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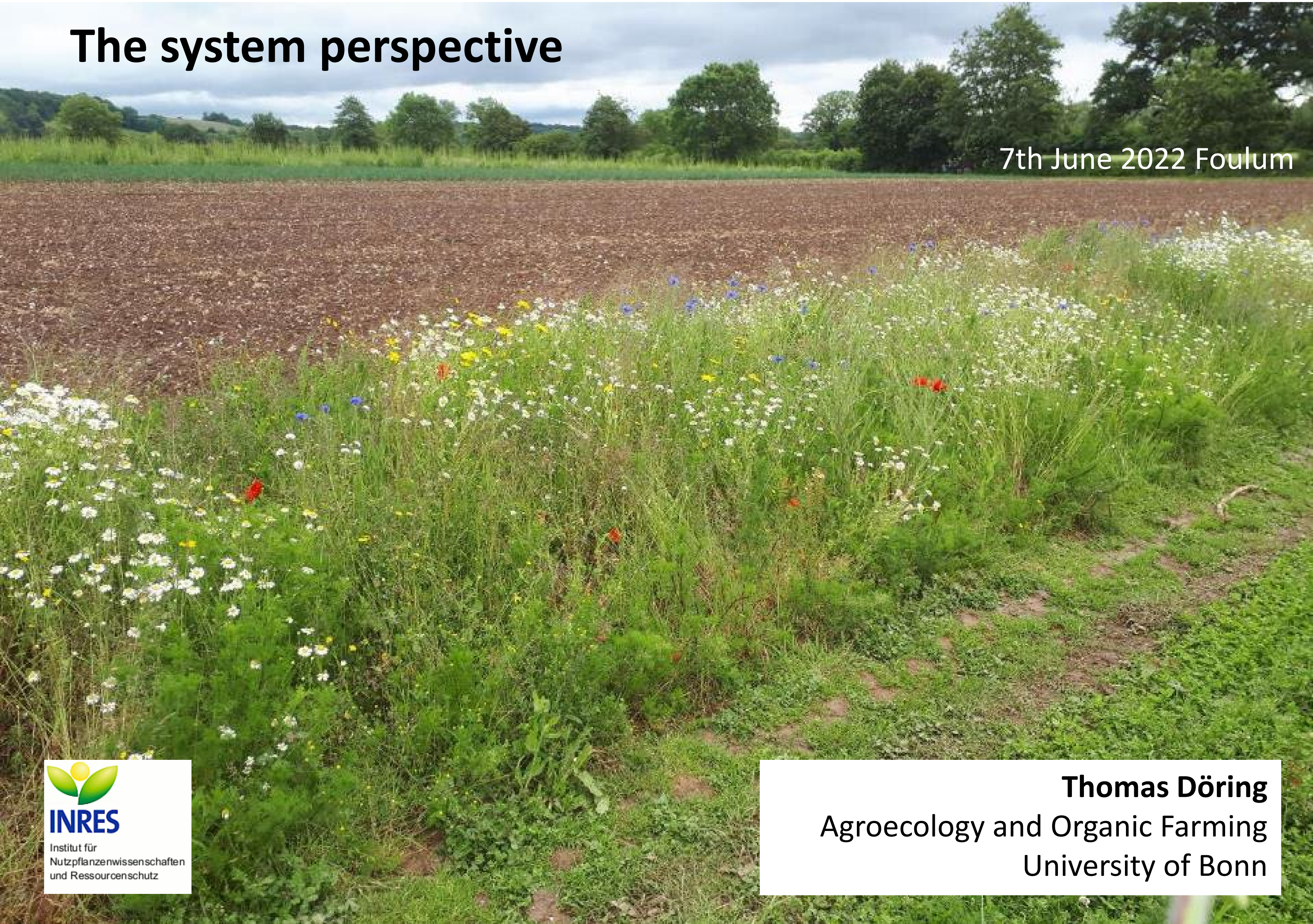
The system perspective



