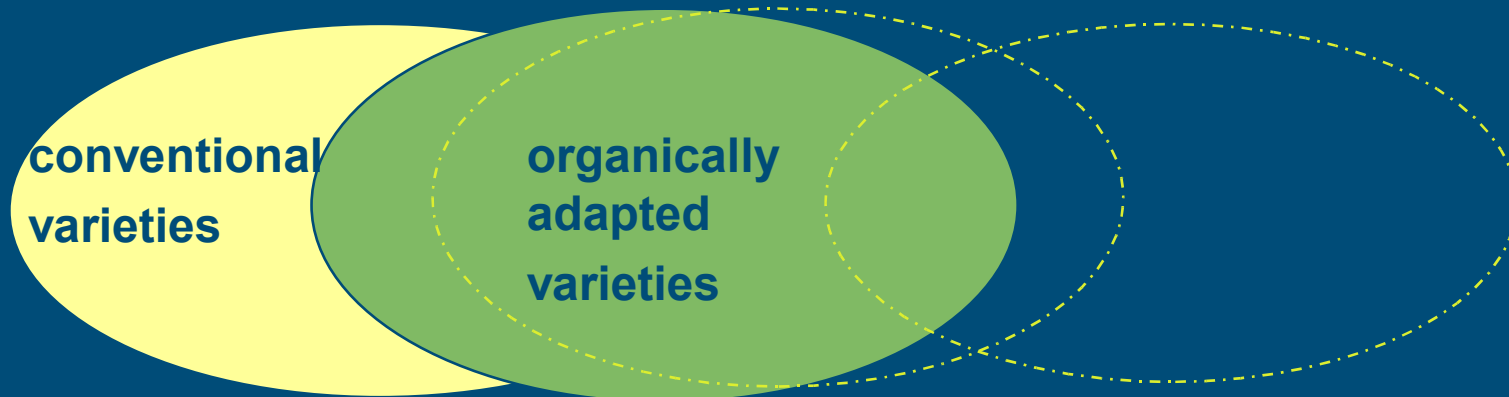
# Outline of this presentation

- Why organic breeding?
- What?
- How?

# Change of variety assortment?

The degree of overlap between conventionally and organically adapted varieties depends on:

