

How can plant breeding contribute to both ecological and societal resilience?

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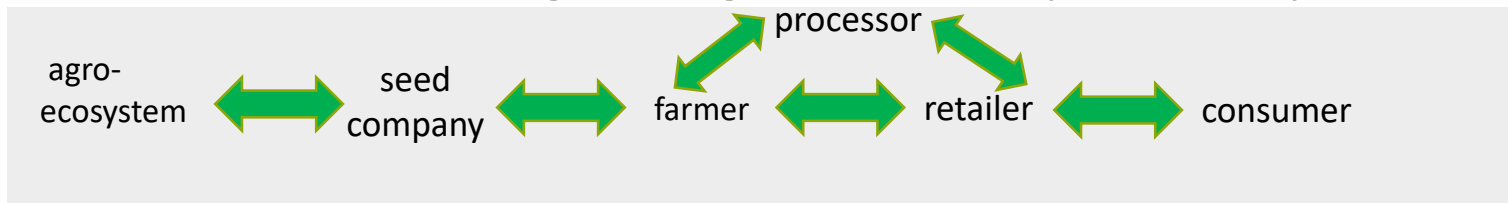
My key message:

- ❑ Plant breeding is not only a concern of breeders and farmers
- ❑ Also actors further up in the value chain have a role to play
- ❑ We have to develop new ways of building true relationships across the value chain to come to 'inclusive efficiency'



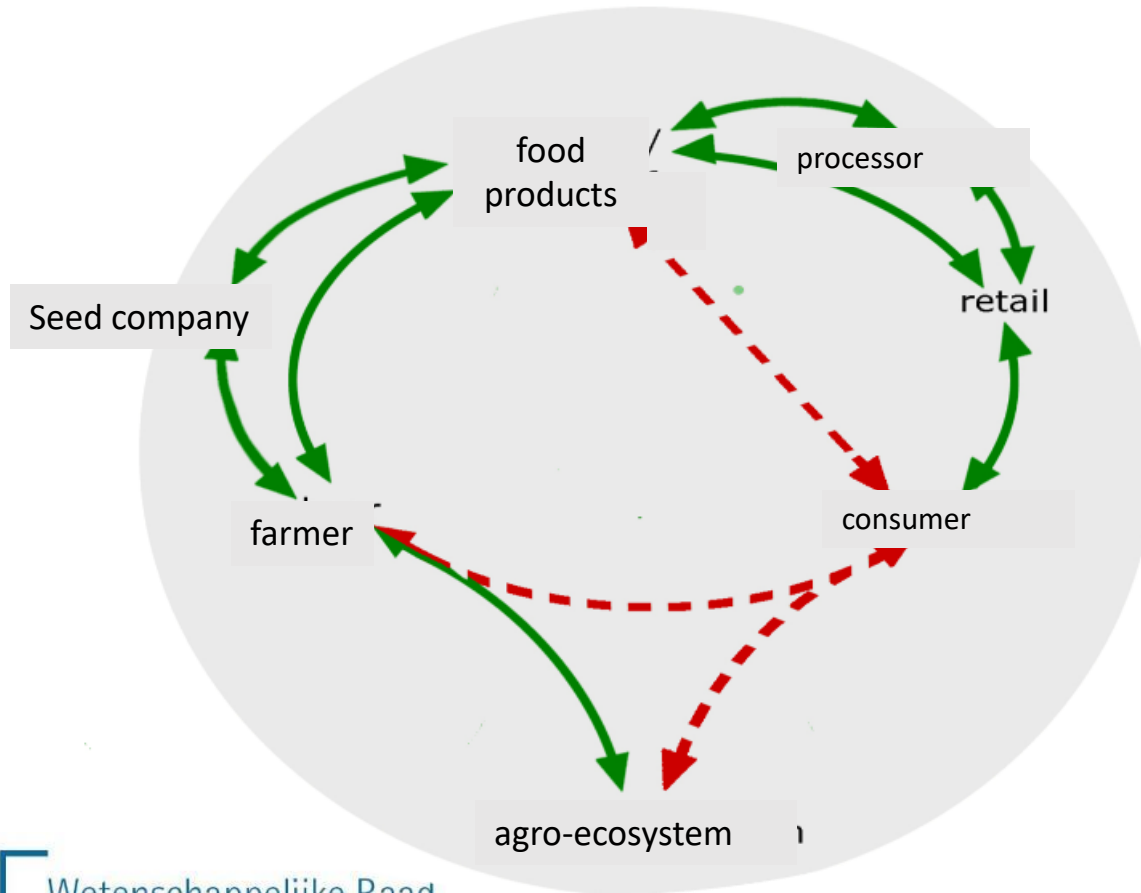
Observation 1: linear organisation of the value chain

- More and more specialisation in agriculture/society:
 - vital relationships have gone lost or corrupted
- Even when each actor would do it's ultimate best to become more sustainable, still it is easy to drop aspects over the fence to the right or left actor,
 - resulting in 'organised irresponsibility'



- Many organic value chains are still traditionally linear organised....

Key question: How can we build true relationships?



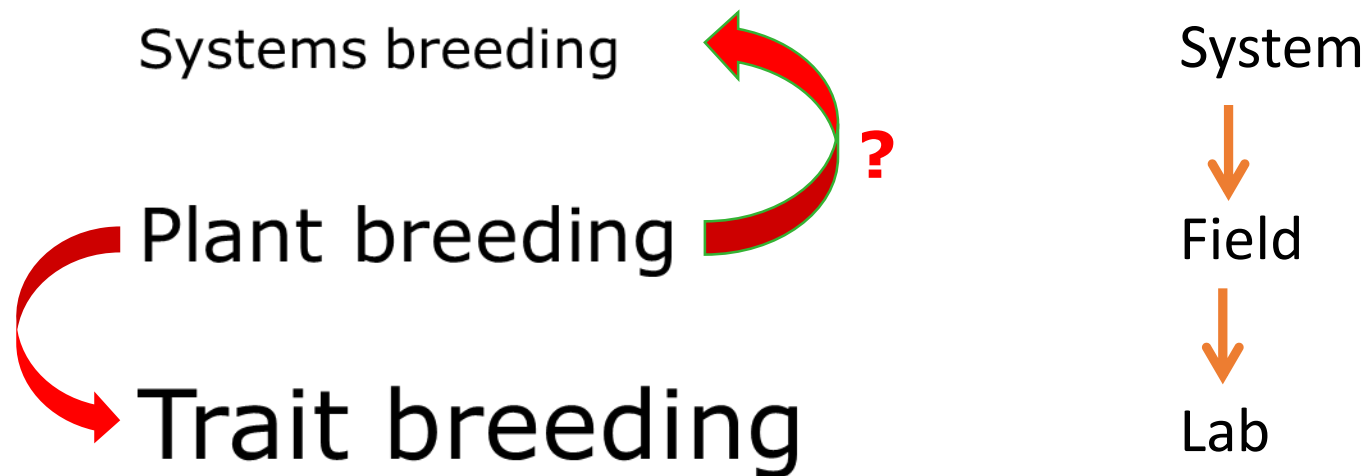
Towards circular
organised value chains:

.....including breeders
as partners in new
'food communities'

To avoid '*exclusive
efficiency*',
and instead
to move towards
'*inclusive efficiency*'

Observation 2: Trait (molecular) breeding

More and more plant breeding is becoming trait breeding



Trend 1: Trait breeding

More and more plant breeding is becoming trait breeding

Systems breeding

Plant breeding

Trait breeding

How to incorporate systems breeding into current breeding?

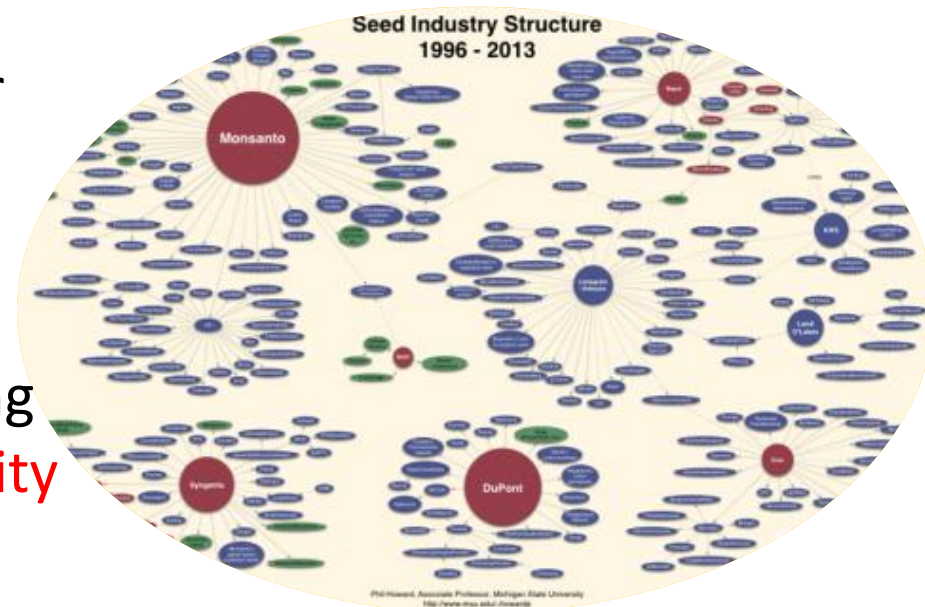


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Observation 3:

Loss of diversity in breeding

- National diets are becoming more diverse, but worldwide diets are increasingly more similar (*Khoury et al. PNAS 2014*).
- Of the 30.000 edible species we grow only 150,
- 95% of our human food calories originate from 30 crop species (*WHO & CBD, 2015*)
- Mergers in the breeding sector
 - ▶ Loss of diversity in breeding
 - ▶ Small crops are orphans
 - ▶ Commercial and public breeding are not focused on **food diversity**

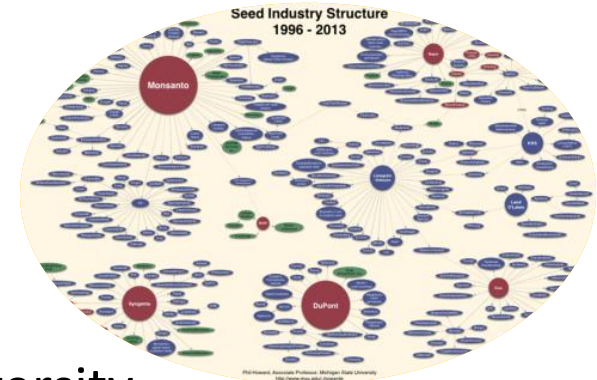


Trend 2:

Loss of small crops in breeding

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(*Khoury et al. PNAS 2014*).
- Of the 30.000 edible species we grow only 150,
- 95% of our human food calories originate from 30 crop species
(*WHO & CBD, 2015*)
- Mergers in the breeding sector
 - ▶ Loss of diversity in breeding programs
 - ▶ Small crops are neglected in breeding
 - ▶ Both commercial and public breeding programs are not focused on food diversity

Who cares?



Observation 4: Breeding for (longterm) ecosystems 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



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Trend 3: Breeding for (longterm) ecosystems services?

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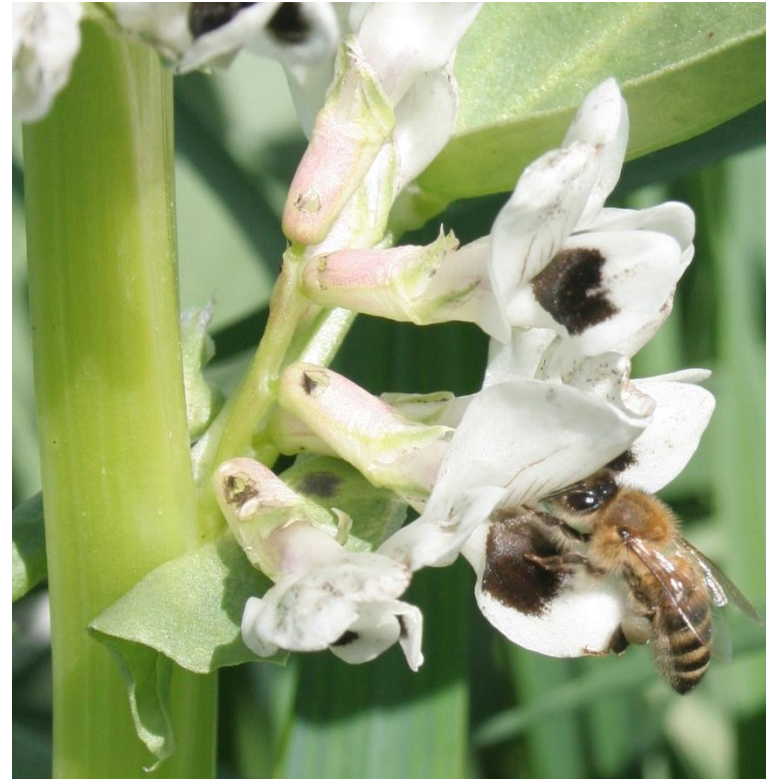
...in turn contributing to food security and quality!



Observation 4: Breeding for (longterm) ecosystems services?

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

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

Observation 4: Breeding for (longterm) ecosystems services?

Breeding for diversity e.g. 'heterogeneous material' and crop mixtures



Composite cross populations:

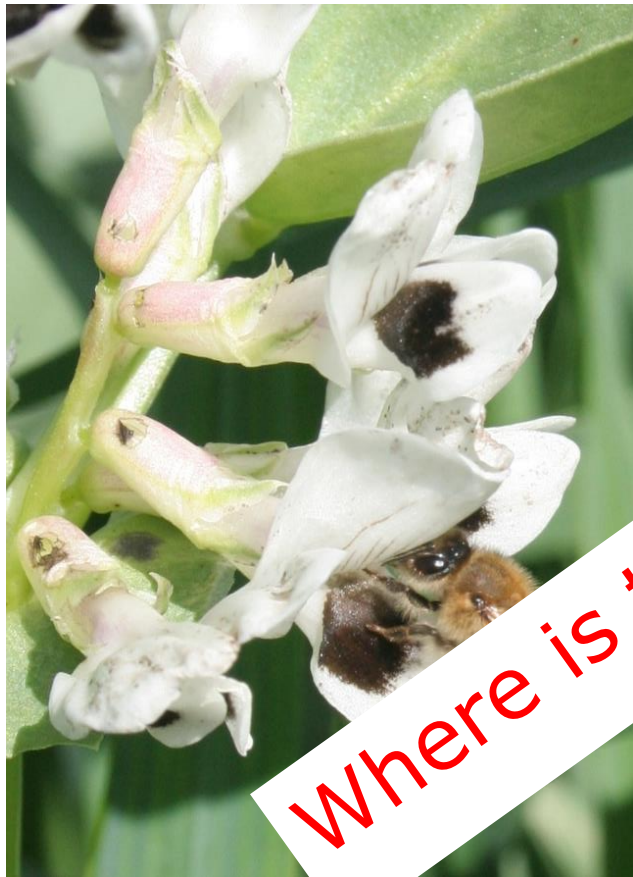
- Multiple crosses



Crop mixtures (e.g. lupine/wheat):

- breeding for combinability

Trend 3: Breeding for (longterm) ecosystems services?

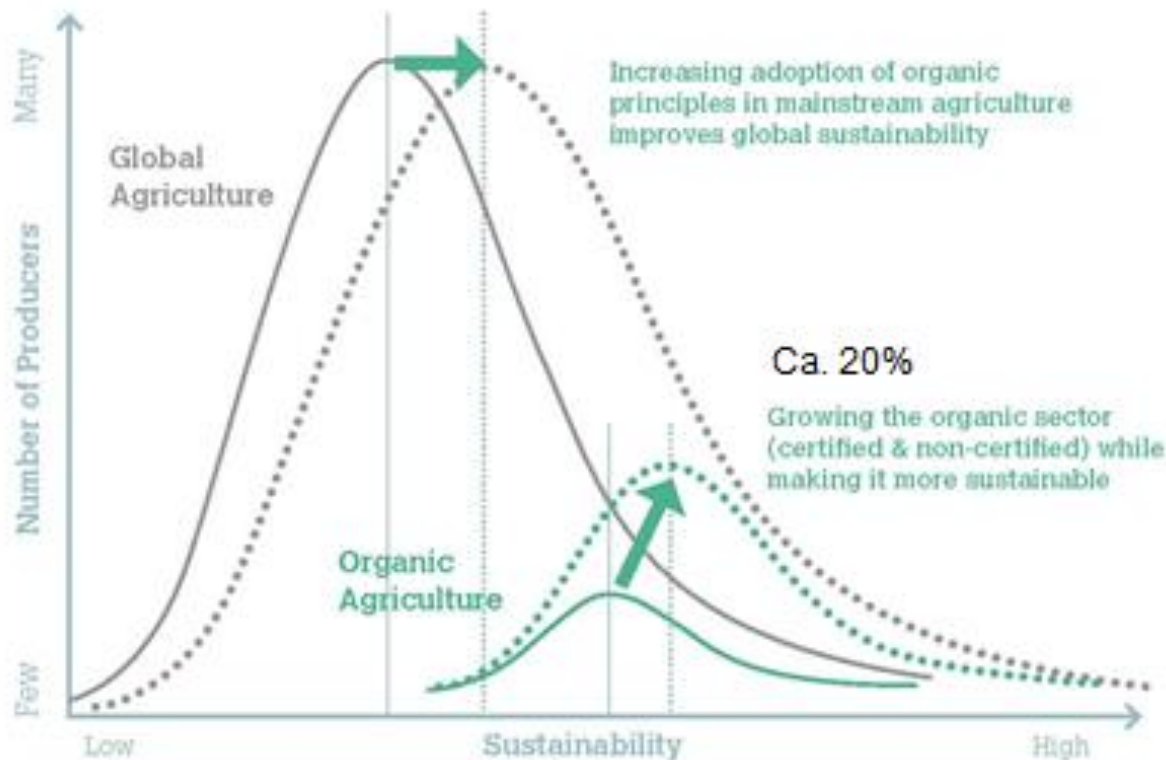


Where is the breeding business?