7th June 2022 Foulum

INRES
Institut für Nutzpflanzenwissenschaften und Ressourcenschutz

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Knowledge gaps regarding system perspective

Examples with focus on -

1. **Climate change adaptation**
2. **Biodiversity conservation**
3. **Soil fertility**
4. **Transformation and transition**

pinterest.es/pin/619948704927024736/

The system perspective

System property	LTEs' suitability
(Long term) **cumulative** & legacy effects, time lags	++
Complexity: multifactoriality and interactions, feedbacks, emergent behaviour	(+/-)
Non-linearity, tipping points, chaotic behaviour (deterministic chaos)	?
Connectedness and openness (energy and material flows)	(+/-)

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Some system descriptors

- Stability
- Resilience and transitions
- Multifunctionality

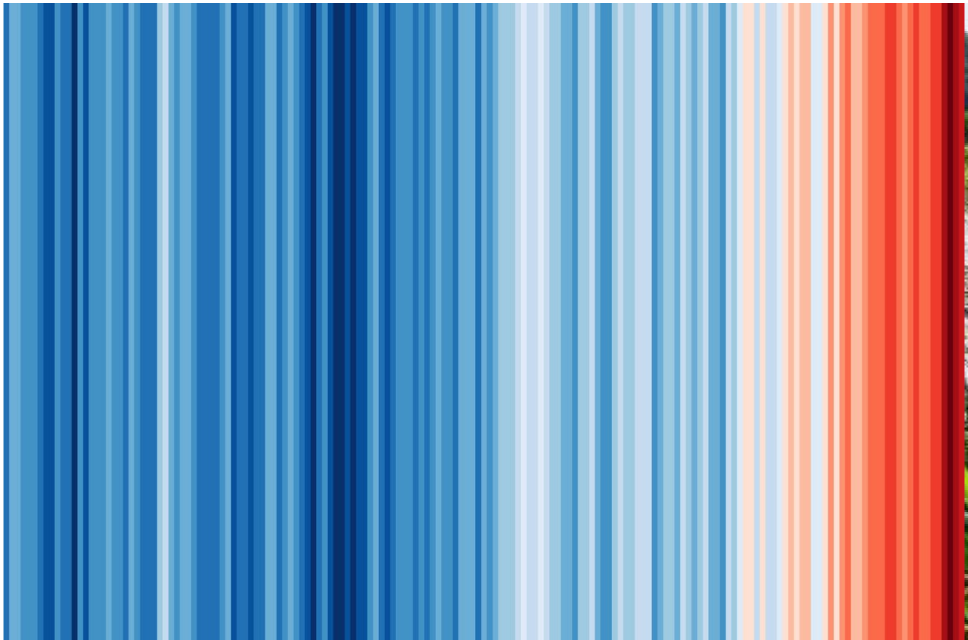
LTEs:

- Determine effects of treatments when external environment is stable
- Determine effects of external environment when treatment is stable

