Organic crop breeding: advances and challenges

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Birmingham, February 2017
Conventional versus organic varieties

The degree of overlap between conventional and organic suited varieties depends on:

- the crop requirements
- applied breeding techniques
Participatory plant breeding models
(Morris & Bellon 2004)

Figure 1. Integrating global and local approaches to plant breeding. Note: F = farmer; S = scientist.
Farmers’ training in variety trials
Participatory plant breeding models

(Morris & Bellon 2004)

*Figure 1.* Integrating global and local approaches to plant breeding. Note: F = farmer; S = scientist.
Organic participatory potato breeding for late blight resistance: Bioimpuls 2009-2019

6 breeding companies
LBI and WUR
12 farmer-breeders
Supporting farmer-breeders
Participatory plant breeding models

(Morris & Bellon 2004)

Figure 1. Integrating global and local approaches to plant breeding. Note: F = farmer; S = scientist.
On-farm wheat breeding in France
Socio-economic values in organic plant breeding

Breeding is not only a technical activity, but also a socio-economic activity with legal issues!

**Organic values in plant breeding:**
- Ecological (no pesticides, no herbicides): what traits?
- Ethical (no GM, no patents): how to breed?
- Social (role of stakeholders?): multi-actor approach?
- Economical (scale): diversity of variety assortment and how to finance breeding for small markets?
Trends in plant breeding

Aggregation levels in breeding

Systems breeding

Plant breeding

Trait breeding (e.g. gene-editing)
Trait oriented research (2)

Aggregation levels in breeding

Systems breeding

Plant breeding

Trait breeding (incl MAS)

Adding traits for low-input systems:
• Durable resistances (stacking genes, horizontal)
• Nutrient efficiency, root systems
• Mycorrhiza’s
• Weed suppression
• Baking quality

E.g.:
• NUE CROPS (EU)
• Green Breeding (NL)

• Knowledge
• Scientific papers
• Breeding tools
• Molecular markers
Systems varieties: multipurpose

for food & feed
for straw, compost
for weed suppression
for soil structure
Towards systems breeding

How can we put more emphasis on systems breeding?

Systems breeding

Plant breeding

Trait breeding
(incl MAS)
Why systems breeding?

Organics not only needs varieties that fit in a low-input system (additional traits),

But that enable the system to work!

- Contribute to resilience
  - ecologically
  - socially
  - economically
From Control towards a Resilience model

Risk management model
- Risk oriented
- Eliminate variability
- Continuous monitoring and direct intervention
- High long-term risk
- Static equilibrium

Resilience model
- System oriented
- Make use of variability
- Enhance self-regulating capacity and indirect management
- Low long-term risk
- Dynamic equilibrium

(After Ten Napel et al. 2006)
Systems varieties: genetically diverse

Composite cross populations:
► Multiple crosses

Crop mixtures (e.g. lupine/wheat):
► breeding for combinability
New models for breeding and IPR (1)

- Community breeding: Common good, open source
- Plant breeding: Breeder’s and Farmer’s Rights?
- Trait breeding: Patents (red X)

For quality of life
New models, new approaches (2)

- How to organise and finance breeding for systems varieties?
  - for more diverse, regional varieties?

- Need for new models! E.g.:
  - Farmer-based breeding
  - Chain-based breeding
  - Community-based breeding
Market introduction needs care
New models ► new research approaches

- Systems-based breeding and research
  - On-farm Research
  - Participatory Research
  - Multi stakeholder networking
  - Open Source models
  - Action Research

- Restoring/renewing lost relationships among partners in the community!
Future research and breeding?

- Systems breeding
- Plant breeding
- Trait breeding

- Community based breeding
- Systems breeding
- Plant/Crop breeding
- Trait/gene breeding