Soil-borne diseases and ecological intensification

Wim van der Putten

Netherlands Institute of Ecology

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Pythium wilt in lettuces

Root rot in canola

Potato cyst nematode

Fruit tree replant disease

Soil-borne disease in crop

Soil-borne diseases are plant diseases that reduce quantity and quality of crop yield, and can be caused by viruses, bacteria, fungi, protists, and nematodes

After: https://www.agric.wa.gov.au/diseases/soil-borne-diseases

Soil pathogens control forbs

Soil pathogens control grasses

Soil-borne diseases also play a role in nature, e.g. driving plant diversity, succession, preventing invasiveness, and controlling aboveground biodiversity

Van der Putten et al. Journal of Ecology 2013

Ecological intensification

- Aims to harness ecosystem services to sustain agricultural production while minimising adverse effects on the environment.

- Requires ‘ecological engineering’ at farm and landscape level, while engaging with local actors, and learning from systems approaches incl. social-ecological interactions.

Doré et al. 2011 European J Agronomy, Bommarco et al. 2013 TREE, Tittonell 2013, Kleijn et al. 2019 TREE

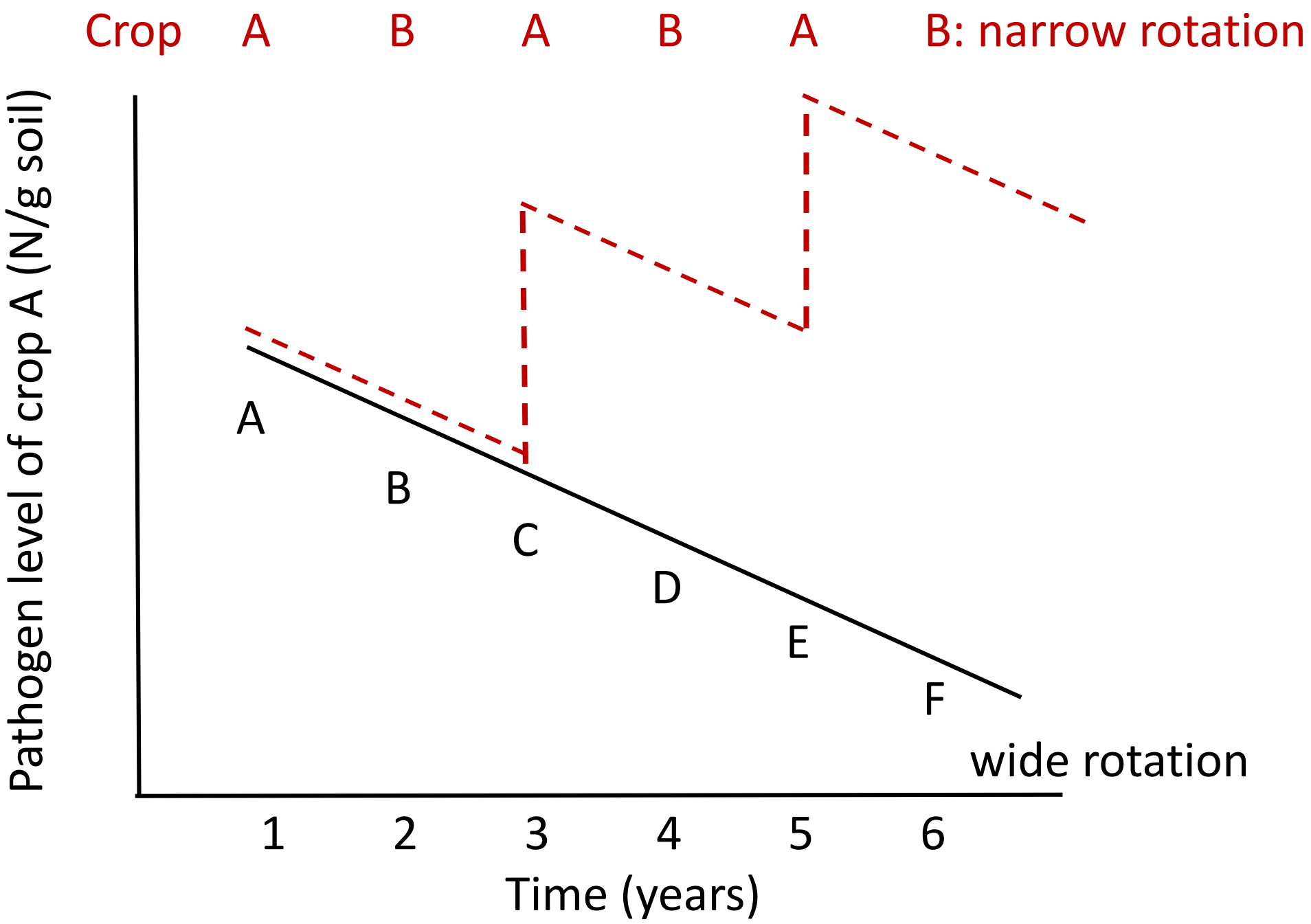
www.growveg.com

Wide rotation
fewer soil-borne diseases

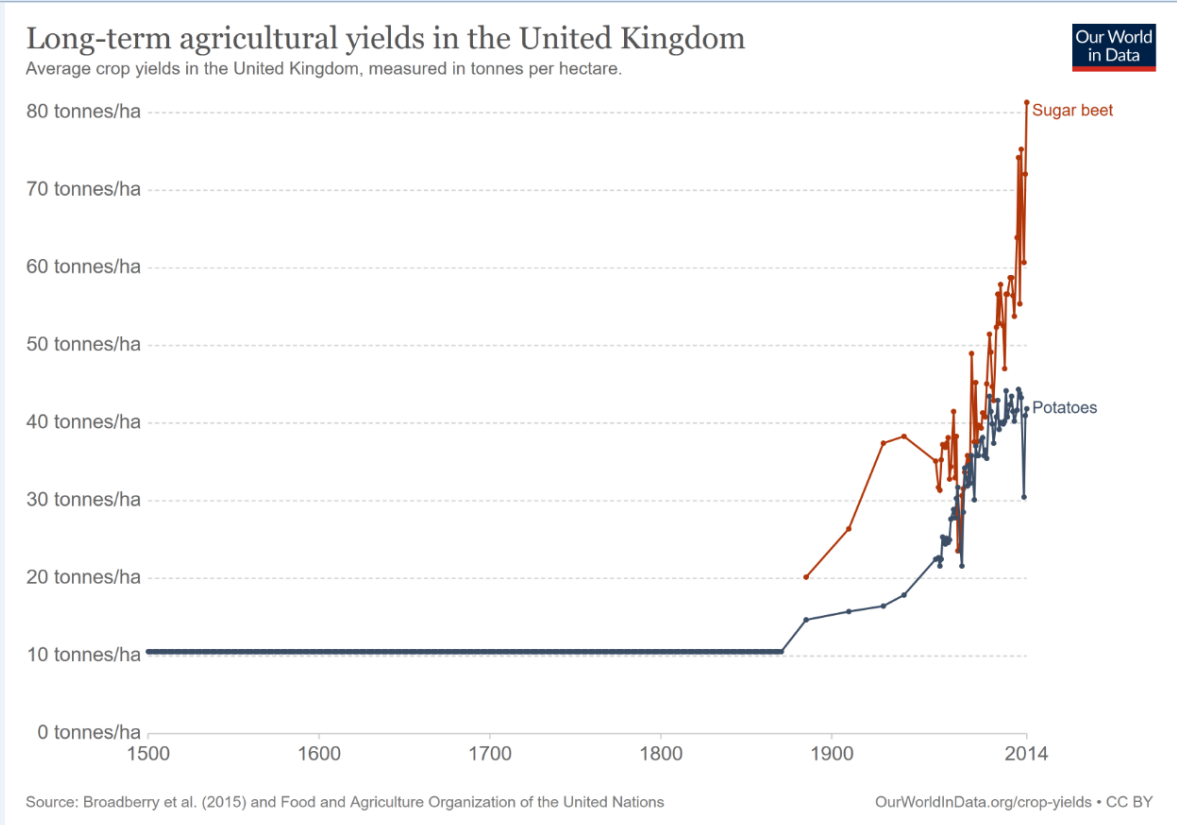
www.agunited.org

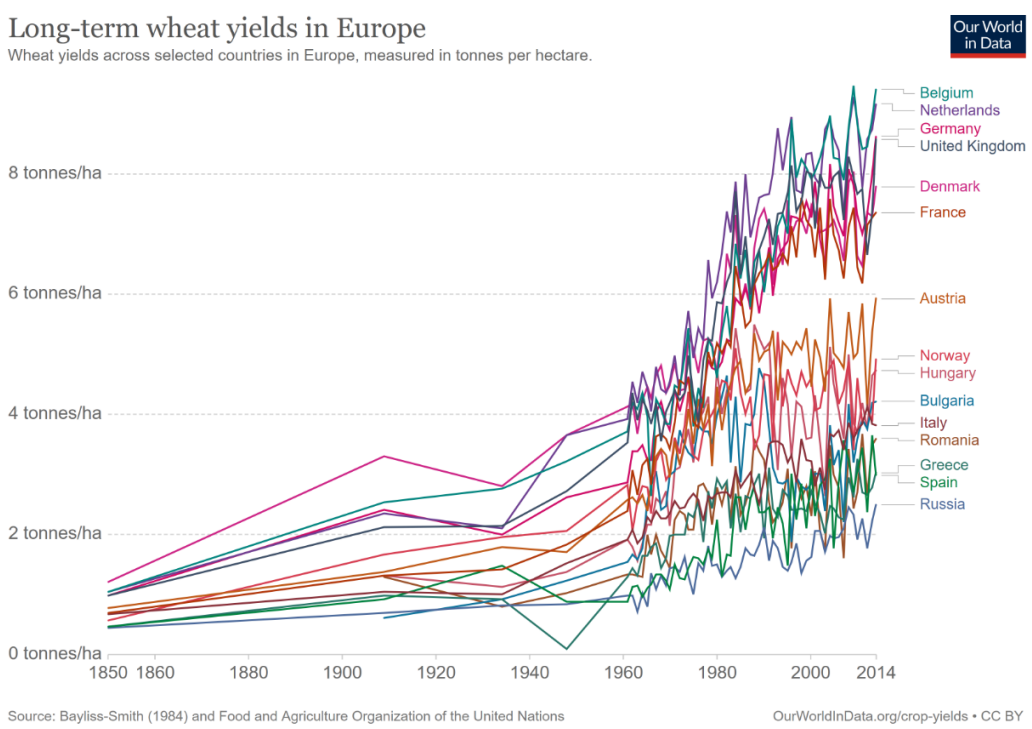
Narrow rotation
more soil-borne diseases

Cause of soil-borne diseases are often too narrow rotations of commercially interesting crops


Crop
A
B
A
B
A
B: narrow rotation
Pathogen level of crop A (N/g soil)
A
B
C
D
E
F
wide rotation
1
2
3
4
5
6
Time (years)

Chemical soil treatment against soil-borne diseases with negative side effects on
soil biodiversity, the
the environment, and
soil ecosystem services
other than crop production.