Observation 5:

Organic 3.0 (IFOAM 2015):

Broadening the organic scope for 2030



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Observation 5:

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



Five dimensions:

- Ecology
- Society
- Culture
- Accountability
- Economy

Trend 4: Organic 3.0 (IFOAM 2015) Broadening the organic scope to 2030



Five dimensions:

- Ecology
- Society
- Culture
- Accountability
- Economy

Observation 6:

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



Trend 5: SDGs of UN (2015) - target ecological and societal

How to transform those criteria into breeding?



Six goals for future plant breeding for ecological AND societal resilience

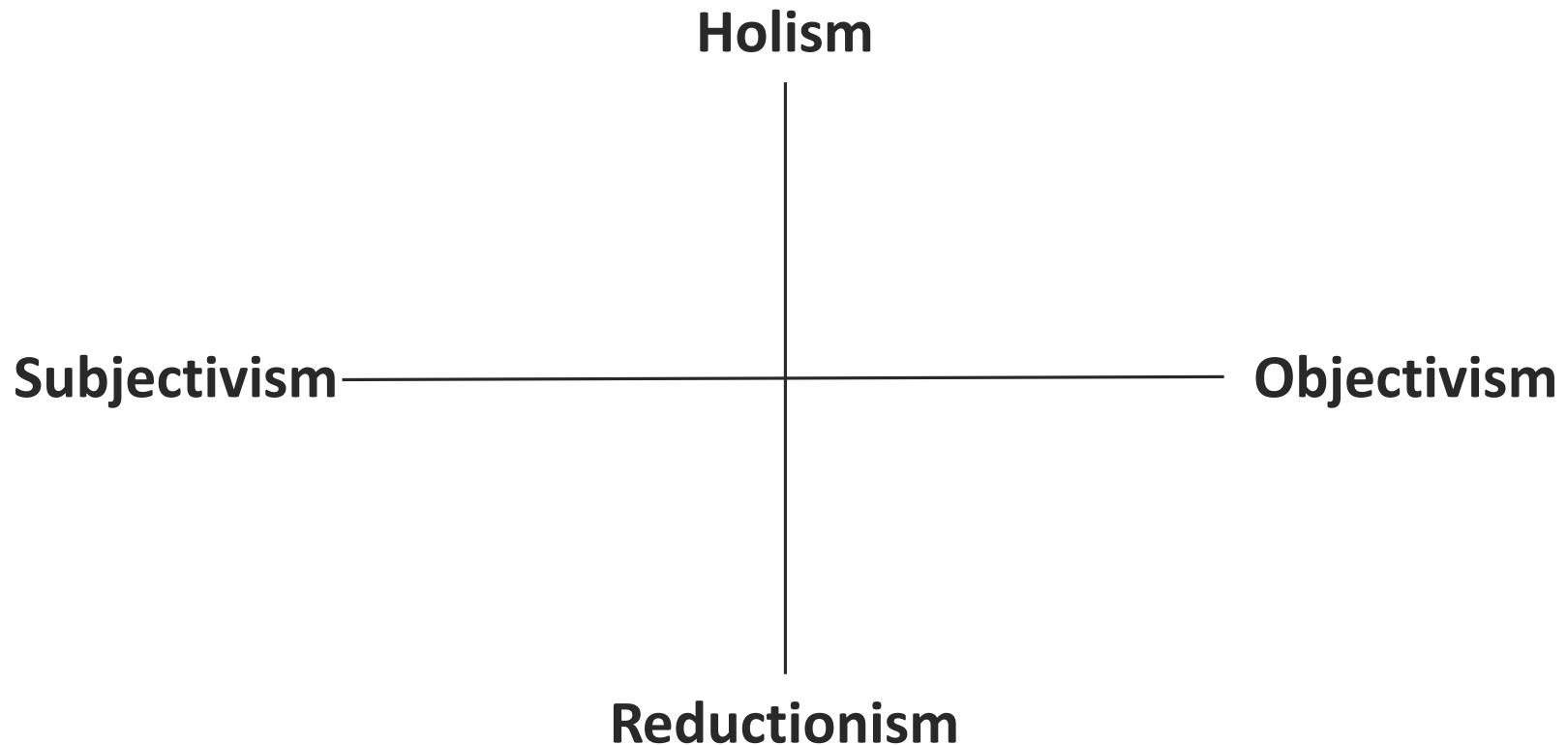
1. Social justice
2. Food security, food quality and safety
3. Food and seed sovereignty
4. Agro-biodiversity
5. Ecosystem services
6. Climate robustness



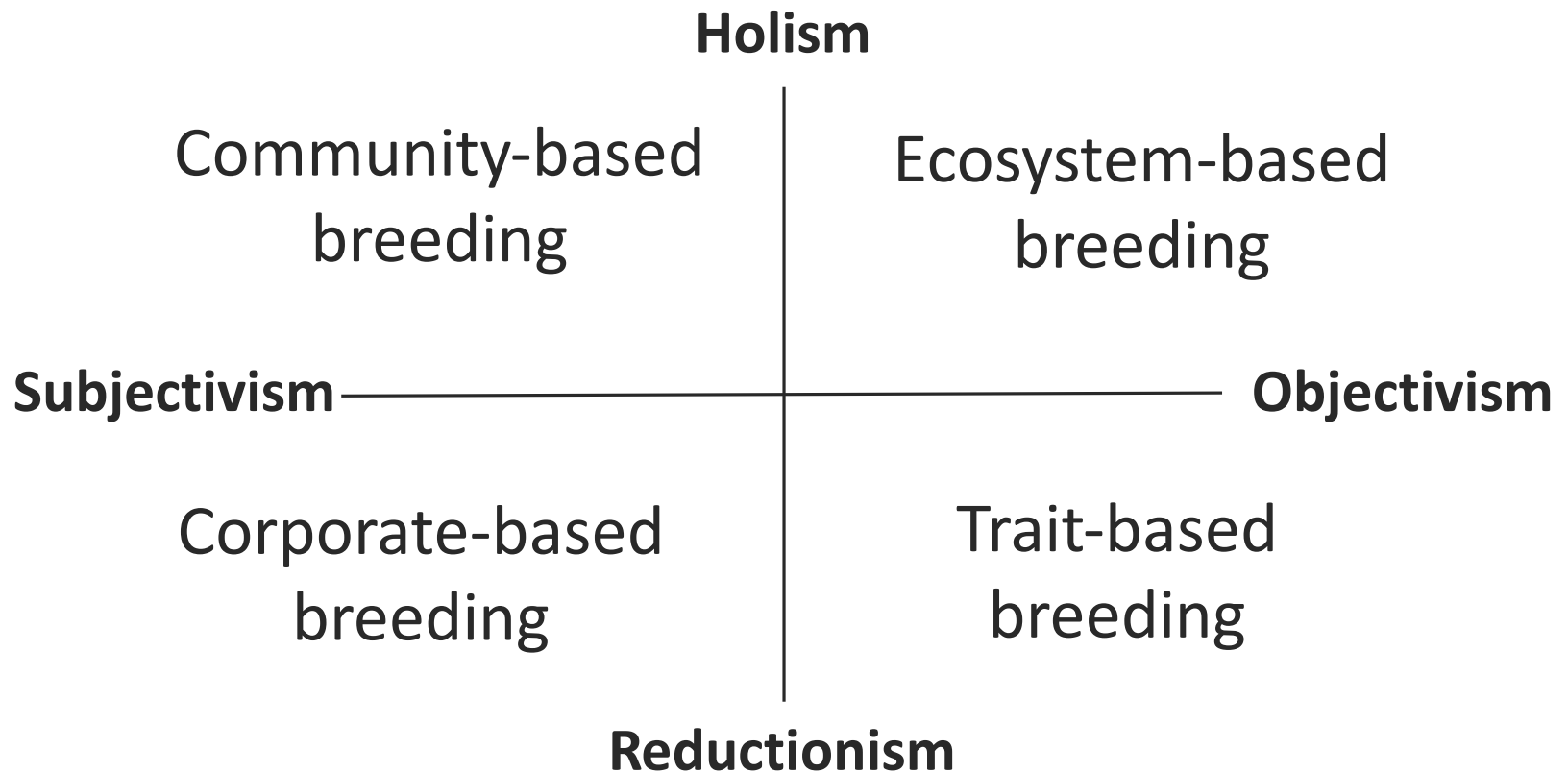
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Where do we stand?