1. Adaptation to climate change

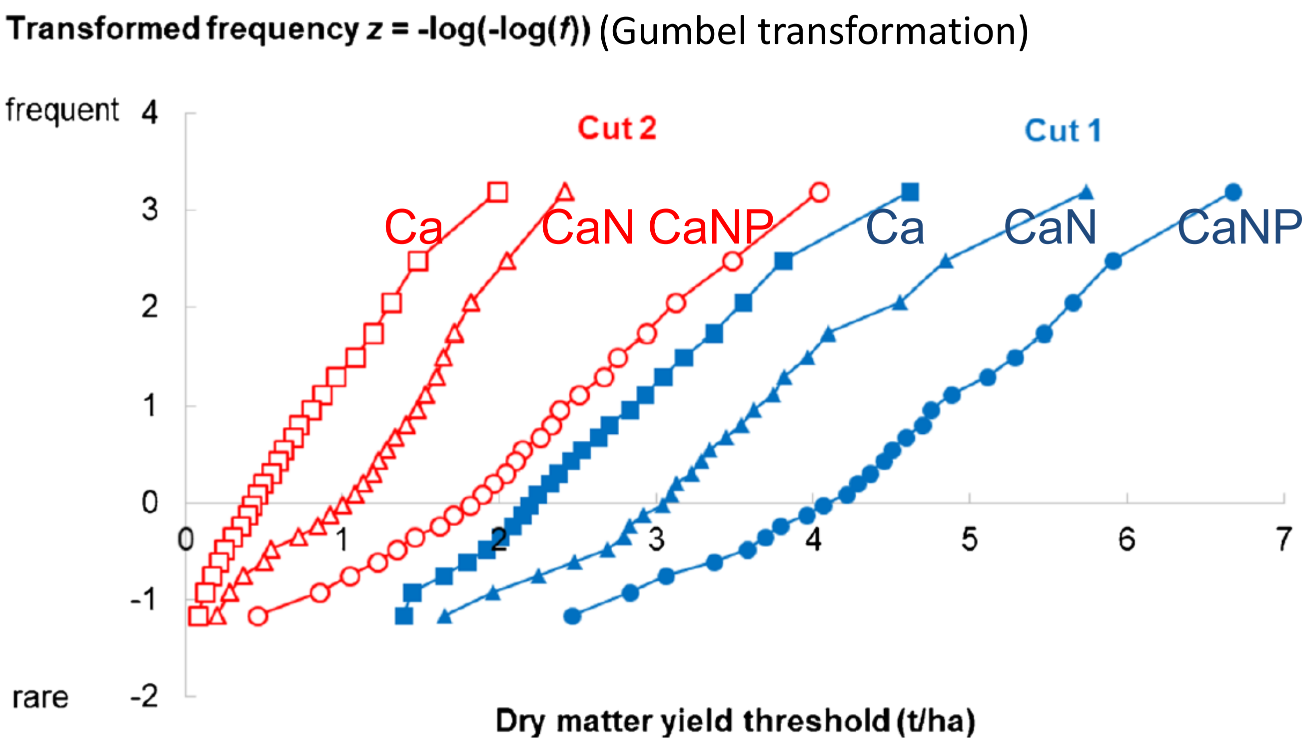
- Stability and response to rare events
- Resilience: ability to recover from stress
- Windows for timely arable management