- the crop requirements
- applied breeding techniques



# Different ranking of varieties in OA vs Conv

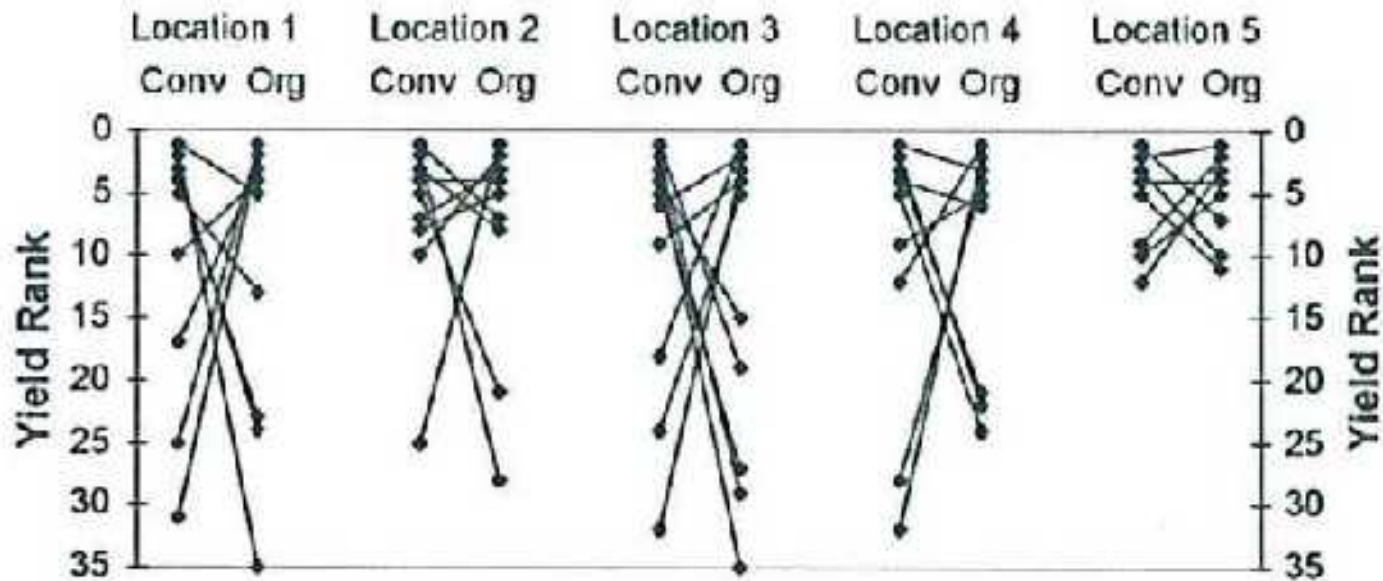
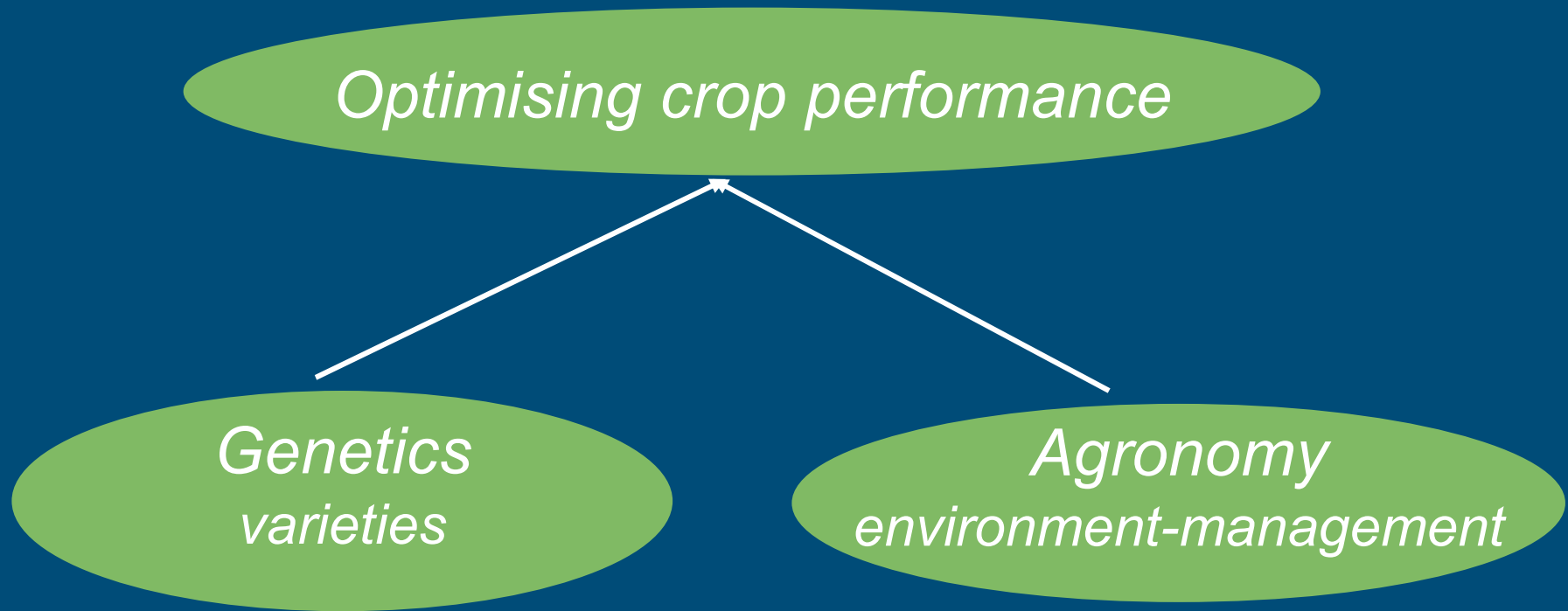


