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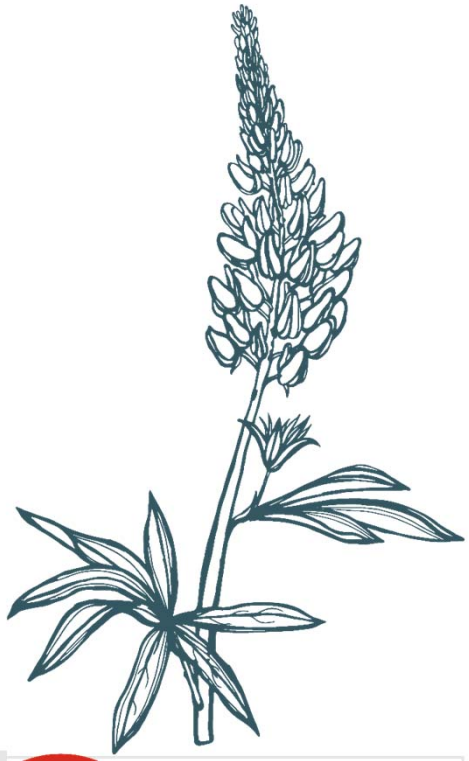
SYSTEMS-BASED BREEDING APPROACH: HOW TO IMPLEMENT IT?

Edwin Nuijten & Edith Lammerts van Bueren

OWC Preconference, 6 September 2021



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Workshop program

15.30-16.00 Introduction

16.00-16.10 Questions

16.10-16.30 Personal exercise

16.30-16.50 Groupwork (in groups of two)

16.50-17.00 Discussion

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Which steps are needed for implementing the systems-based breeding approach?

- Describe:
  - current trends in breeding
  - solution pathways: systems-based breeding
  - all relevant aspects of breeding and seed systems
- Provide:
  - methods for self-reflection
  - methodology for group-reflection
  - guidelines for other steps at value chain level

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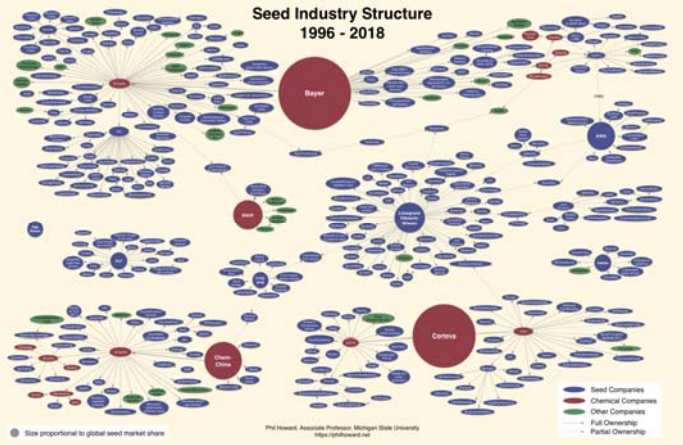
Current trends in agriculture and plant breeding

- Continuous focus on linear value chains
- More focus on molecular traits
- Loss of agro-biodiversity



Summary of distribution of variety registration at CPVO in the period 2012-2016, according to crop, company and country (Annual report 2016)

	arable crops	vegetable crops	fruit crops
Top 5 crops	69,4	67,2	60,9
Top 10 crops	85,3	79,5	81,4
Top 5 companies	47,0	69,3	22,2
Top 15 companies	63,5	95,3	43,6
Top 5 countries	63,5	94,2	39,9

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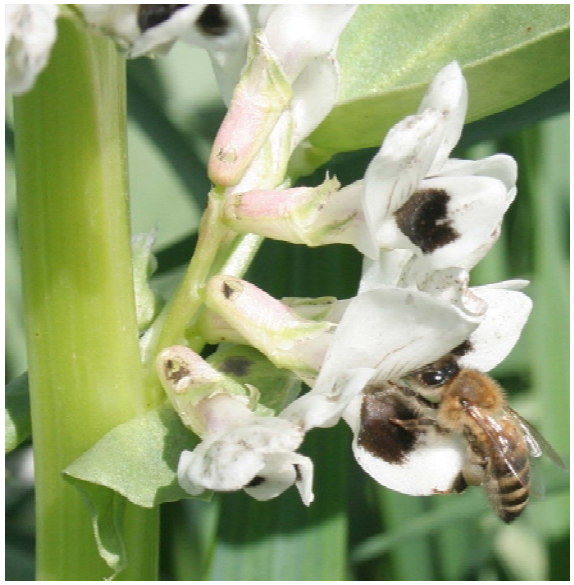
How to breed for long term ecosystem-services?