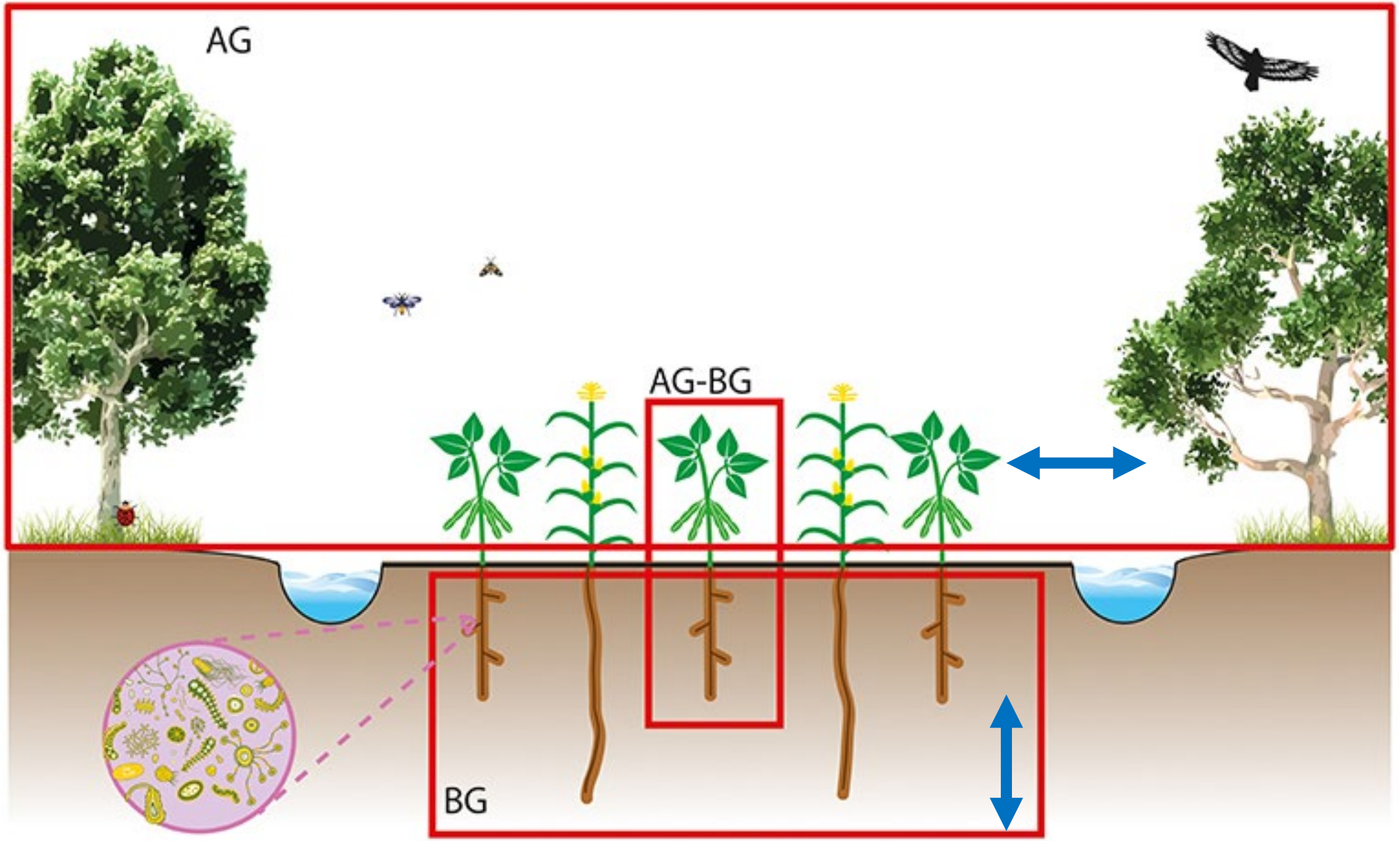


The paradox of soil: why do (soil) ecologists say that it is going bad with soil while yields are increasing?

Well, yields may increase, but other soil ecosystem services decline, leading to loss of soil structure, soil fertility, ground water quality, surface water quality, disease suppression, and aboveground biodiversity.

May ecological intensification be the solution for soil-borne diseases?

