Lijbert Brussaard, Wageningen University & Research

SOILMAN conference 'Soil biota driven ecosystem services in European agriculture' Braunschweig, Germany, 22-23 October 2019









- Setting the scene of soil biodiversity
- How is soil biodiversity associated with soil processes and ecosystem services?
- Which practices contribute to restoring, maintaining and improving soil biodiversity?
 - Arable field management vs. landscape effects
 - Heavy machinery use (compaction and tillage)
 - Water management
 - Organic matter management
- Regenerative agriculture: *back to the future and fast forward*





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Starting points:

- 1. The soil is our capital; soil biodiversity is part of it
- Soil degeneration is <u>living off that capital</u>
- Soil regeneration is return to <u>living off the interest</u> on that capital
- 2. "Regenerative agriculture" is about all processes in the agriculture-food system









Photos: Th Heijerman, R.G.M. de Goede, J. Bloem

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Soil processes & ecosystem services







Based on: Truchy et al., 2015, <u>http://dx.doi.org/10.1016/bs.aecr.2015.09.004</u> and Manning et al., 2018, <u>https://doi.org/10.1038/s41559-017-0461-7</u>



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Heemsbergen et al., 2004, doi: 10.1126/science





B. Leaf litter mass loss

A. Soil respiration





100 years

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Land use in the Netherlands, 2012















Hoeksche Waard, The Netherlands, appr. 40 x 30 km https://www.youtube.com/watch?v=xP-fSqXRu58&feature=youtu.be



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By default, field margins enhance soil biodiversity



Landscape and management effects of/on earthworms?











.... and by tillage, especially moldboard ploughing



Crittenden et al, 2015, Eur J Soil Biol, http://dx.doi.org/10.1016/j.ejsobi.2014.11.007



100 years



Intermediate conclusions 'landscape vs. arable fields'

- Field margins enhance soil biodiversity
- Management, not landscape negatively affects earthworms in arable fields by:
 - moldboard ploughing vs. non-inversion tillage
 - frequency of pesticide application
- Management and landscape and soil affect earthworms in field margins positively by
 - no-tillage
 - age of margin



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100 years





100 years





WAGENINGEN JNIVERSITY & RESEARCH









Based on Pulleman et al., 2003, Soil Use Manag,

https://doi.org/10.1079/SUM2003186







Based on Pulleman et al., 2003, Soil Use Manag, https://doi.org/10.1079/SUM2003186







Based on Pulleman *et al.*, 2005, Eur J Soil Sci, https://doi.org/10.1111/j.1365-2389.2004.00696.x



Liu et al., 2019, Land Degrad Dev, https://doi.org/10.1002/ldr.3349







Intermediate conclusions 'Compaction and tillage'

- Soil compaction in organic non-inversion tillage < conventional noninversion tillage, but....
- less pronounced so between organic and conventional moldboard ploughing
- When soil tillage is reduced, earthworms increase in abundance
- Earthworms and crop diversity both enhance soil structure

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Earthworm effect on water infiltration rate (meta-analysis)



No such relationship for soil feeders!

Spurgeon et al., 2013, BMC Ecology, http://www.biomedcentral.com/1472-6785/13/46



100 years



Liu et al., 2019, Land Degrad Dev, https://doi.org/10.1002/ldr.3349







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Cong et al., 2014, J Ecol, https://doi.org/10.1111/1365-2745.12280







Liu et al., 2019, Land Degrad Dev, <u>https://doi.org/10.1002/ldr.3349</u>



Gattinger et al, 2012, Proc Nat Acad Sci, https://doi.org/10.1073/pnas.1209429109







Intermediate conclusions on Organic matter management

- Crop diversity enhances SOM
- Soil organic carbon in *organic* > *conventional* agriculture
- Higher organic matter ⇒ more earthworms







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Reduction of mechanical load

Non-inversion tillage and surface-ploughing

Summary of conclusions

- Mixed cropping enhances SOM
 - Organic ag SOM > conventional ag SOM
- Reduction of tillage favours earthworms, especially if combined with organic management
- Organic management and crop diversity favour earthworms with positive effects on
 - soil porosity

- water infiltration
- stability of aggregates







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Regenerative soil management







Courtesy Wijnand Sukkel (WUR)

Increasing crop diversity in space and time is an important part of regenerative soil management



Illustration: Fogelina Cuperus (WUR)

Coordinated effort for system transformation is needed between Ecology & Technology

Regenerative agriculture building blocks



Increasingly more diverse, robust and regenerative soils and, indeed, agroecosystems