Biodiversity and ecosystems services are key factors that contribute to:

- natural pest control
- pollination
- nutrient (re)cycling
- soil conservation
  (structure and fertility)
- water provision
  (quality and quantity)
- carbon sequestration



Enhancing legume ecosystems services through plant-pollinator interplay.
Suso et al. 2016

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How to breed for long term ecosystem-services?

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- water provision
  (quality and quantity)
- carbon sequestration

Genetic variation in root biomass in grass (Lolium multiflorum). Deru et al. 2014

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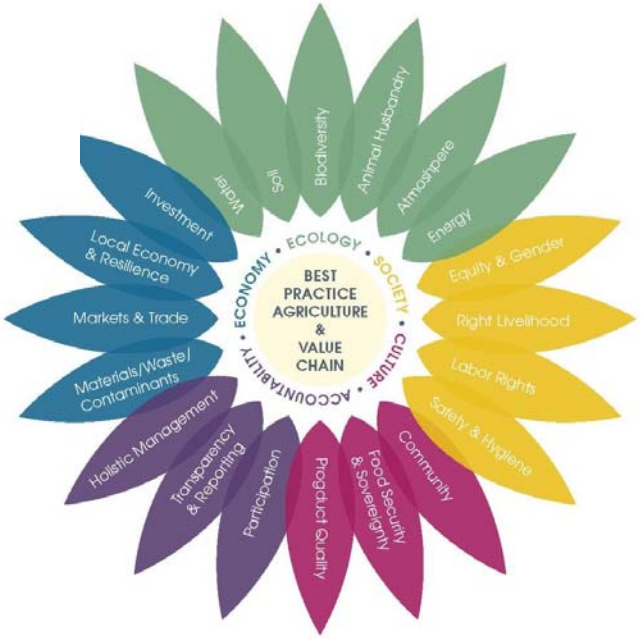
Organic 3.0 (IFOAM 2015): Broadening the organic scope for 2030



Five dimensions:

- Ecology
- Society
- Culture
- Accountability
- Economy

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SDGs of UN (2015) - targets for ecological and societal resilience

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Six goals for future plant breeding for ecological AND societal resilience

1. Social justice
2. Food security, food quality and safety
3. Food and seed sovereignty
4. Agro-biodiversity
5. Ecosystem services
6. Climate robustness

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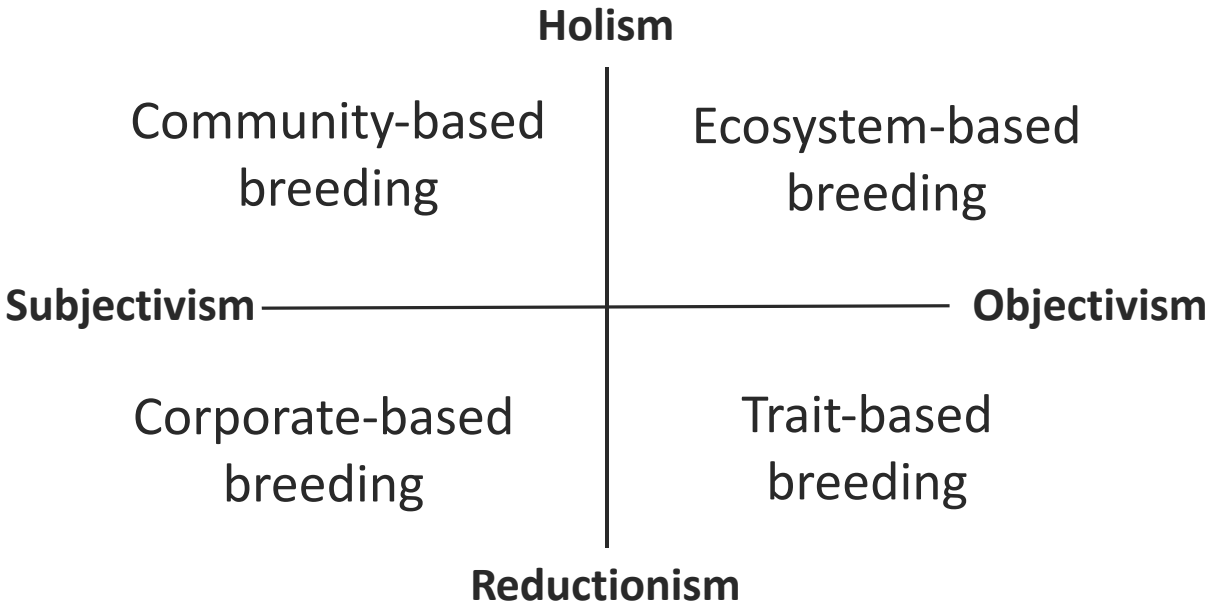
Current state of the art: Four breeding orientations ('paradigm positions', styles of thought)