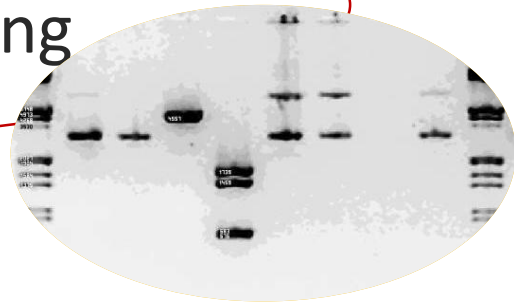
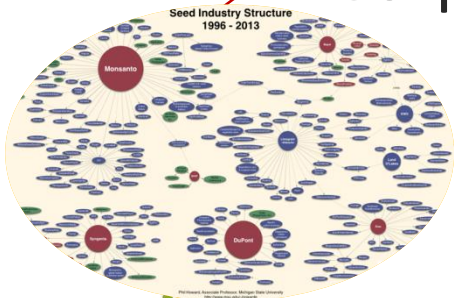
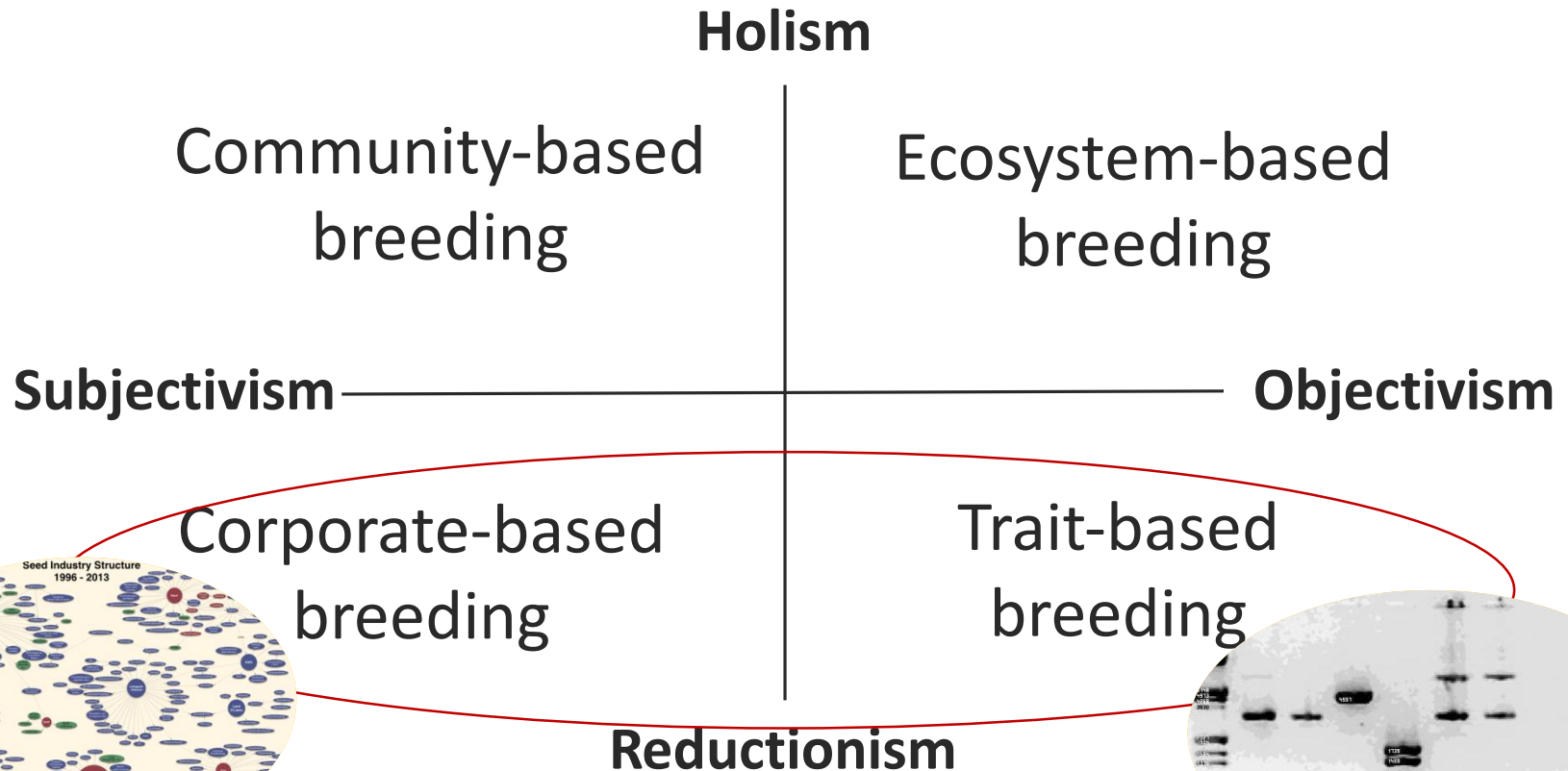
Framework of analysis



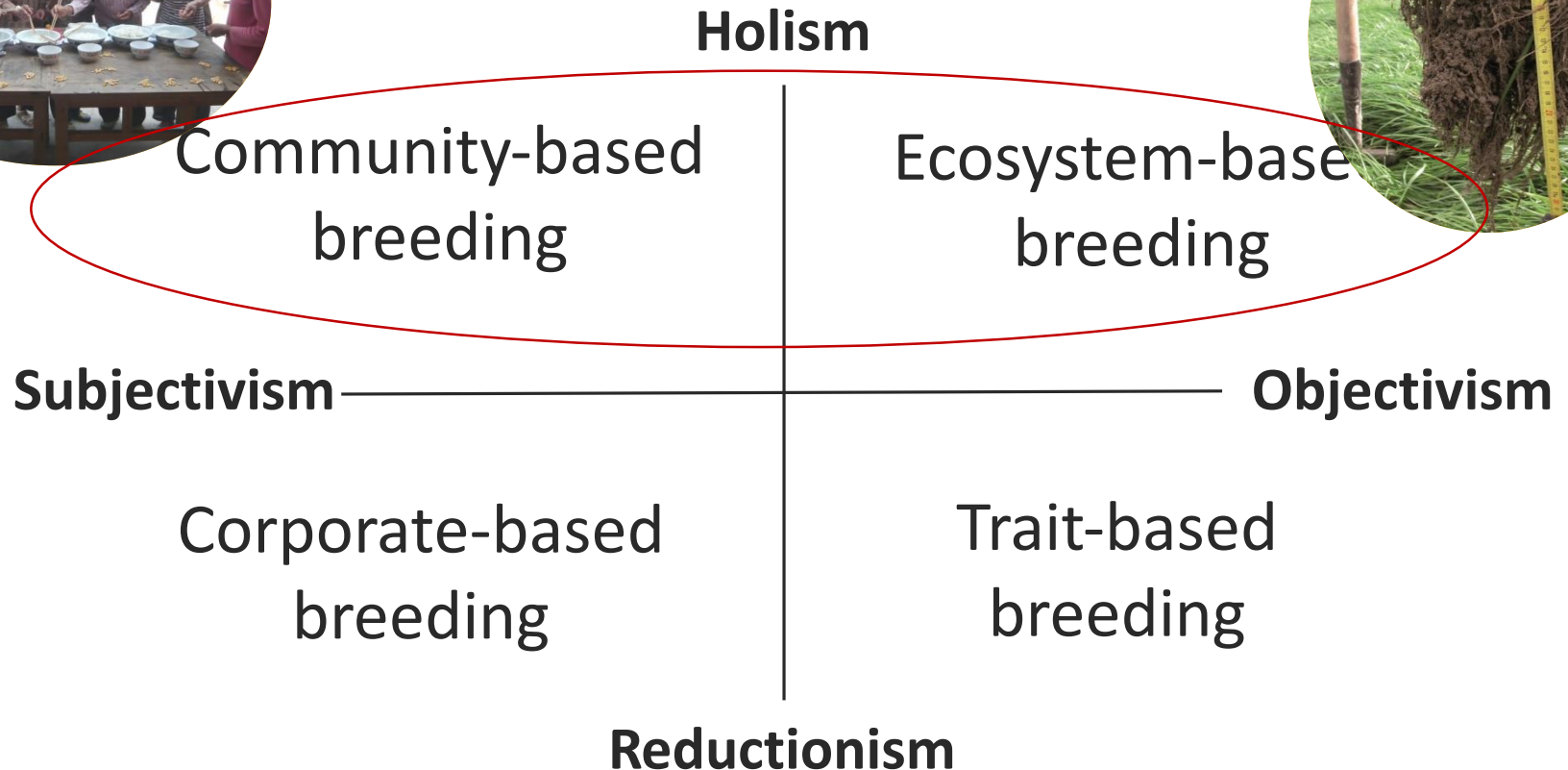
Current state of the art: Four breeding orientations (‘paradigm positions’, styles of thought)