- Irrigation
- ‚New' species
- Diversification



Stability and extreme / rare events

Reckling et al. 2021. Agron Sust Dev 41:27

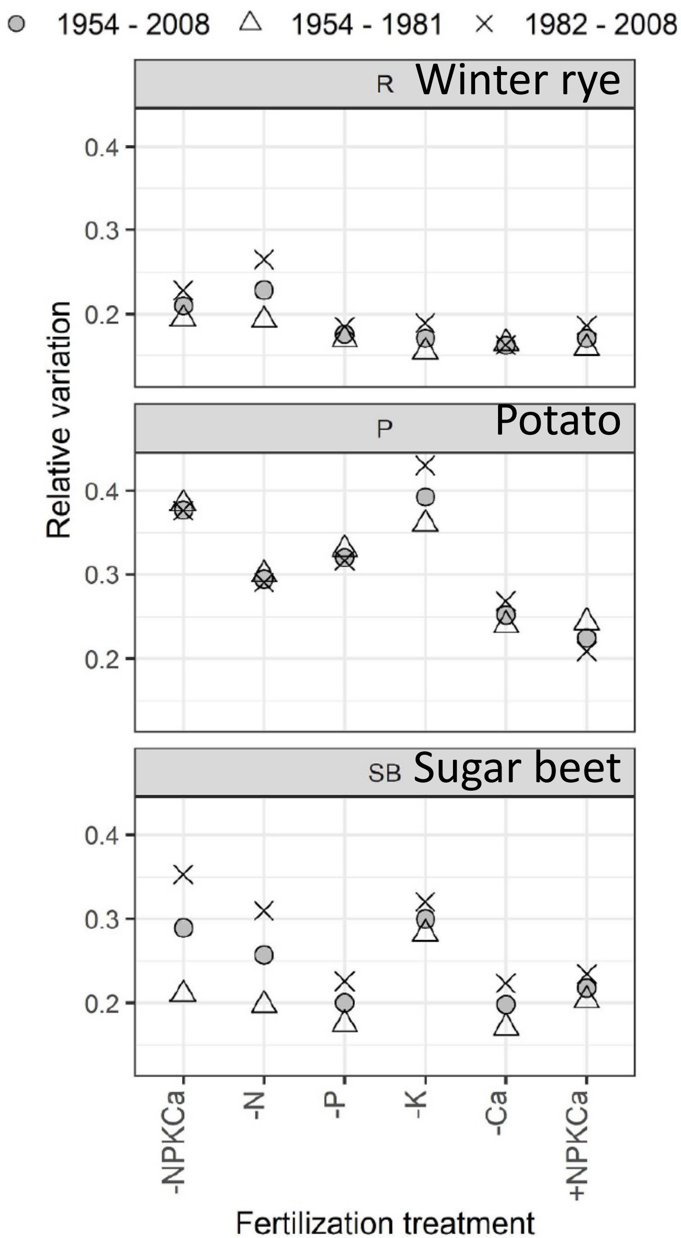


Grassland LTE in Rengen, Establ. 1941

LTEs provide an excellent (yet underexplored) opportunity to assess yield stability and response of treatments to rare or extreme events.

Stability and extreme / rare events

Ahrends et al. 2021. Env Res Lett 16: 014003



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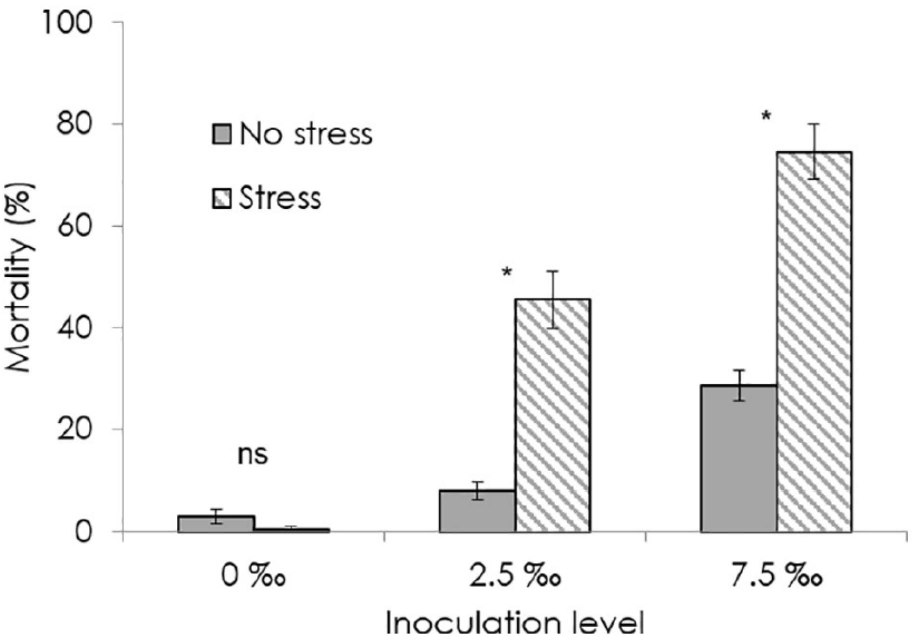
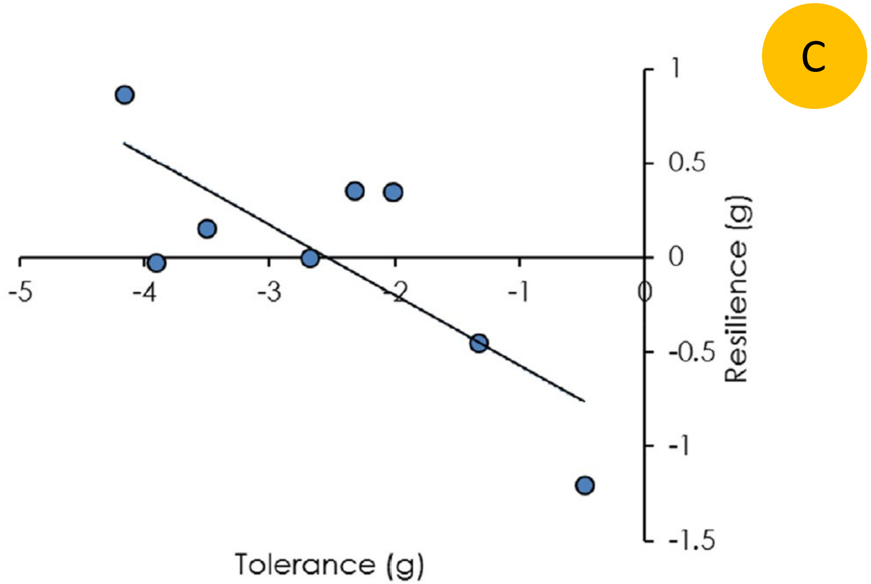
Fertilization LTE at Dikopshof, Est. 1904