Ecological Intensification: aboveground: landscape scale

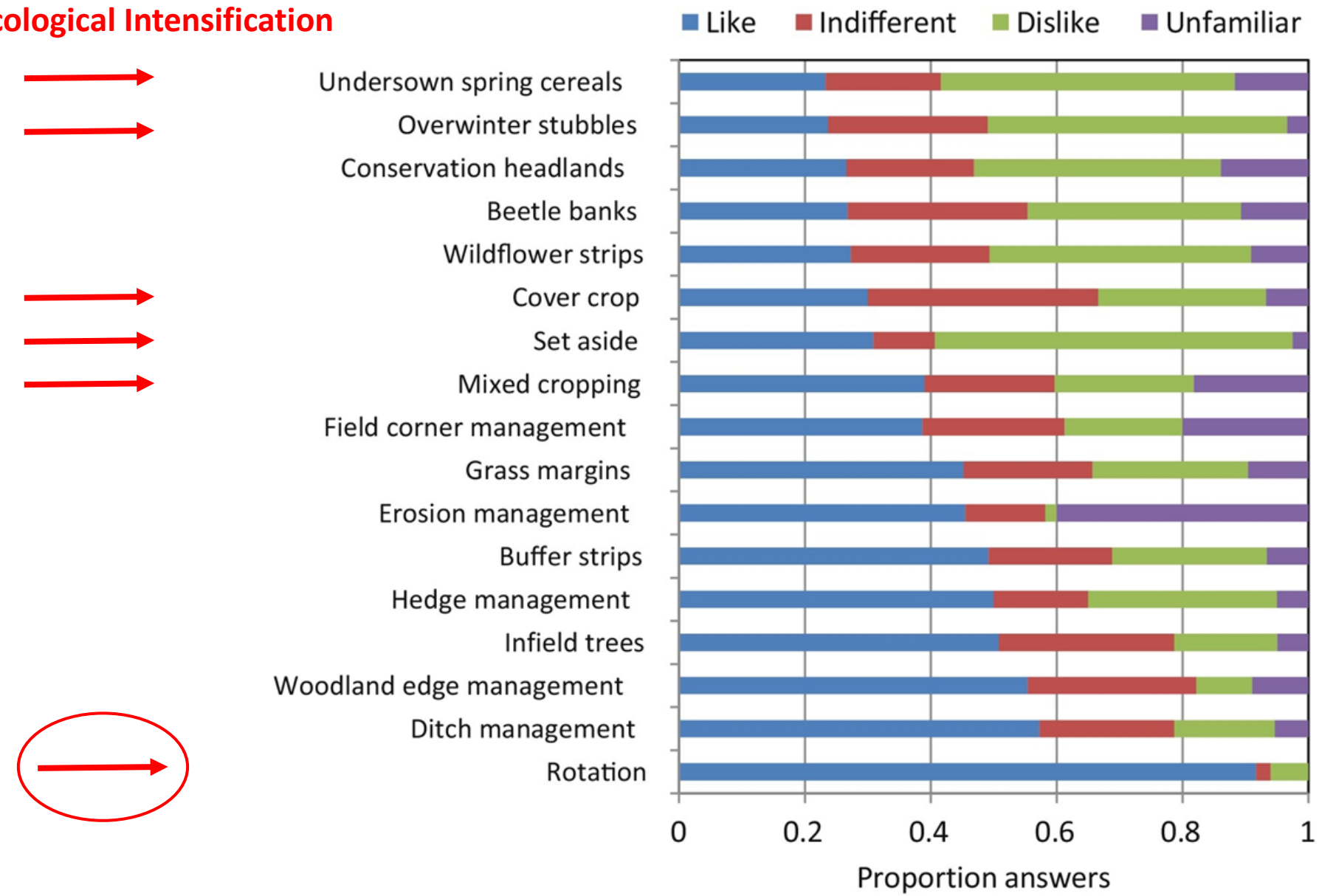


Belowground: local scale

We need an aboveground-belowground perspective on