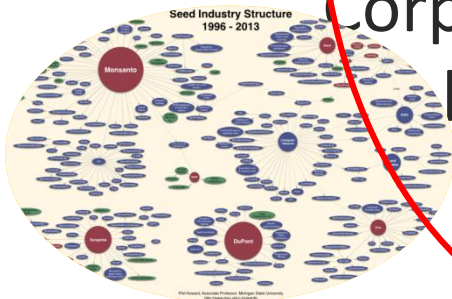
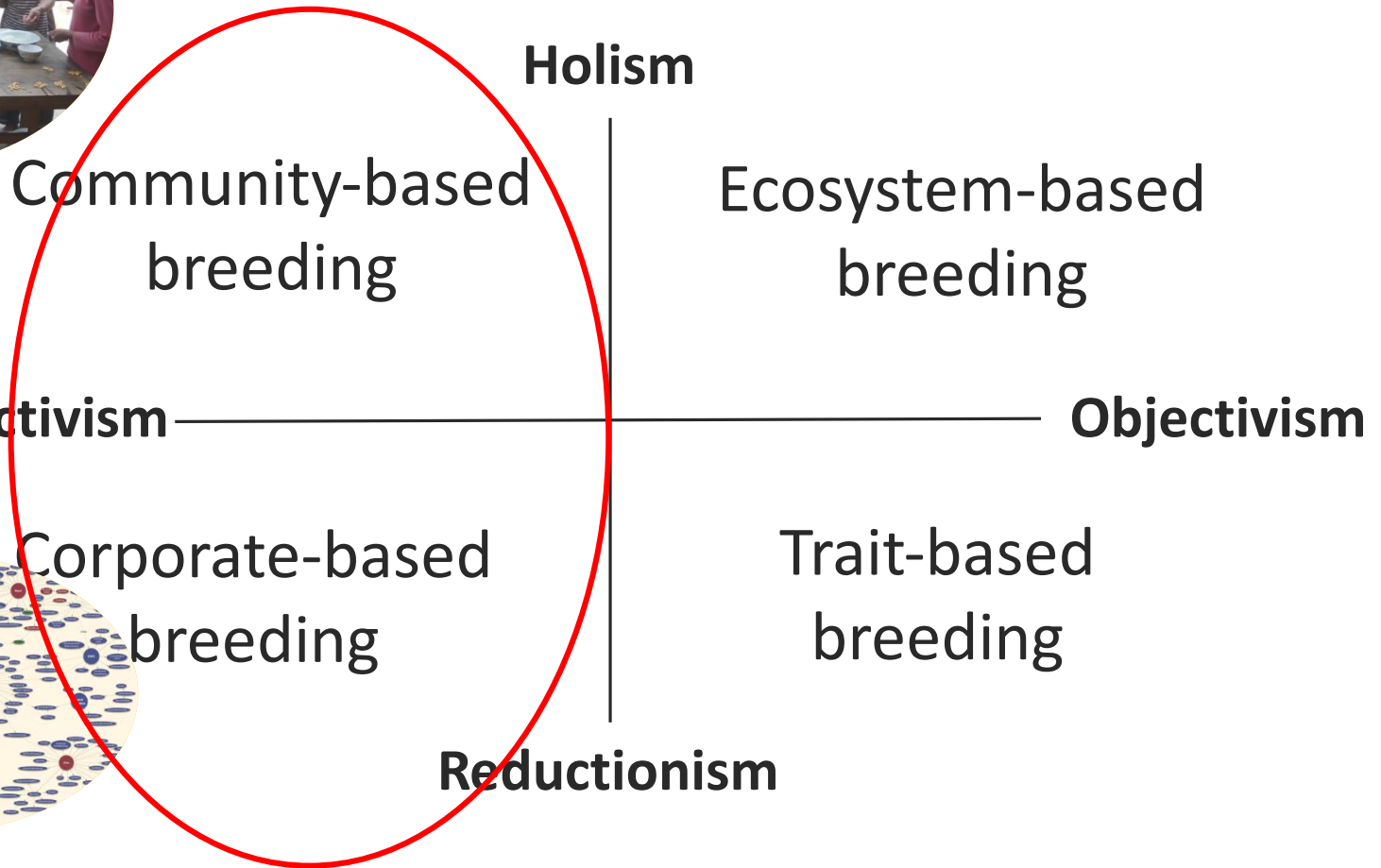
Four breeding orientations