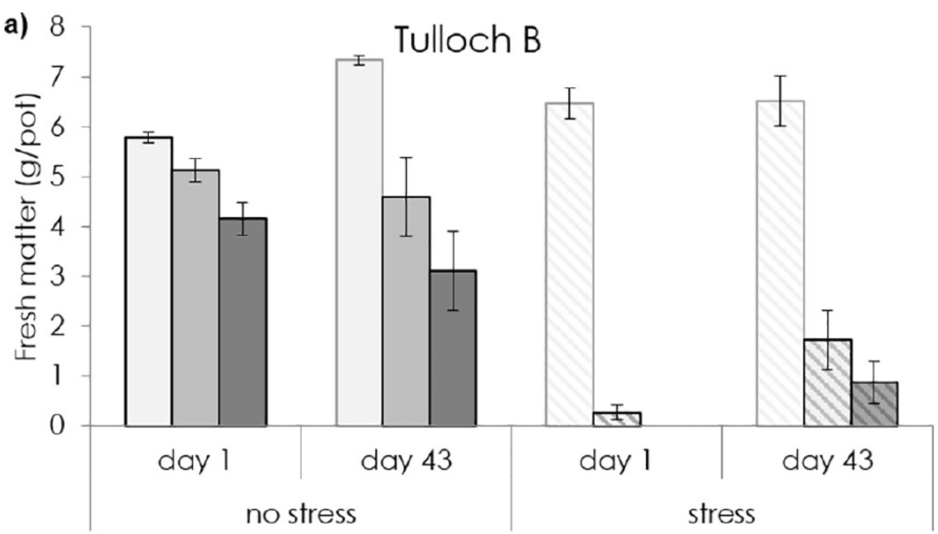
Knowledge gaps: Temporal stability of different (organic) cropping systems regarding yields and quality; response to extreme events

Resilience

Döring et al. 2020. Appl Soil Ecol 149: 103482







Tulloch Organic Rotation LTE, Est. 1991

Knowledge gaps: Resilience of different (organic) cropping systems in response to heat, drought and flooding

Irrigation

Polkoswki et al. in prep.