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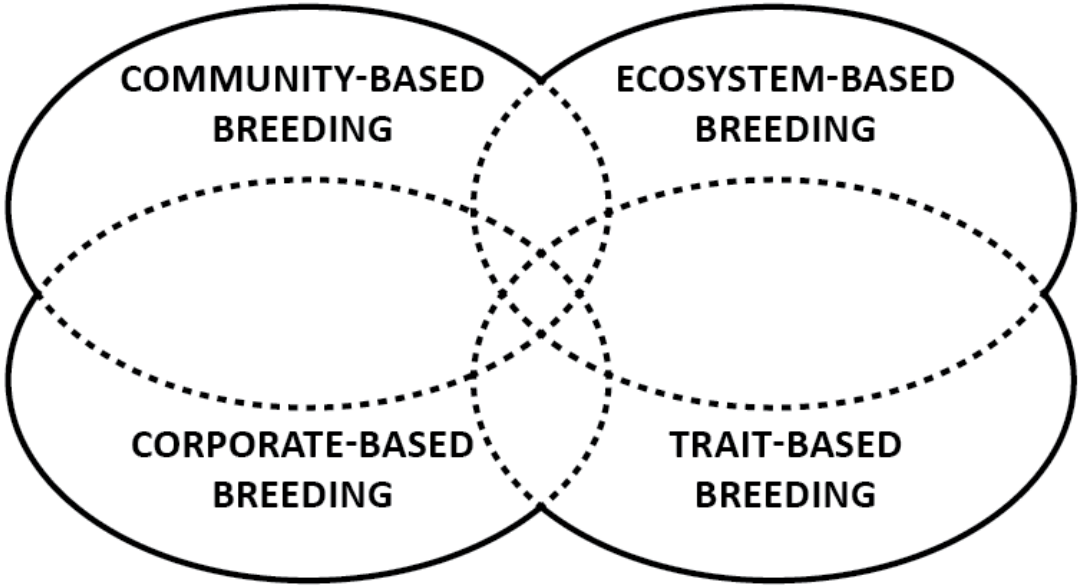
Need for balance, optimal interaction and synergy



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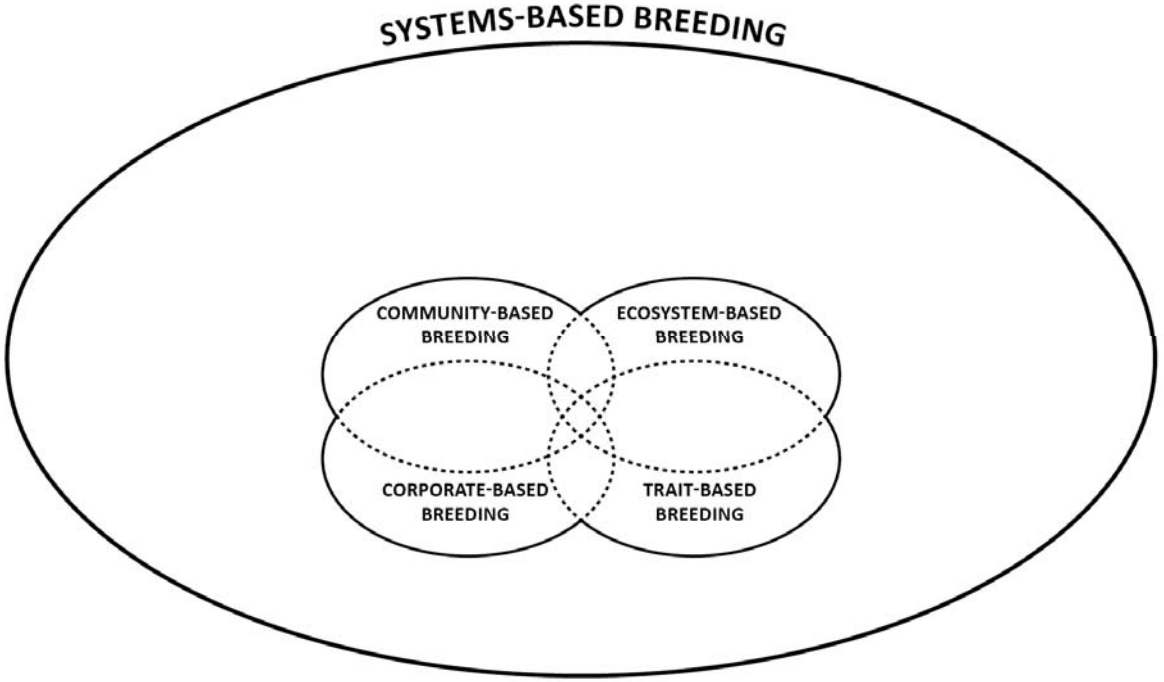
Hence, a need for systems-based breeding approaches