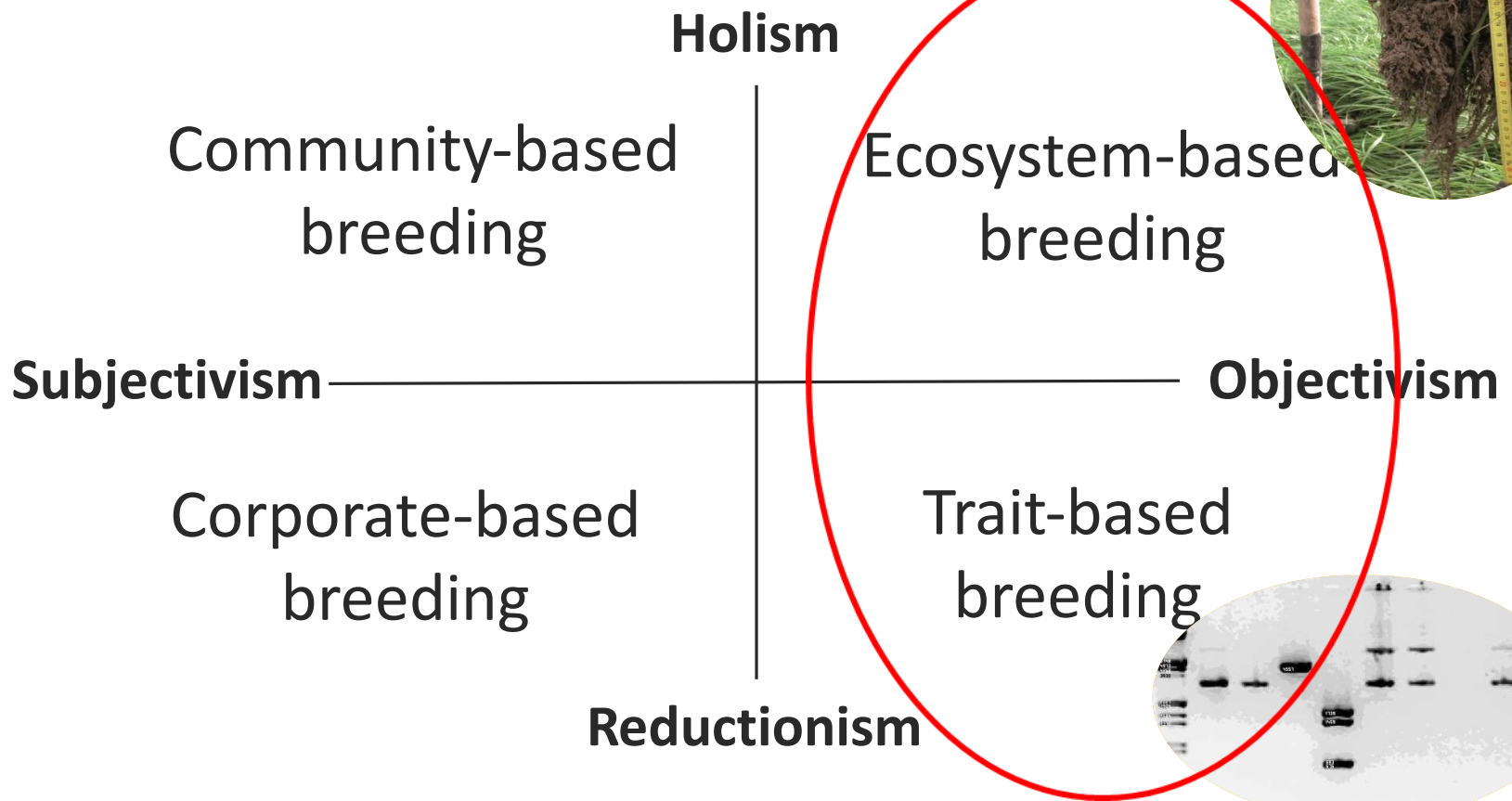
Four breeding orientations



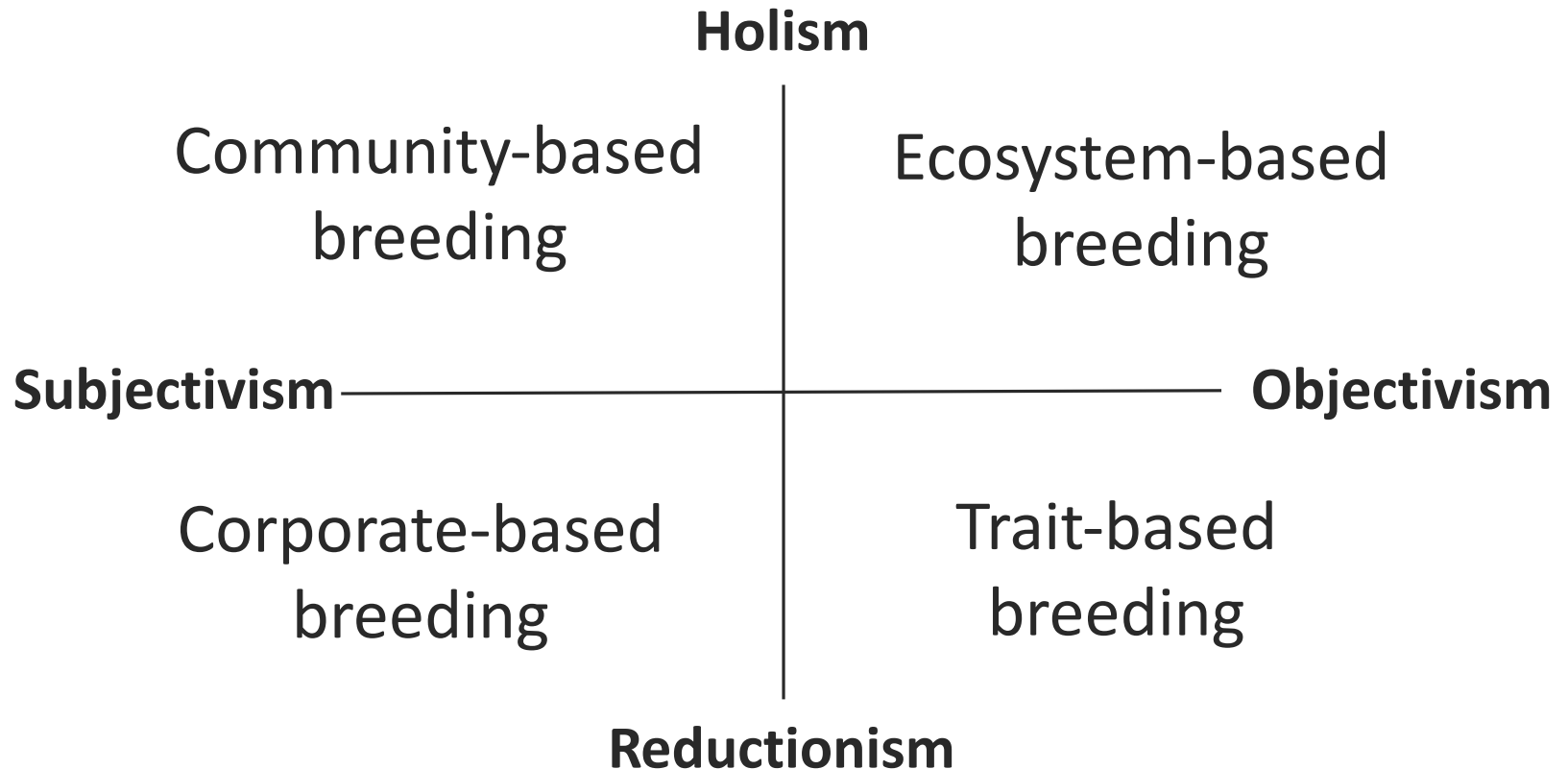
Four breeding orientations



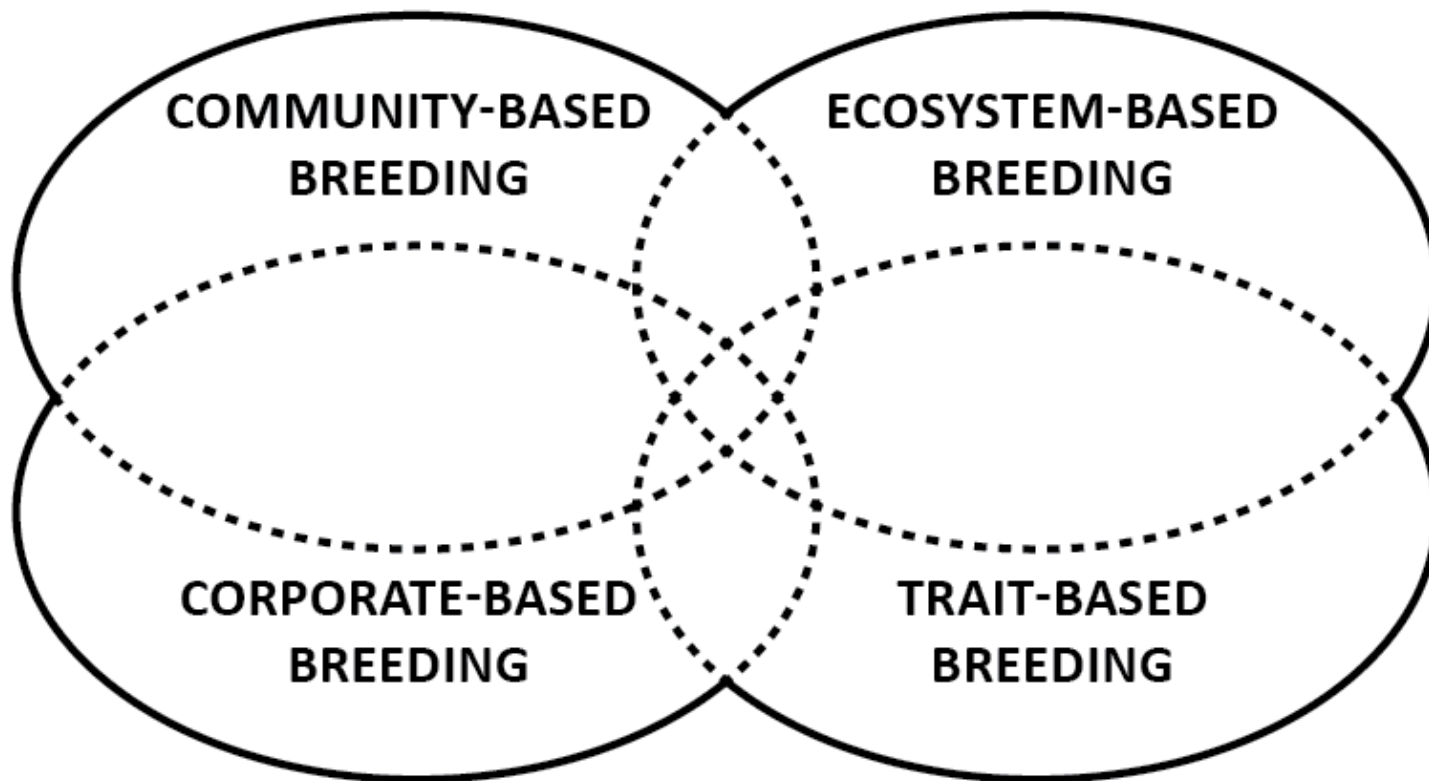
Four breeding orientations



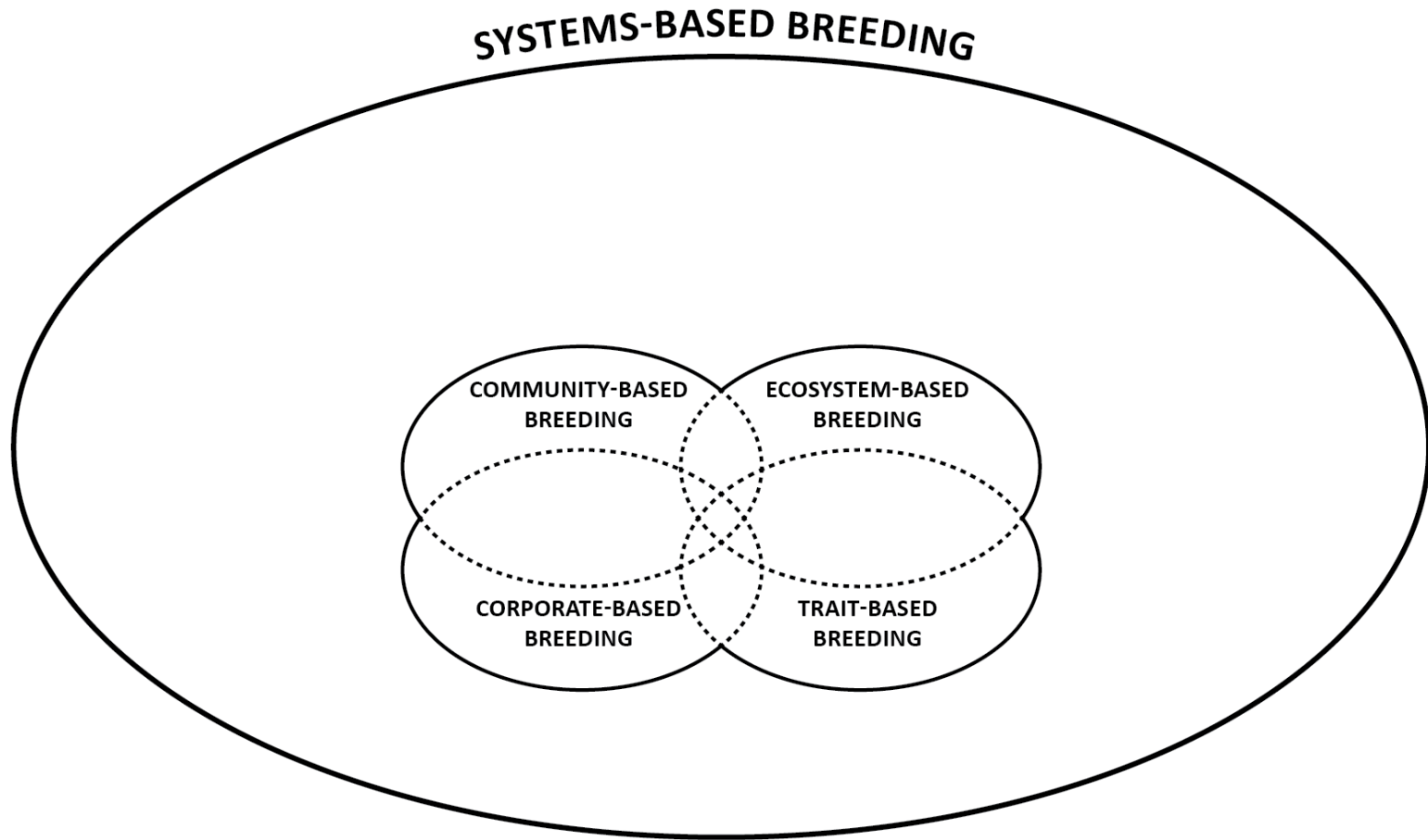
Each style of thoughts has its strengths and weaknesses