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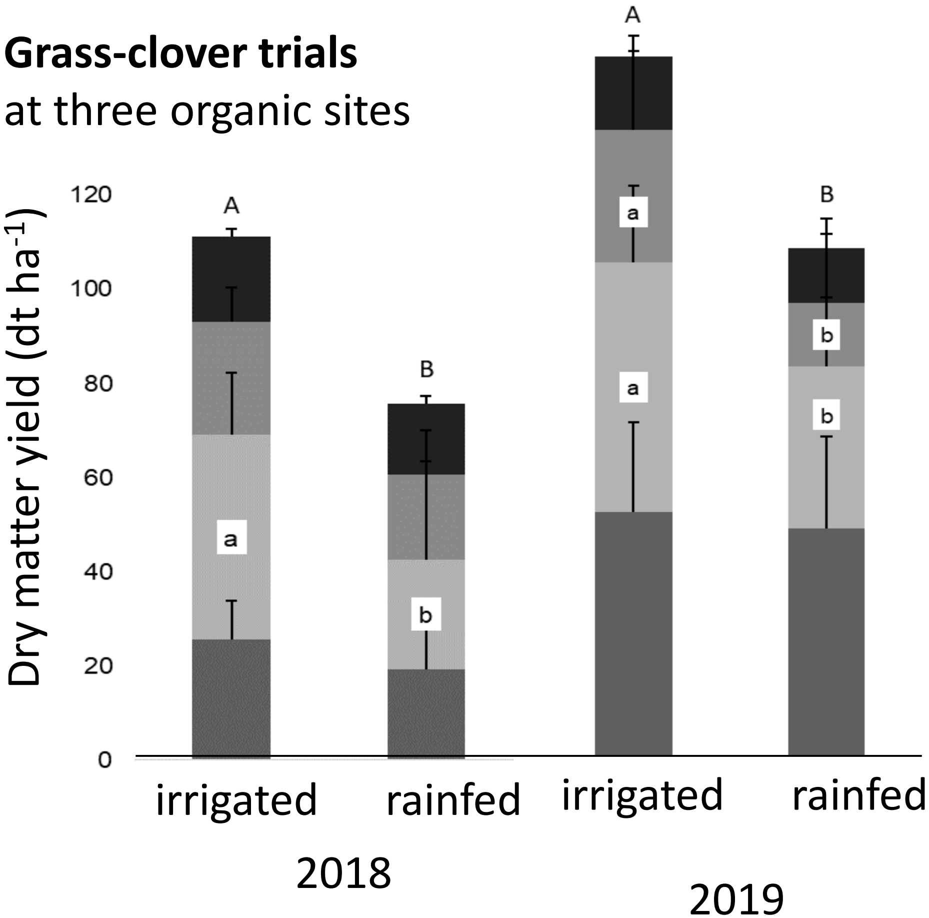
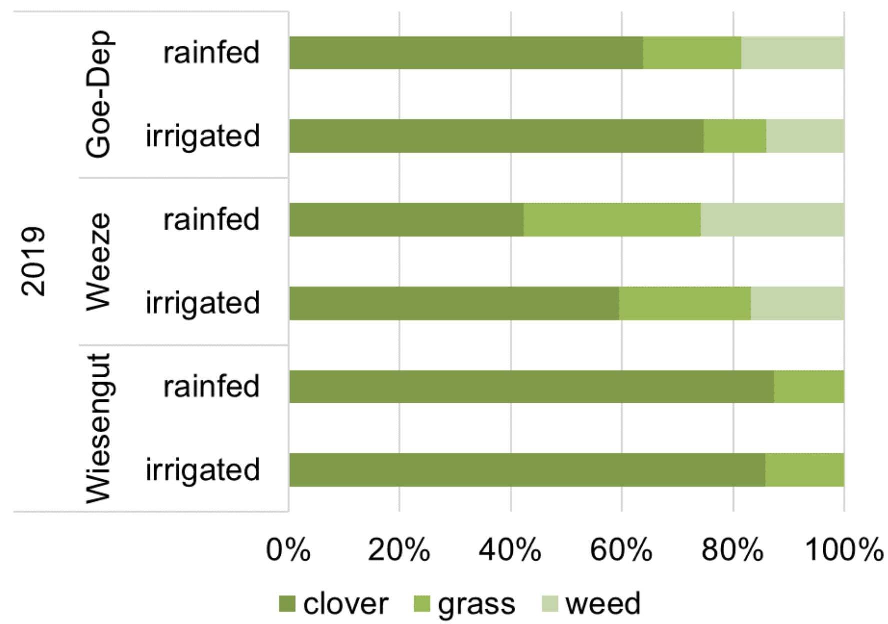
Grass-clover trials
at three organic sites





Knowledge gaps: Systemic rotational effects of irrigating forage legumes

There was no significant irrigation effect on the percentage of nitrogen derived from the atmosphere (%Ndfa).

