

# Measuring plant stress to design and steer agroecological systems

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CIRAD/PERSYST/PROSE

## Transition towards sustainable agriculture in Europe: the agroecology

Agroecology webinar

May, 19<sup>th</sup>, 2021

# Measuring plant stress to design and steer agroecological systems

Plant Soil (2013) 362:389–417  
DOI 10.1007/s11104-012-1429-7

REVIEW ARTICLE

## Redox potential (Eh) and pH as drivers of soil/plant/microorganism systems: a transdisciplinary overview pointing to integrative opportunities for agronomy

Olivier Husson

Literature review from scattered articles  
20 disciplines, 800 articles => 8 000 nowadays

Plant and Soil

Soil and plant health in relation to dynamic sustainment of Eh and pH homeostasis: A review  
–Manuscript Draft–



 agronomy

Article

Leaf Eh and pH: A Novel Indicator of Plant Stress. Spatial, Temporal and Genotypic Variability in Rice (*Oryza sativa* L.)

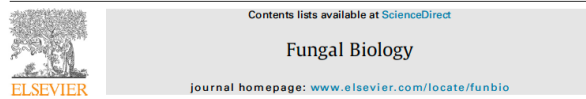
Olivier Husson <sup>1,2,3,\*</sup>, Alain Audebert <sup>4,5,6</sup>, Jaroslav Benada <sup>7</sup>, Brigitte Soglonou <sup>1</sup>, Firmin Tano <sup>1</sup>, Ibrou Dieng <sup>1</sup>, Lydia Bousset <sup>8</sup>, Jean-Pierre Sarthou <sup>9</sup>, Stephen Joseph <sup>10,11,12</sup>, Philinne Menozzi <sup>1,2,3</sup>, Stéphanie Boulakia <sup>2,3</sup> and Koichi Futakuchi <sup>1</sup>

Fungal Biology 123 (2019) 117–124

Practical improvements in soil redox potential (Eh) measurement for characterisation of soil properties. Application for comparison of conventional and conservation agriculture cropping systems

Olivier Husson <sup>a,\*</sup>, Benoit Husson <sup>b</sup>, Alexandre Brunet <sup>c</sup>, Daniel Babre <sup>c</sup>, Karine Alary <sup>c</sup>, Jean-Pierre Sarthou <sup>d</sup>, Hubert Charpentier <sup>e</sup>, Michel Durand <sup>f</sup>, Jaroslav Benada <sup>g</sup>, Marc Henry <sup>h</sup>

Soil & Tillage Research 176 (2018) 57–68



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Research paper

Conservation Agriculture systems alter the electrical characteristics (Eh, pH and EC) of four soil types in France

Olivier Husson <sup>a,b,\*</sup>, Alexandre Brunet <sup>c</sup>, Daniel Babre <sup>c</sup>, Hubert Charpentier <sup>e</sup>, Michel Durand <sup>f</sup>, Jean-Pierre Sarthou <sup>d</sup>

A method to measure redox potential (Eh) and pH in agar media and plants shows that fungal growth is affected by and affects pH and Eh

Lydia Bousset <sup>a,\*</sup>, Magali Ermel <sup>a</sup>, Brigitte Soglonou <sup>b</sup>, Olivier Husson <sup>b,c,d</sup>

Effects of soil redox potential (Eh) and pH on growth of sunflower and wheat

Jérémy Cottes, Alix Saquet, Ludovic Palayret, Olivier Husson, Robin Beghin, Deonie Allen, Javier Scheiner, Cédric Cabanes & Maritxu Guissee

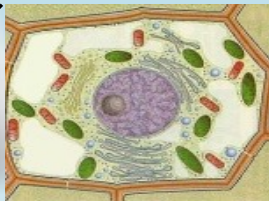
# Measuring plant stress to design and steer agroecological systems

Simple conceptual framework:

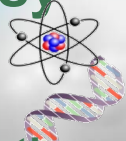
Dynamic sustainment of Eh (electrons) and pH (protons) homeostasis is a key to soil and plant health

- The various plant parts constitute different Eh-pH niches, with temporal variations, related to plant genotype
- Pests and pathogens thrive in specific Eh-pH niches
- Plants become susceptible to pest and pathogen attacks if their compartments are subjected to imbalanced Eh-pH conditions with specific Eh-pH values for each pest or pathogen to thrive
- Environmental (abiotic and biotic) stresses alter Eh-pH in the plant compartments