Need for optimal interaction and synergy



5th breeding orientation as driver: systems-based breeding



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SYSTEMS-BASED BREEDING

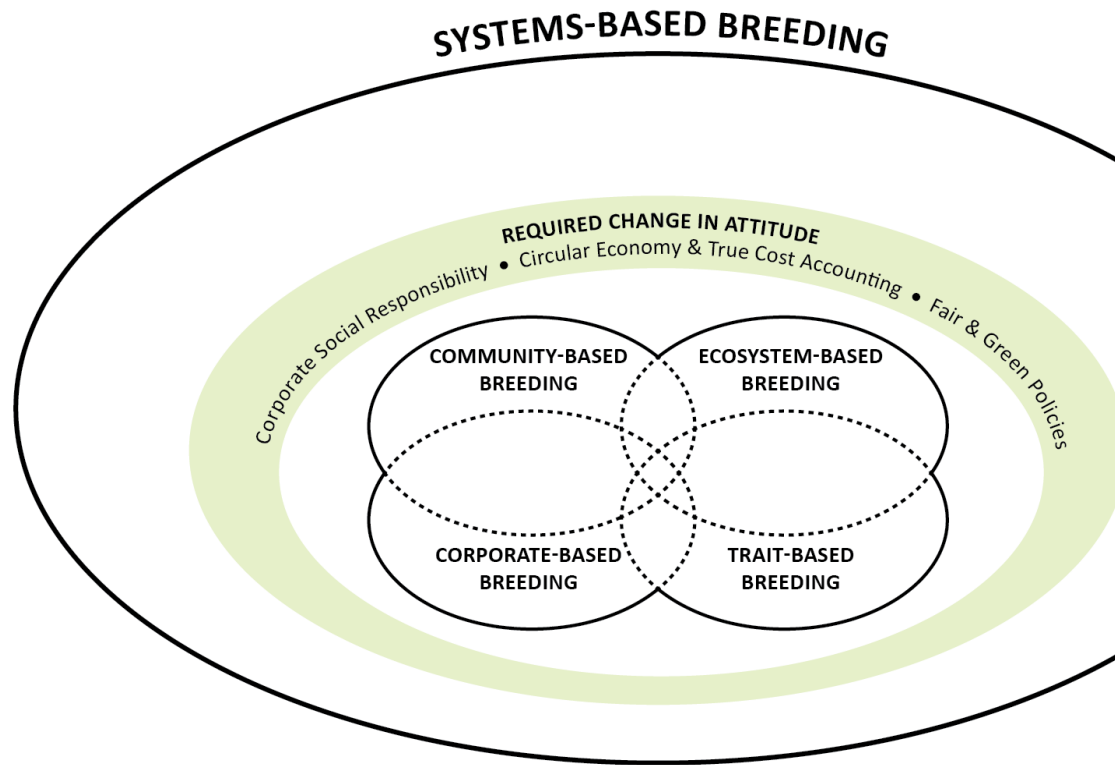
Steps needed towards systems-based breeding:

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

BREEDING

BREEDING

Required change in attitude



Three key-elements:

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

Example 1:

Required change in attitude



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



Organic farmer breeder Frank
Morton Oregon-USA

Three key-elements

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

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
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Example 3:

Required change in attitude

Composite cross populations versus pure line varieties



Three key-elements

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

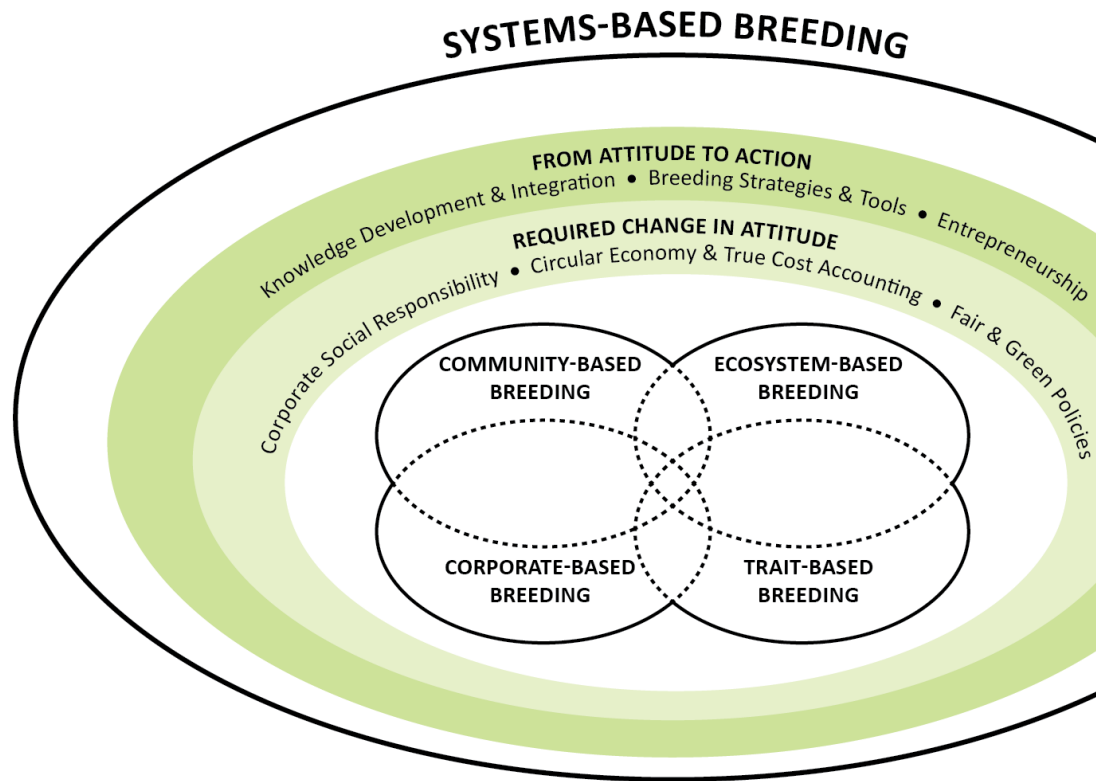
(1) EU experiment (2014-2021) to allow heterogeneous material to be described and marketed

(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

Example 1: From attitude to action



100% employee owned

Three key-elements:

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



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Example 2: From attitude to action

De Beersche Hoeve



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

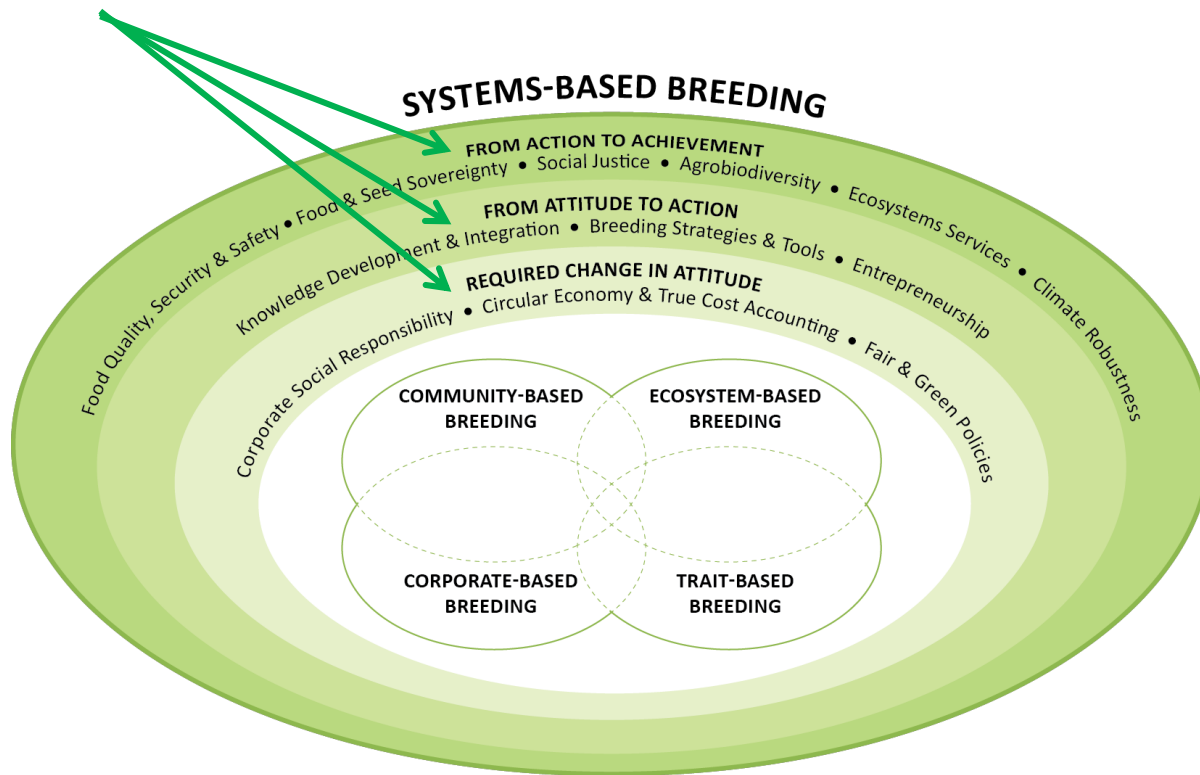
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From action to achievement: 6 goals



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

Examples of elements of the question: How can we build true relationships?