2. Biodiversity conservation

- Deep diversity: taxon. depth and breadth
- Feedbacks
- Landscape perspective
- Land sparing / land sharing
- Stacked diversification
- Diversity x management

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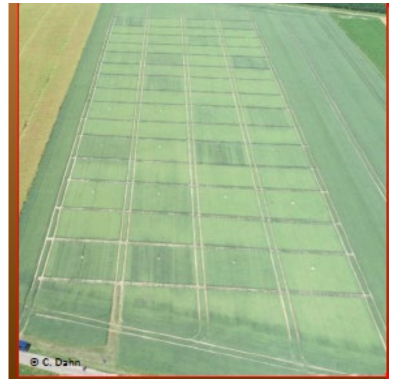
Deep diversity

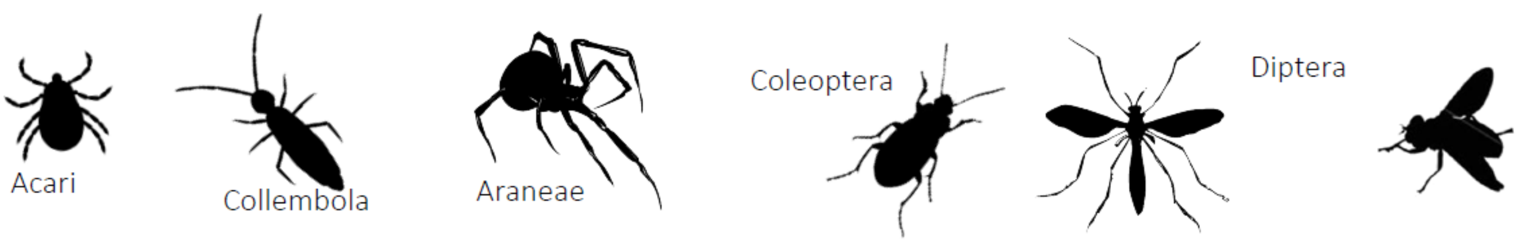
Sites
Organic: Wiesengut
Conventional: Klein-Alterndorf

Treatments
1. Unfertilized control
2. Unfertilized control without cover crop
3. Cattle manure
4. Liquid manure
5. Compost
6. Biogas digestate
7. Straw
8. Min NPK or PPL



Monitoring methods
Pitfall traps
Berlese traps
eDNA
Emergence traps

Isabel Kilian at Wiesengut



Knowledge gagps: Effects of cropping systems on *total* (edaphic) biodiversity

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Stacked diversity

Séverin Hatt at the Wide Synergies trial

Knowledge gaps: Interactive effects of stacked diversification options

Wide Synergies static diversification experiment at Wiesengut organic farm:
Factor (1) Flower strips (with/without);
Factor (2): Within-field diversification (intercropping, living mulch, monocrops)