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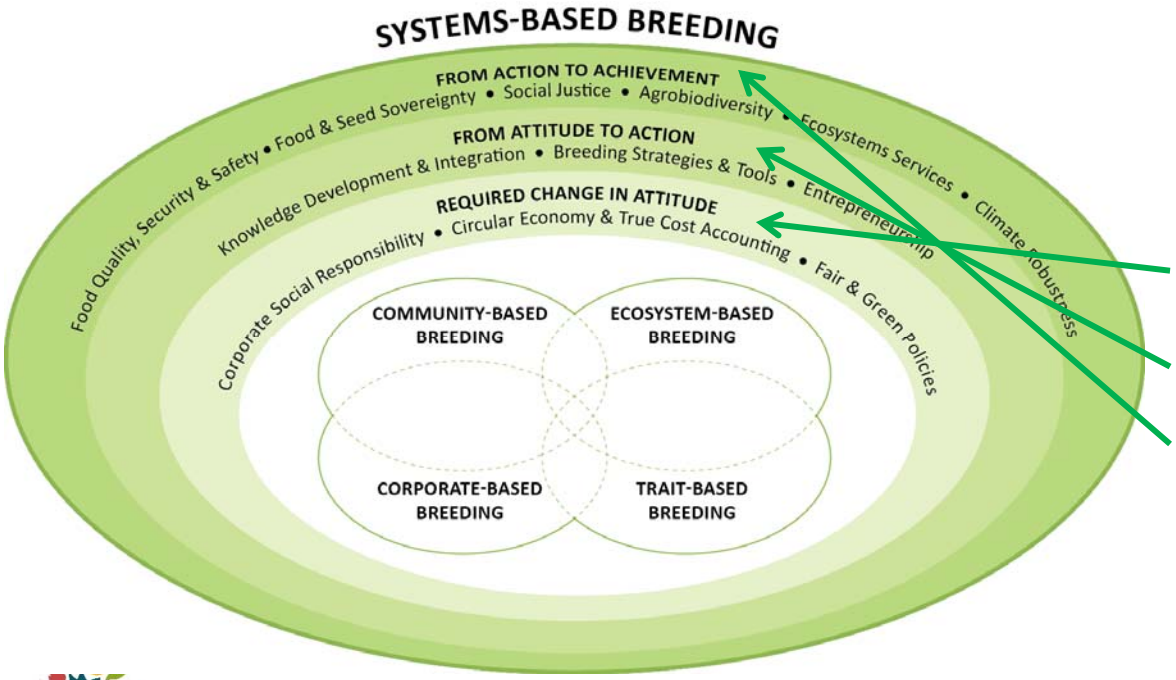
Steps needed towards systems-based breeding:



Three categories of steps:

1. Required change in attitude
2. From attitude to action
3. From actions to achievements

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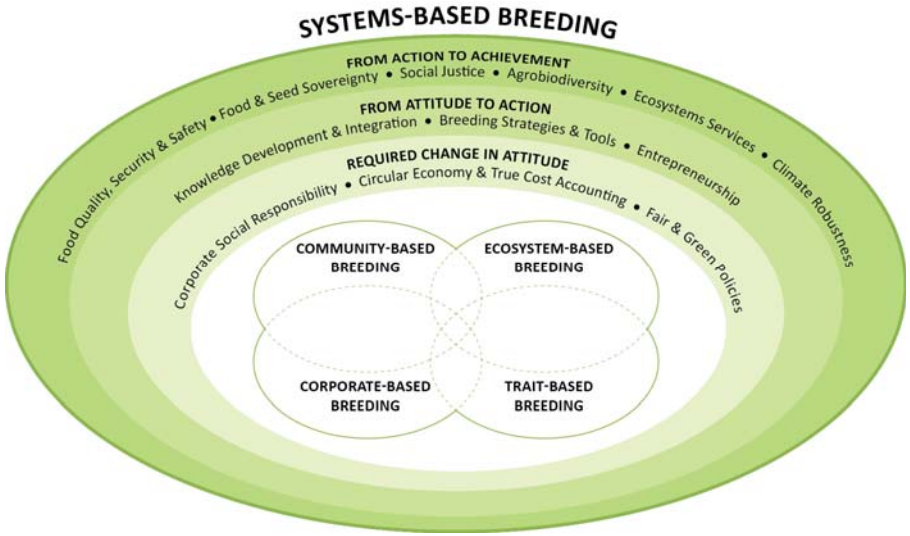
Required change in attitude



Three key-elements:

1. Corporate Social Responsibility
2. Circular Economy & True Cost accounting
3. Fair & Green Policy

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Example 1:
Required change in attitude

10% of turn-over of Frank's free varieties to Seed Company High Mowing

Three key-elements

1. Corporate Social Responsibility
2. Circular Economy & True Cost accounting
3. Fair & Green Policy

Organic farmer breeder Frank Morton Oregon-USA

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Example 2:
Required change in attitude

- New resistant potato varieties were not adopted by the market and continuous (in NL illegal) copper use and harvest failures
- In 2017, in NL full commitment of all supermarkets achieved to sell only resistant cultivars for organic potato by 2020

Three key-elements:

1. Corporate Social Responsibility
2. Circular Economy &
   True Cost accounting
3. Fair & Green Policy

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Example 3:
Required change in attitude

Composite cross populations versus pure line varieties

(1) EU experiment (2014-2021) to allow heterogeneous material to be described and marketed

Three key-elements

1. Corporate Social Responsibility
2. Circular Economy &
   True Cost accounting
3. Fair & Green Policy

(2) Allowing changes in official Variety Testing protocols (VCU)

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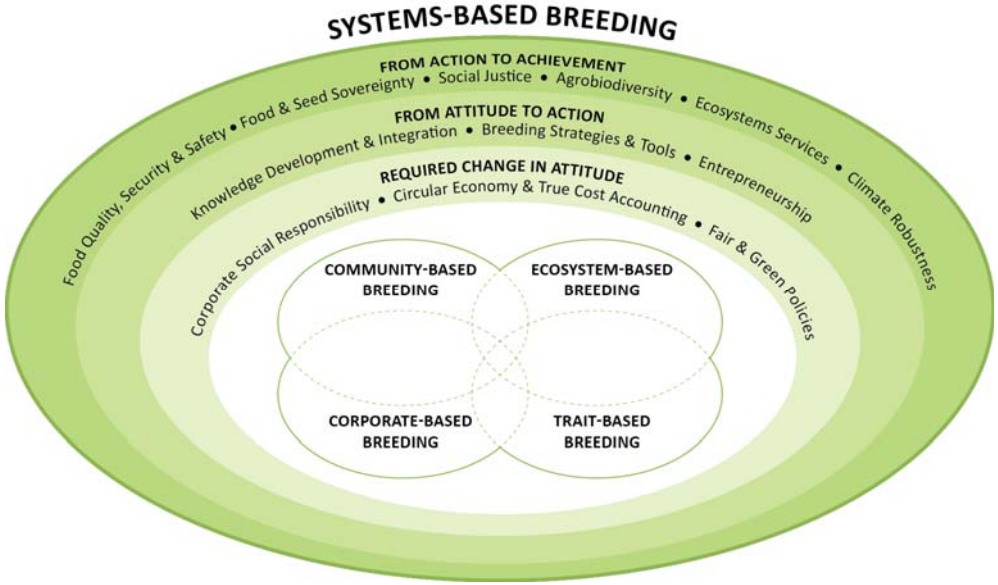
From attitude to action



Three key-elements:

1. Knowledge development & Integration of knowledge
2. Breeding strategies & tools
3. Entrepreneurship

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Example 2
From attitude to action

Breeding for diversity e.g. ‘heterogeneous material’ and crop mixtures

Composite cross populations:
► Multiple crosses

Crop mixtures (e.g. lupine/wheat):
► breeding for combinability

Three key-elements:

1. Knowledge development & Integration of knowledge
2. Breeding strategies & tools
3. Entrepreneurship

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Example 3:
From attitude to action

Johnny's Selected Seeds

100% employee owned

Three key-elements:

1. Knowledge development & knowledge integration
2. Breeding strategies & tools
3. New entrepreneural models

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Example 3:
From attitude to action

De Beersche Hoeve demeter

Biodynamic Seed & Vegetable Farm
100% daughter of
Food Cooperative Odin

Three key-elements:

1. Knowledge Development & knowledge integration
2. Breeding strategies & Tools
3. New entrepreneural models

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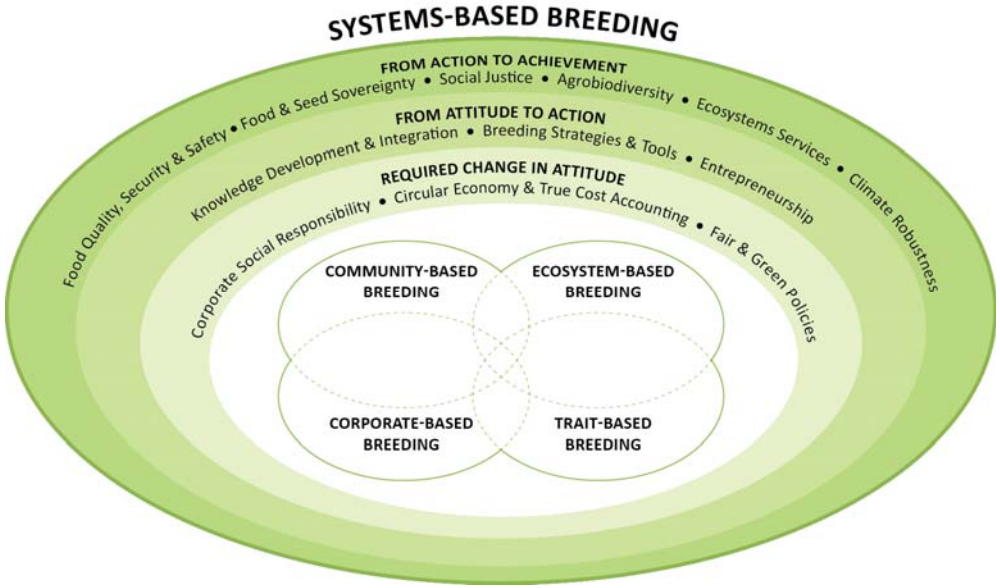
From action to achievement: six goals for ecological and social resilience



(Lammerts van Bueren et al. 2018. ***Towards resilience through systems-based plant breeding. A review.*** *Agronomy for Sustainable Development.)*

Six key-elements (goals):

1. Social justice
2. Food security, quality and safety
3. Food and seed sovereignty
4. Agro-biodiversity
5. Ecosystem services
6. Climate robustness

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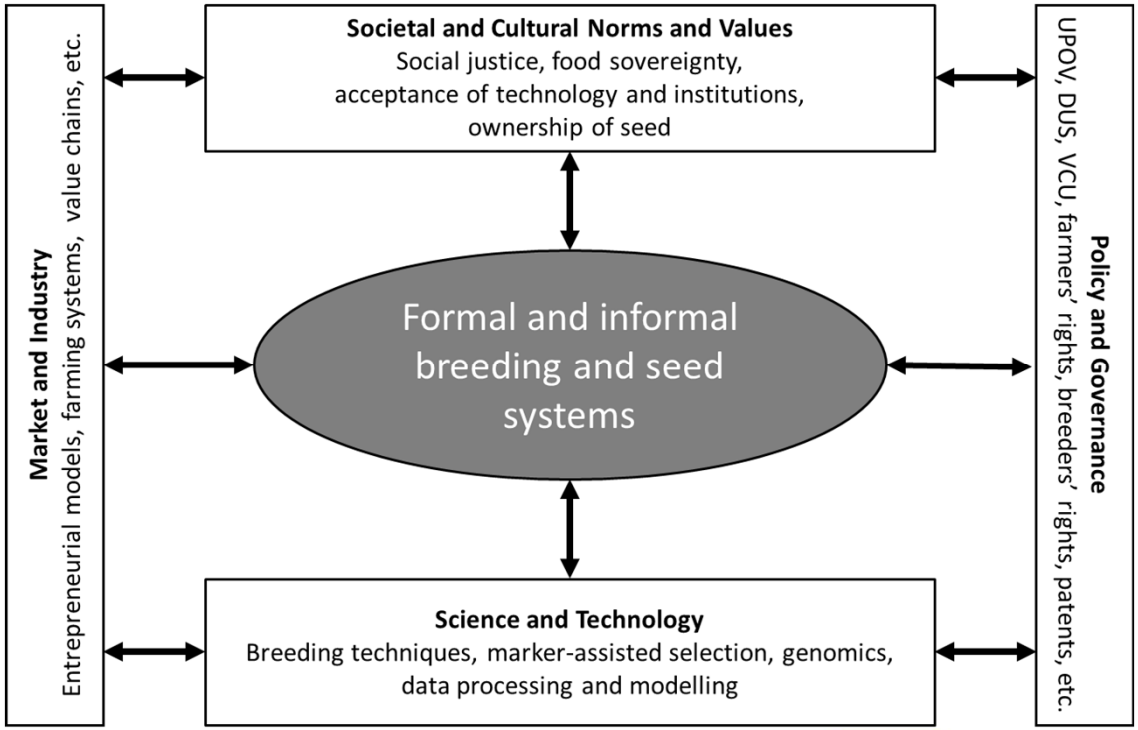
Roles and positioning of breeding and seed systems within their economic, scientific, institutional and cultural environment *(Figure 3, Lammerts van Bueren et al. 2018)*



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Witzenhausen workshop 2018: workshop outcomes organised according to the four categories as described in Figure 3 (Lammerts van Bueren et al. 2018)