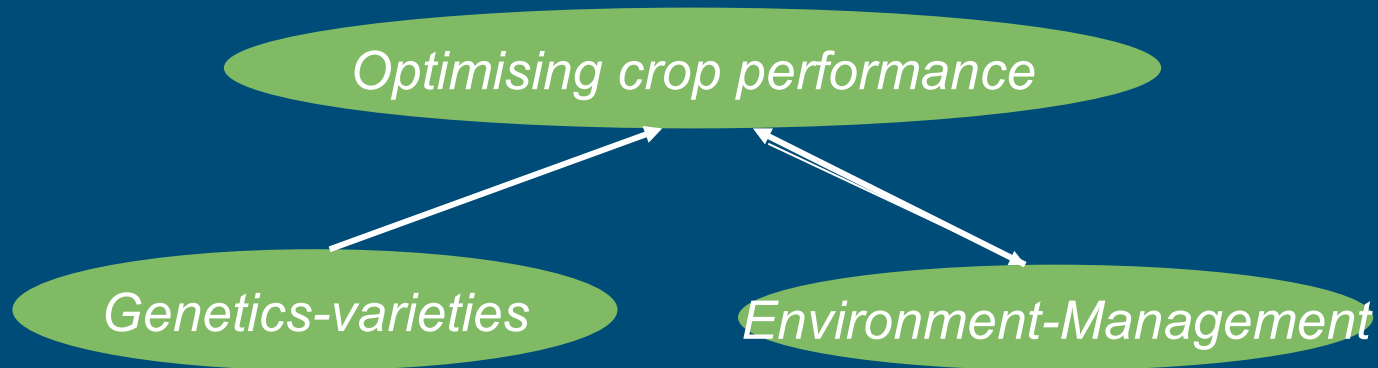
Fig. 1. Genotypic change in rank between organic and conventional wheat nurseries. The top five ranking genotypes for yield in both organic and conventional systems were compared at each location. Genotypes are ranked from 1 = highest yield to 35 = lowest yield.

*(K.Murphy et al., 2007)*

# The role of plant breeding



# The focus of the question



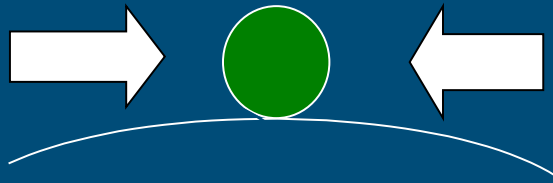
Optimising the environment to fit the plant?

or

Optimising the plant to fit the (limited) environment?

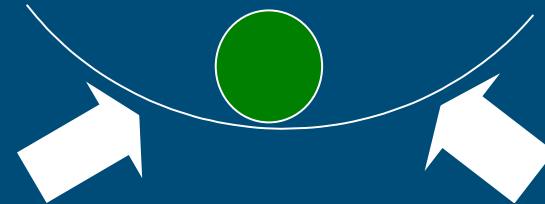
# Control vs adaptation approach

## Control model



- focus on the problem
- ruling out variation
- continuous monitoring
- direct interference
- static balance.

## Adaptation model



- focus on the system
- exploiting variation
- stimulating self regulation
- indirect management
- dynamic balance.

(Ten Napel *et al.*, 2006; WUR/LBI)

# Organic farming systems: challenge for breeding!

- Systems based on the principle of self-regulation instead of overruling variation,
  - makes systems more complex,
  - and more difficult to generalize;
- Interactions (incl.  $G \times E \times M$ ) are more significant;
- Intrinsic variation in process rates, timing and duration;
- Therefore requires 'flexible', 'robust' varieties!

# Mineral vs organic fertilisers

Lower input level of N and slower release in spring;

▶ More weed sensitive.



Conventional 29.4

Organic 29.4

(FiBL, 2009)

# Mono vs Multipurpose variety (1)



Heine 7 (1943)



Jubilar (1961)