ecological intensification by adding a ‘spacial dimension’ to the concept

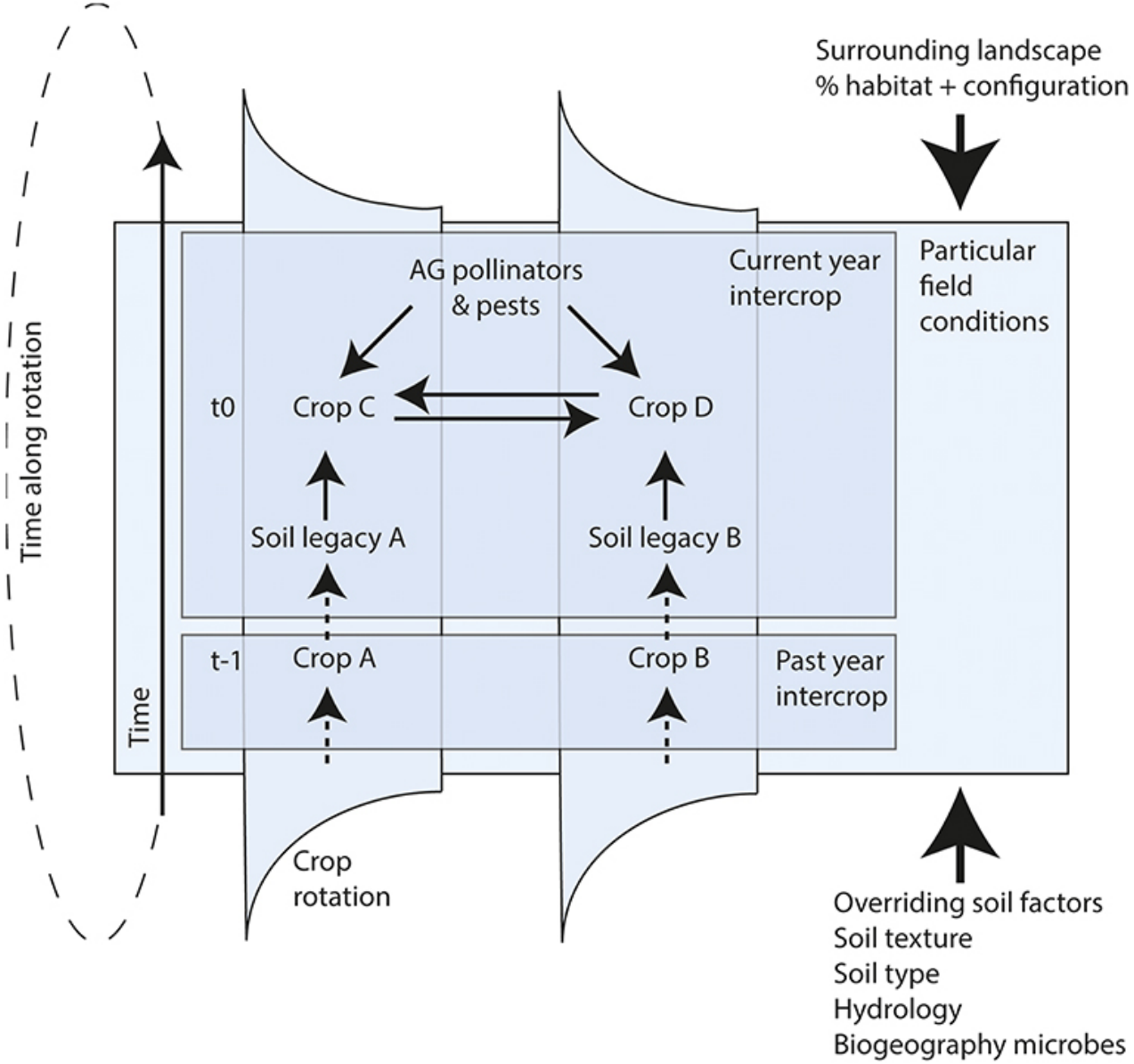
Veen, Wubs et al. 2019 Frontiers in Ecology and Evolution