Category		Solutions (in %)	Obstacles (in %)	Examples (in %)
	N =	85	68	39
Market and Industry	69	27%	37%	54%
Policy and Governance	43	18%	32%	15%
Science and Technology	51	33%	18%	28%
Societal and Cultural Norms and Values	29	22%	13%	3%

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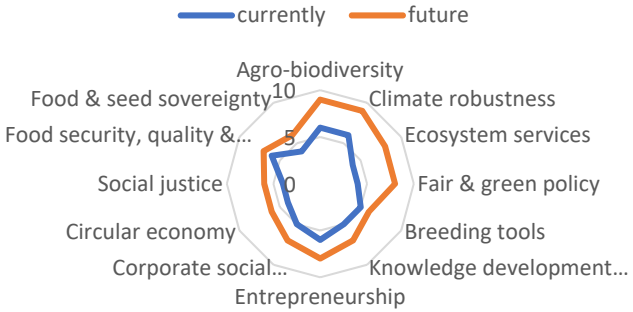
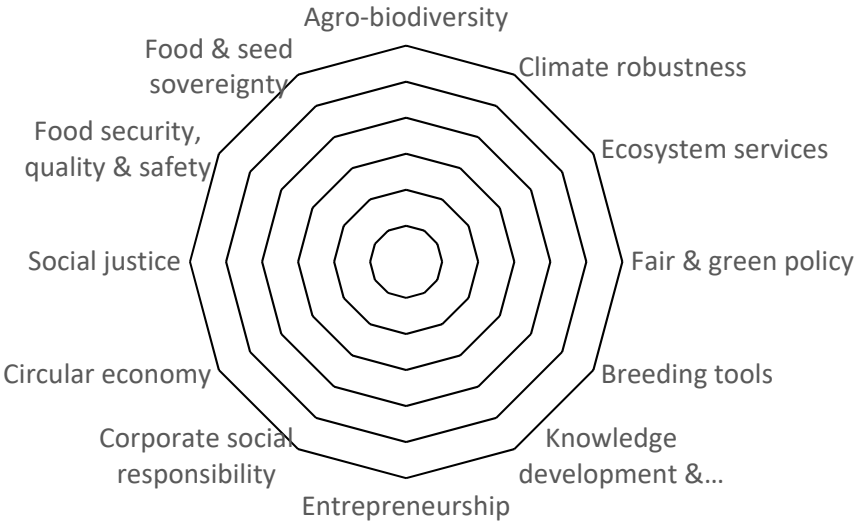
Tool for self reflection: applying 12 key elements in an assessment

	Key elements
Required change in attitude	Corporate social responsibility
	Circular economy & True cost accounting
	Fair & green policy
From attitude to action	Knowledge development and integration
	Breeding strategies and tools
	Entrepreneurship
From action to achievement	Food security, safety & quality
	Food & seed sovereignty
	Social justice
	Agrobiodiversity
	Ecosystem services
	Climate robustness

Spider chart per company/initiative





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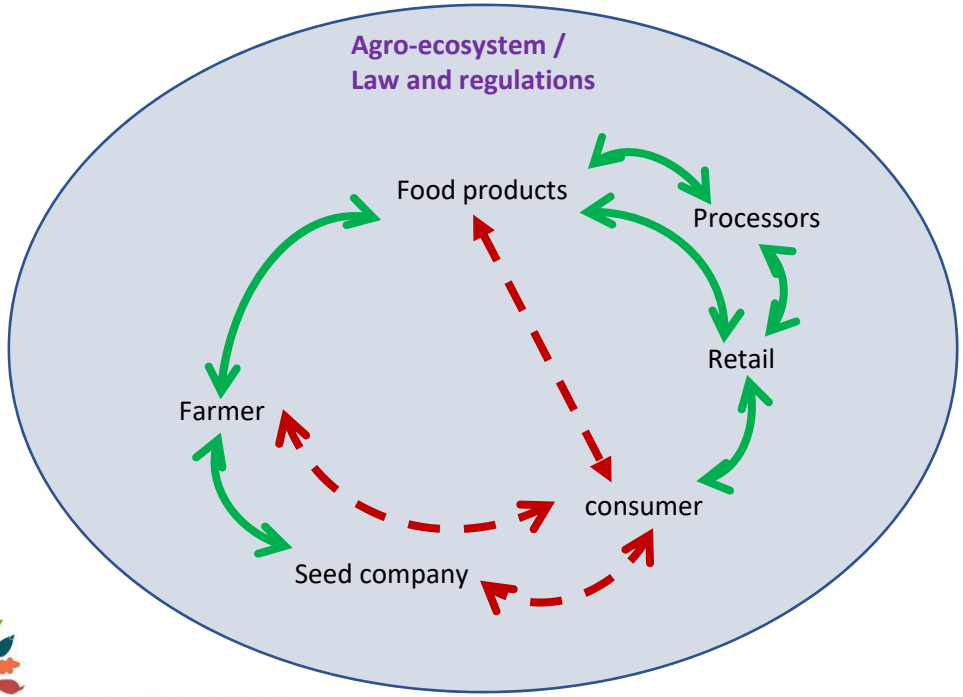
For circular economy we need rebuilding of linear value chains: towards circular organised food systems



.....including breeders as partners in new 'food communities'
……including shared risk taking to overcome individualism.