Modern varieties

*photos: Lochow-Petkus*

# Mono vs multi-purpose varieties (2)



for food & feed

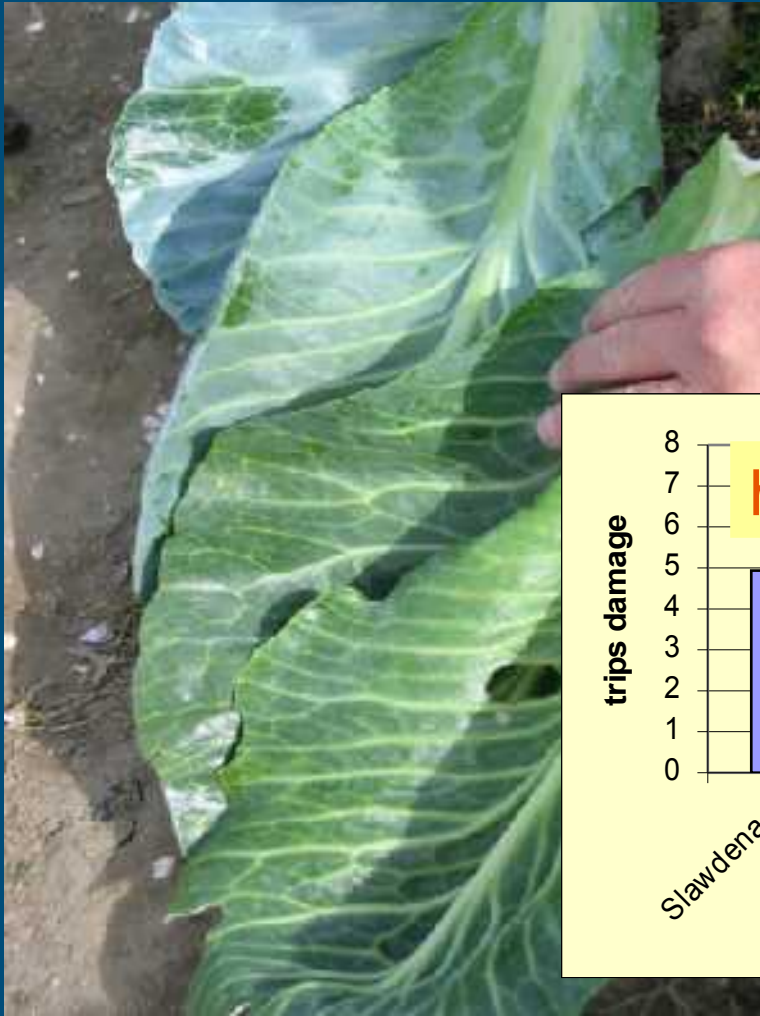


for soil structure

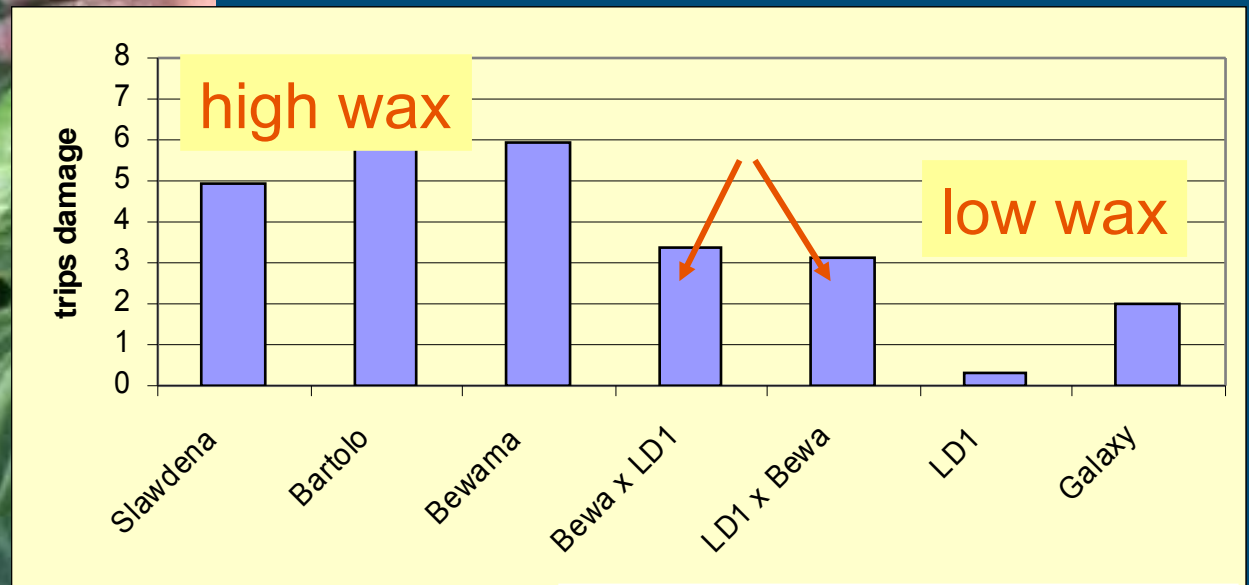


for straw

# Breeding research for trips resistance in cabbage



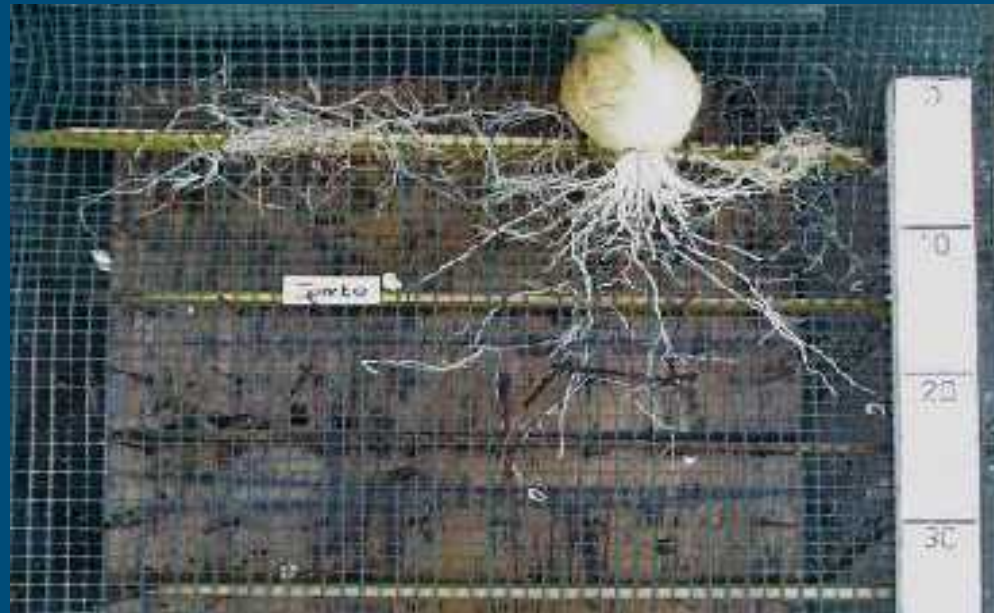
Breeding for more wax layer on leaves against trips damage in cabbage



*Voorrips et al., WUR & LBI 2004-2011*

# Onion: improved root system

- Onion needs high level of nutrients
- Root system of onion
  - lack of root hairs
  - shallow and scarcely branched
- Uptake improvement
  - Better root system
  - Higher mycorrhizal responsiveness