Example 1: Required change in attitude



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

Three key-elements

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Organic farmer breeder Frank Morton Oregon-USA

LIVESEED

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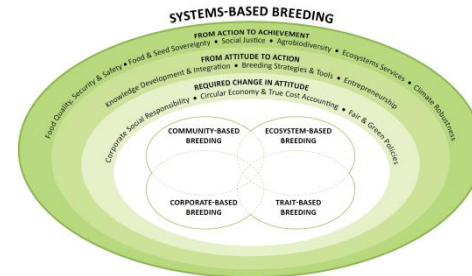


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Research questions to foster 'From attitude to action'

Three key-elements:

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

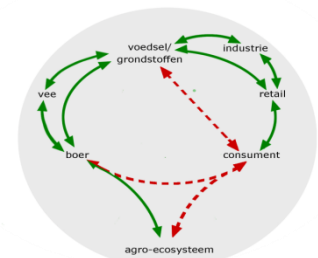


Towards new ways of organising/financing plant breeding in light of systems-based breeding:

- How to involve value chain partners?
- How to involve consumers and the public?
- How to create a balance between public and private interest in PB?
- How to create balance in public and private financial support for PB?

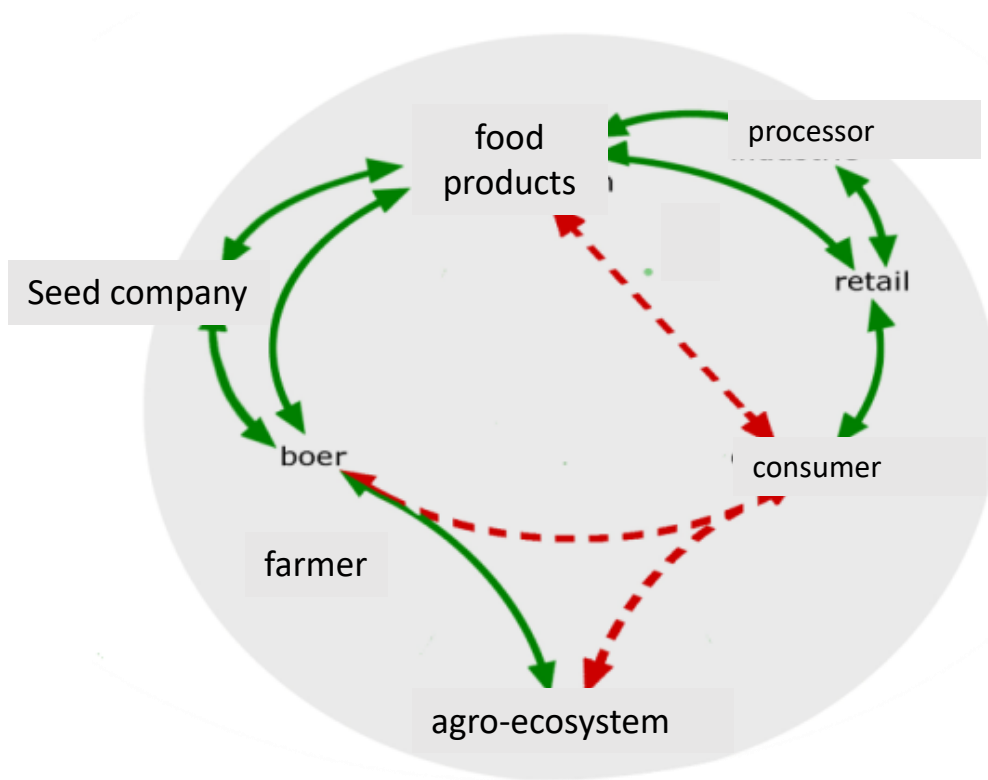


How can we find ways to make plant breeders part of our food communities?



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Key question: How can we build true relationships?

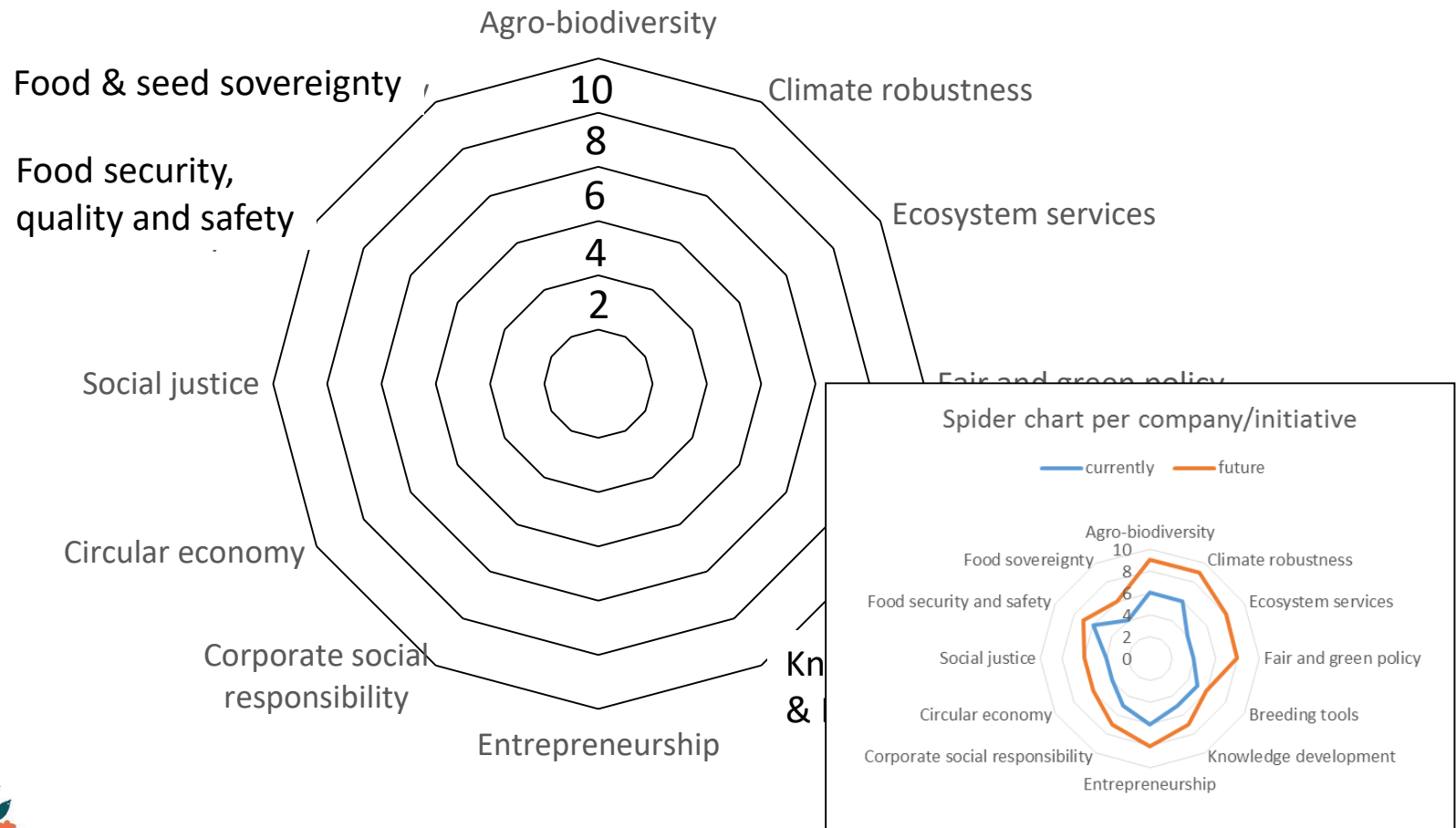


Towards circular
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To avoid '*exclusive efficiency*',
and instead
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12 Key-elements of systems-based breeding: in an assessment tool for breeders



Acknowledgements

The scientific papers underlying this concept is:

- *Lammerts van Bueren E.T., Struik P.C., Van Eekeren N., Nuijten E. (2018) Towards resilience through systems-based plant breeding. A review. Journal of Agronomy for Sustainable Development 38: 42 (open access)*
- *Nuijten, E., de Wit, J., Janmaat, L., Schmitt, A., Tamm, L., Lammerts van Bueren, E.T., 2018. Understanding obstacles and opportunities for successful market introduction of crop varieties with resistance against major diseases. Organic Agriculture 8 (4): 285-299.*



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