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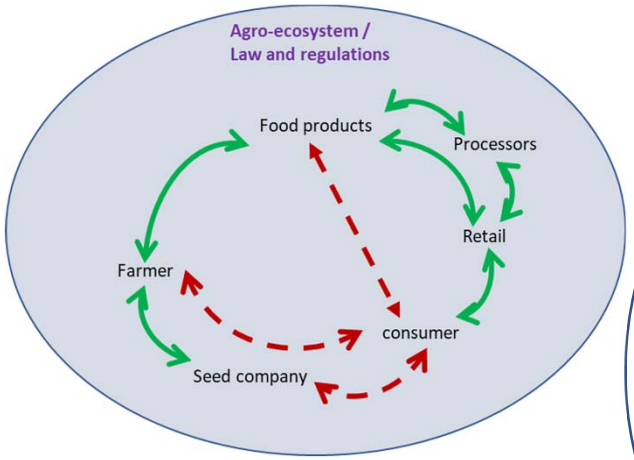
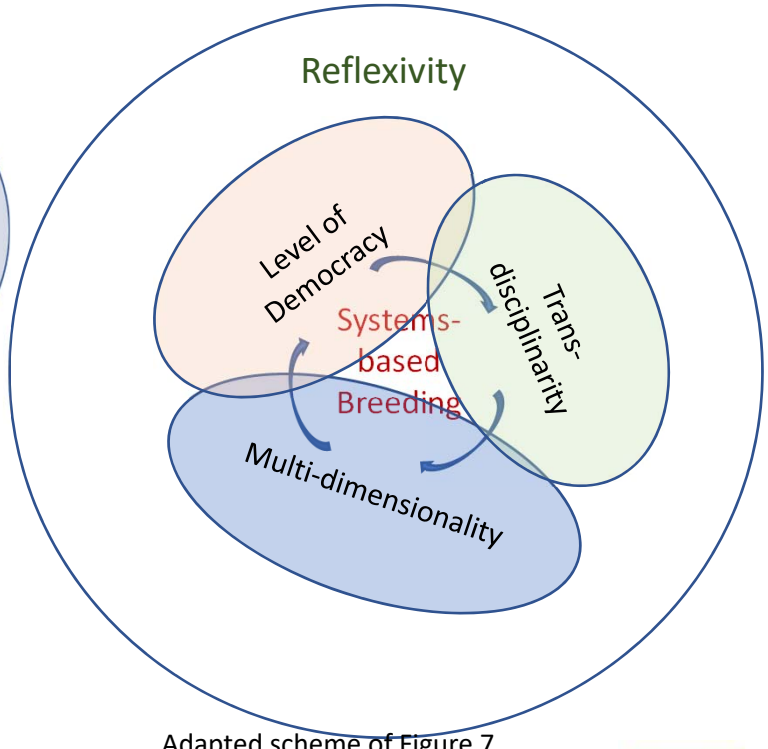
Lessons learned from DIVERSIFOOD on multi-actor processes: reflection in a group process

especially with respect to technical and social aspects





Adapted scheme of Figure 7, Deliverable 1.3, EU-Project DIVERSIFOOD

Reflection in a group process

- Involve various actors of the value chain;
- Make the implicit explicit;
- What are our assumptions?
  - We are often unaware of them
  - The perspectives of each actor can be different;

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Biofach workshop 2019: systems-based approach in organic plant breeding: integration into value chain partnerships

- Main questions remained to address collectively:
  - Why should different value chain actors support organic plant breeding?
  - The advantage of organic plant breeding for value chain (farmer, processors, traders)
  - The advantage of organic plant breeding for consumers and society (local and global)
- Tailor-made approaches are needed
  - Needs to include ***new*** approaches for: knowledge exchange, communication, marketing, education, etc

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The importance of a systems-based approach

- Fostering diversity in breeding approaches and breeding initiatives helps:
  - maintain agrobiodiversity
  - make agriculture more climate robust
  - foster the development and maintenance of knowledge
  - develop new types of relationships
  - keep an open mind on what seeds are: part of our common heritage

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