3. Soil fertility

- Soil compaction
- Soil-borne diseases
- Below-ground effects of diversity

- Rotation (x diversity)
- Reduced tillage
- Light-weight machinery

Below-ground effects of diversty

Kemper et al. 2022. Plant & Soil

Mixing lupine and winter rye

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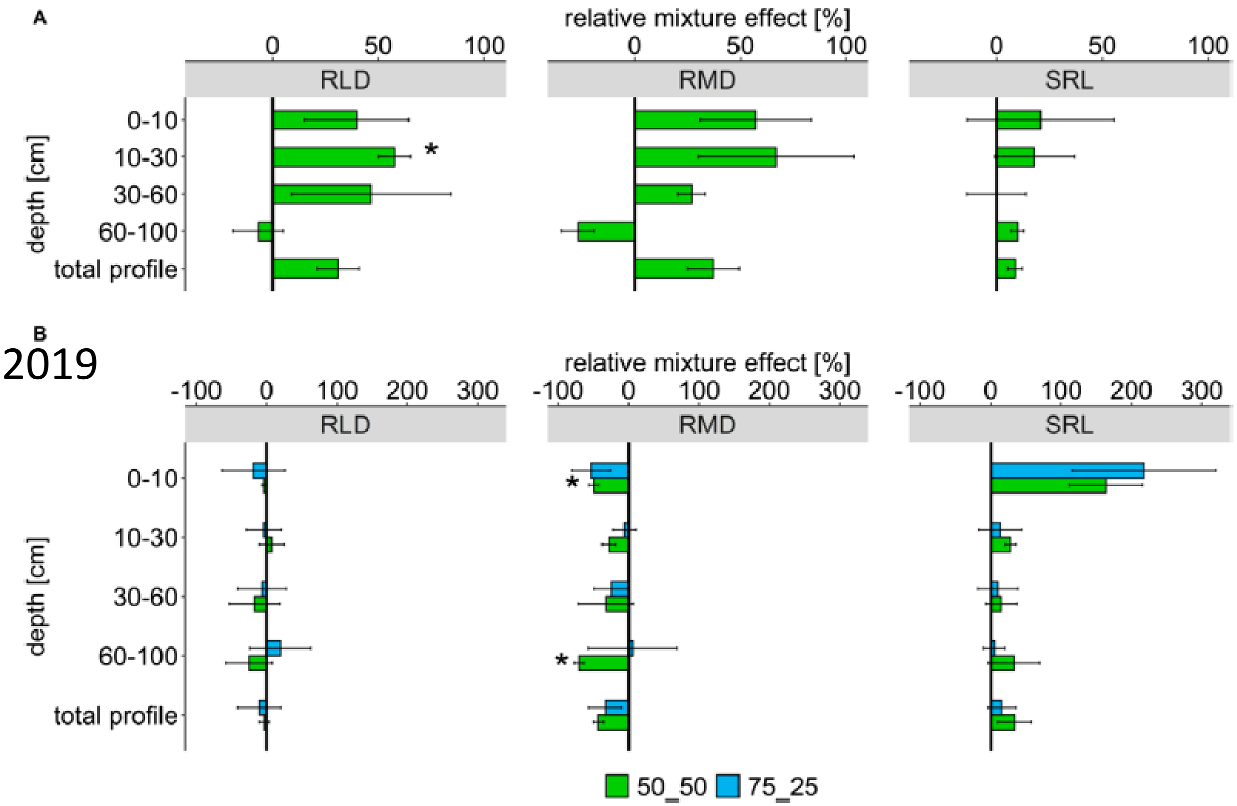
2018

2019



Knowledge gaps: Factors driving the complementarity of rooting systems; legcacy effects of rooting systems (e.g. biopores)

Light-weight machinery

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Knowledge gaps: How do light(er) weight autonomous agricultural machines („robots“) impact soil fertility?
How do they influence the possible designs of cropping systems?

4. Transition and transformation

- Participation
- Integration
- Enthusiasm
- Hope
- Health
- Communities
- Value chains

Knowledge gaps:

How can LTEs be designed to support transition, learning and transformation?

Which factors are allowed to be dynamic and responsive?

a) anticipate change, but be static

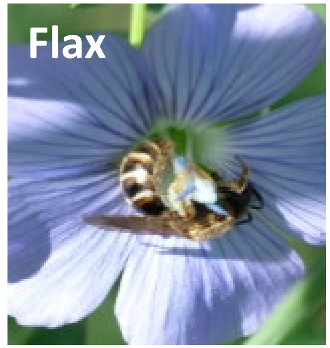
b) be open to change within trial

- document decision making process
- agree on consistent reference level

How can the transition towards more diversification be achieved?

„New“ crops

Use the full spectrum of crop species!



Cultivar mixtures & populations

Hundreds of ways to diversify

Species mixtures, agro-forestry, perma-culture

Thank you for your attention!

Contact: tdoering@uni-bonn.de