*(De Melo & Kik, 2003)*

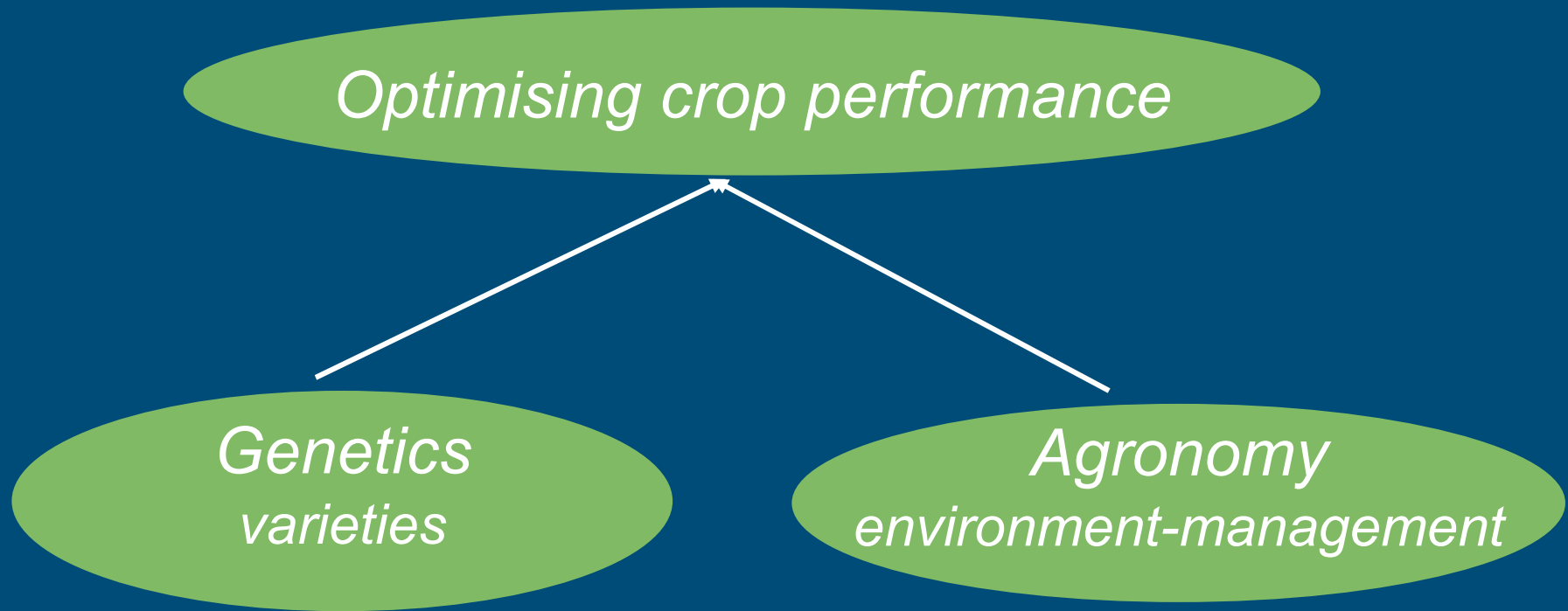
# Improving neglected traits

- yield stability, rather than yield as such
- adaptation to low-input:
  - nutrient efficiency, nutrient plasticity
  - more intensive root system,
  - interaction with beneficial soil micro-organisms
- weed suppressiveness
- reduced susceptibility
  - incl morphological and physiological traits
- good storability without sprouting inhibitors (onion)
- good seed quality (e.g. vital hybrid parent lines).

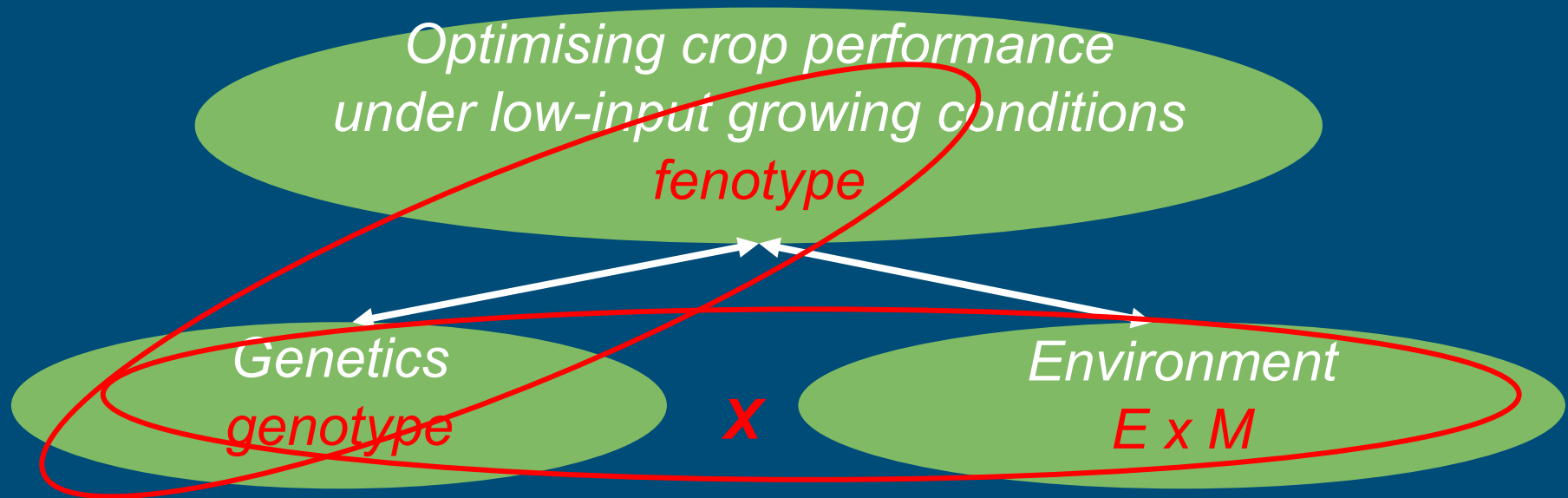
# Research areas for Plant Breeding

- Selection criteria for robust varieties
- Selection strategies
  - Selection environment
    - conv vs org, low or high input, direct vs indirect selection
    - wide or specific adaptation
  - Genetic diversity
  - Molecular markers