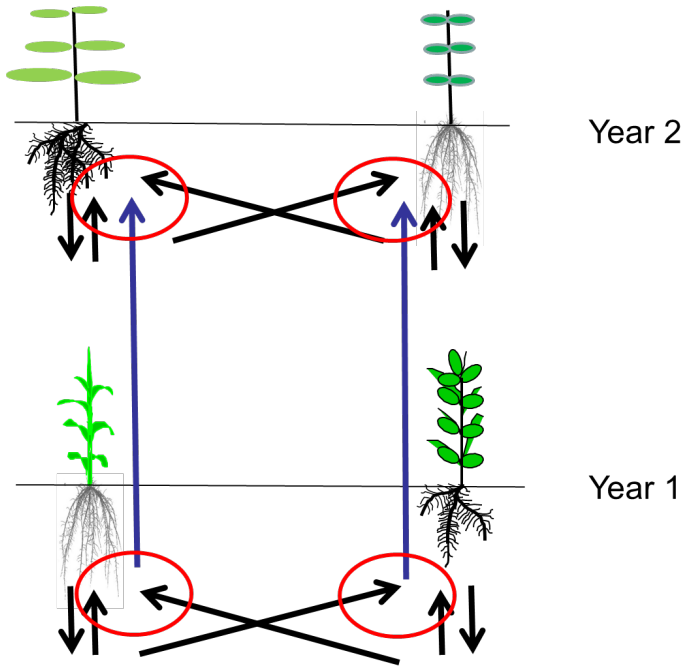
Belowground effects of Ecological Intensification



Trends in Ecology & Evolution

Kleijn et al. 2019 TREE



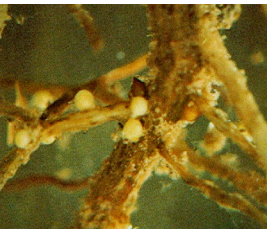


Ecological Intensification scheme from an belowground-aboveground perspective:
Build in ecological memories of soil and landscape perspecive of aboveground-belowground interactions

Veen, Wubs et al. 2019 Frontiers in Ecology and Evolution

Lessons from nature EU-EcoTrain rtn-project:
nematode control in dunes: soil biodiversity matters

Ammophila arenaria
(marram grass)



Cyst nematode

Root knot nematode

Root lesion nematode

Ammophila arenaria

Bottom-up control cyst nematode

Mutualists:
Arbuscular mycorrhizal fungi
and Endophytes

Nematodes:
Cyst nematodes
Root knot nematodes
Root lesion nematodes
Ectoparasites

Cyst nematode outcompetes rt kn nematode

AM fungi control migratory endoparasites
Endophytes neutralize migratory endoparasite competition

Top-down control of ectoparasites & cyst nematodes by microorganisms

Egg parasites
(e.g. *Pochonia chlamydosporia*)
Juvenile parasites
(*Pasteuria penetrans*)

Piśkiewicz et al. Soil Biology & Biochemistry 2008; EcoTrain team papers

Conclusions:

1. Ecological intensification will benefit from including soil biodiversity and aboveground-belowground interactions
2. Soil biodiversity operates at a smaller spatial scale than aboveground biodiversity.
3. We need to be aware of memory effects and soil biodiversity that influence soil-borne diseases.

Thank you for your attention