# The role of plant breeding



# A need to broaden the scope in PB



The need to bridge the gap between genotype and phenotype by:

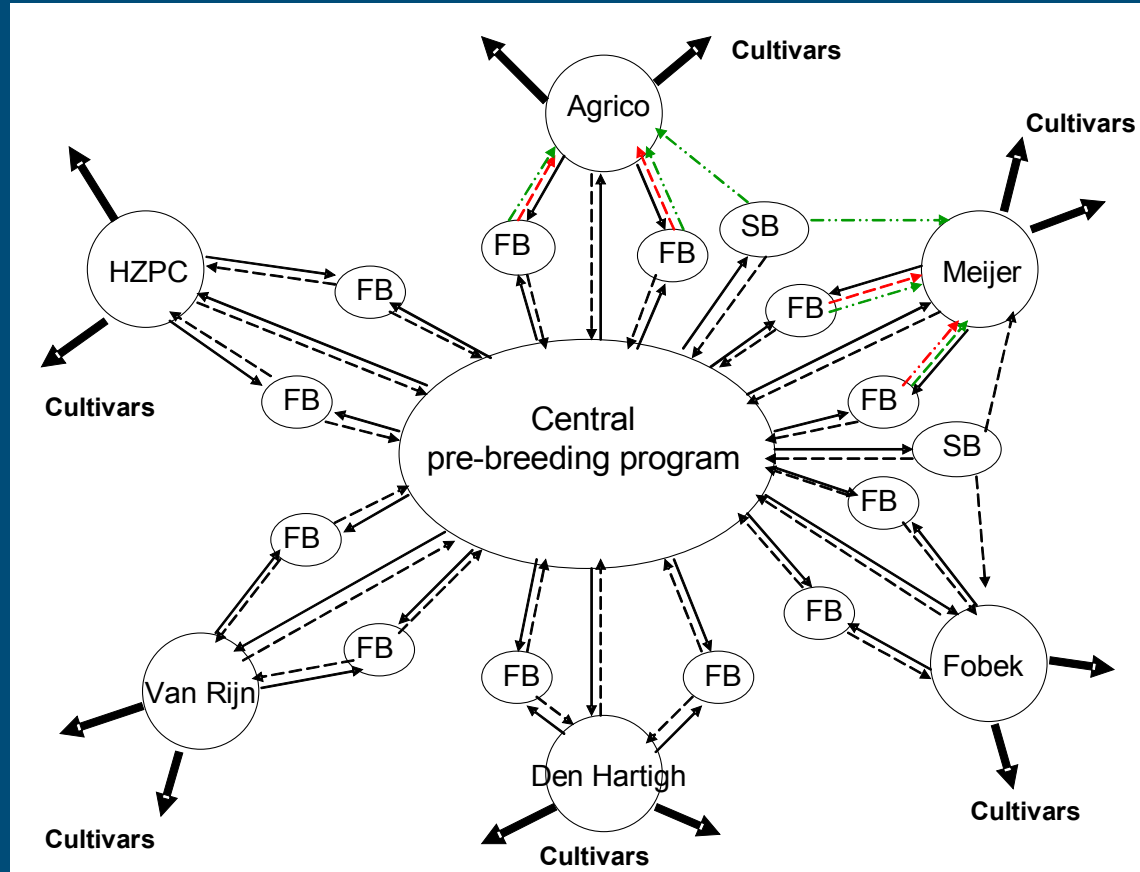
- including crop physiology to find QTLs for complex traits in complex environments, see NUE CROPS (WP potato)

# Research areas for Plant Breeding

- Selection criteria for robust varieties
- Selection strategies
- Socio-economic & legal aspects
  - participatory, collaborative models (within a production chain)
  - legislation rules for dealing with genetic diversity, see FarmSeedOpportunities (FSO)

# Exploiting different collaborative model

e.g. in potato in NL (2008-2013)



# Conclusions

- To optimize OA, we need:
  - better adapted varieties, including new traits;
  - breeding approaches that can deal with the complexity of organic and low-input farming systems;
  - development of innovative concepts and strategies by including other disciplines;
- COST Action can stimulate trans- and interdisciplinary networks!