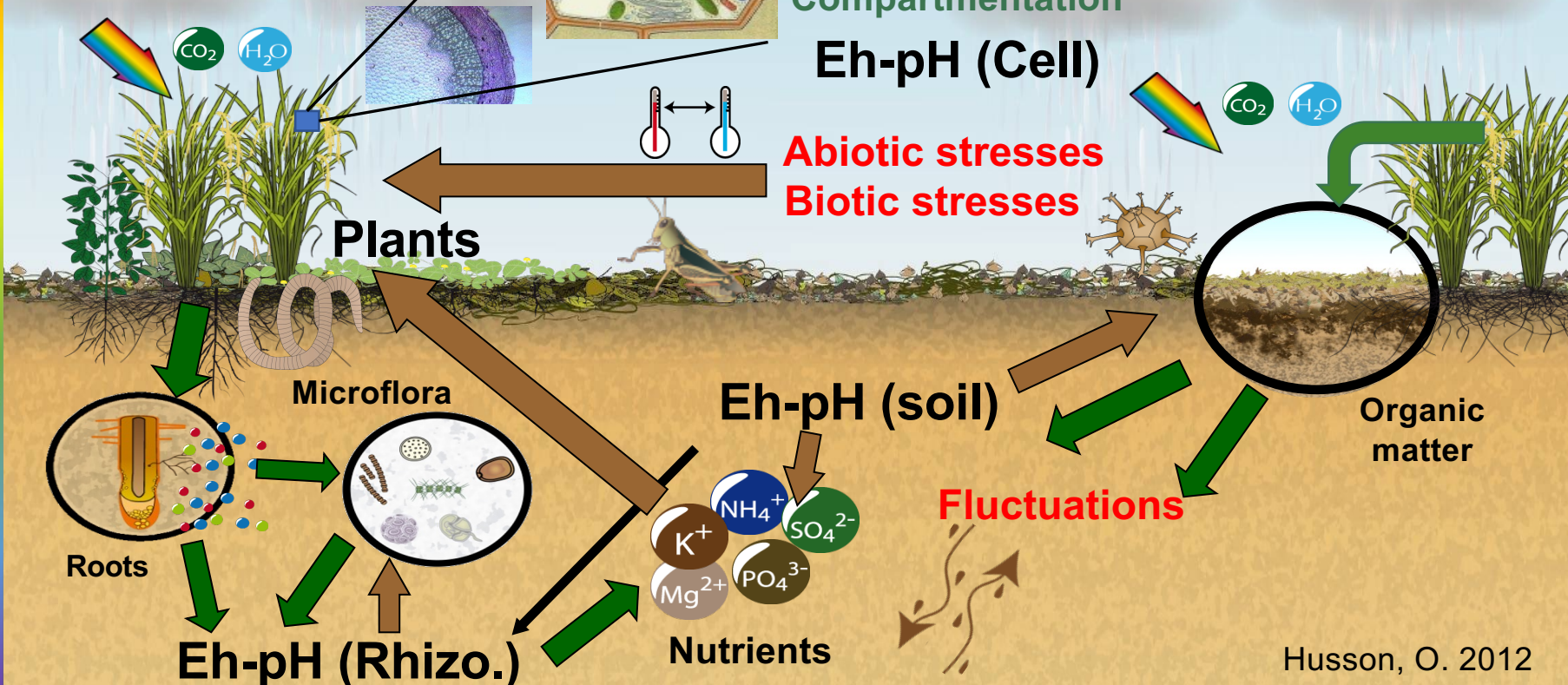
# Compartmentation Eh-pH (Tissues)



# Homeostasy Buffers Transcription Compartmentation Eh-pH (Cell)



# Regulation



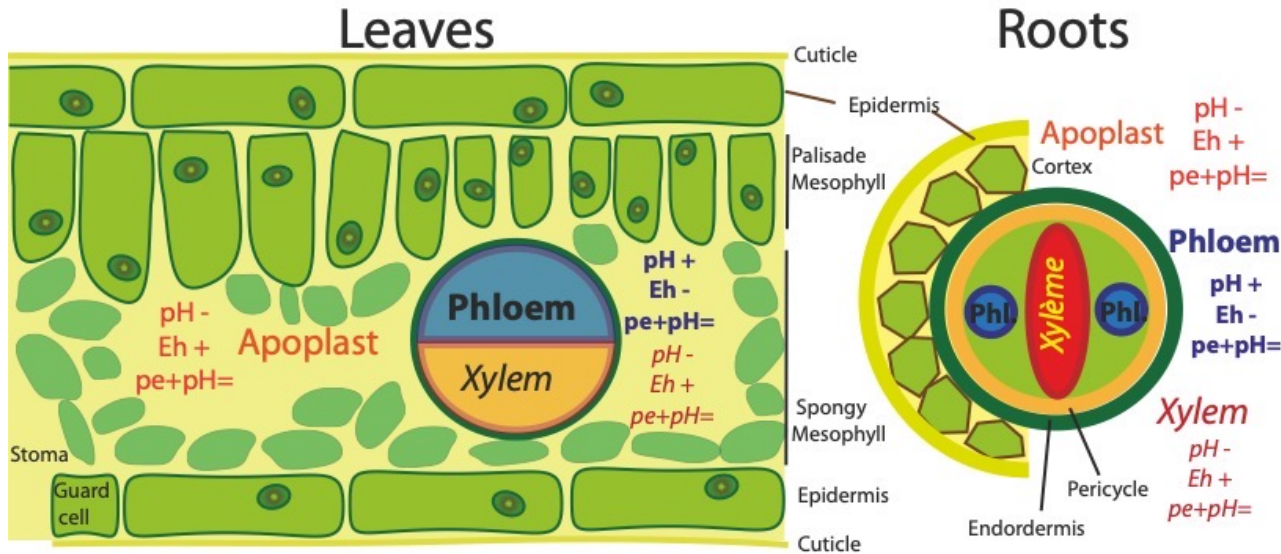
Husson, O. 2012



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- The various plant parts constitute different Eh-pH niches, with temporal variations, related to plant genotype

Leaves are more acidic and reduced (photosynthesis) than roots

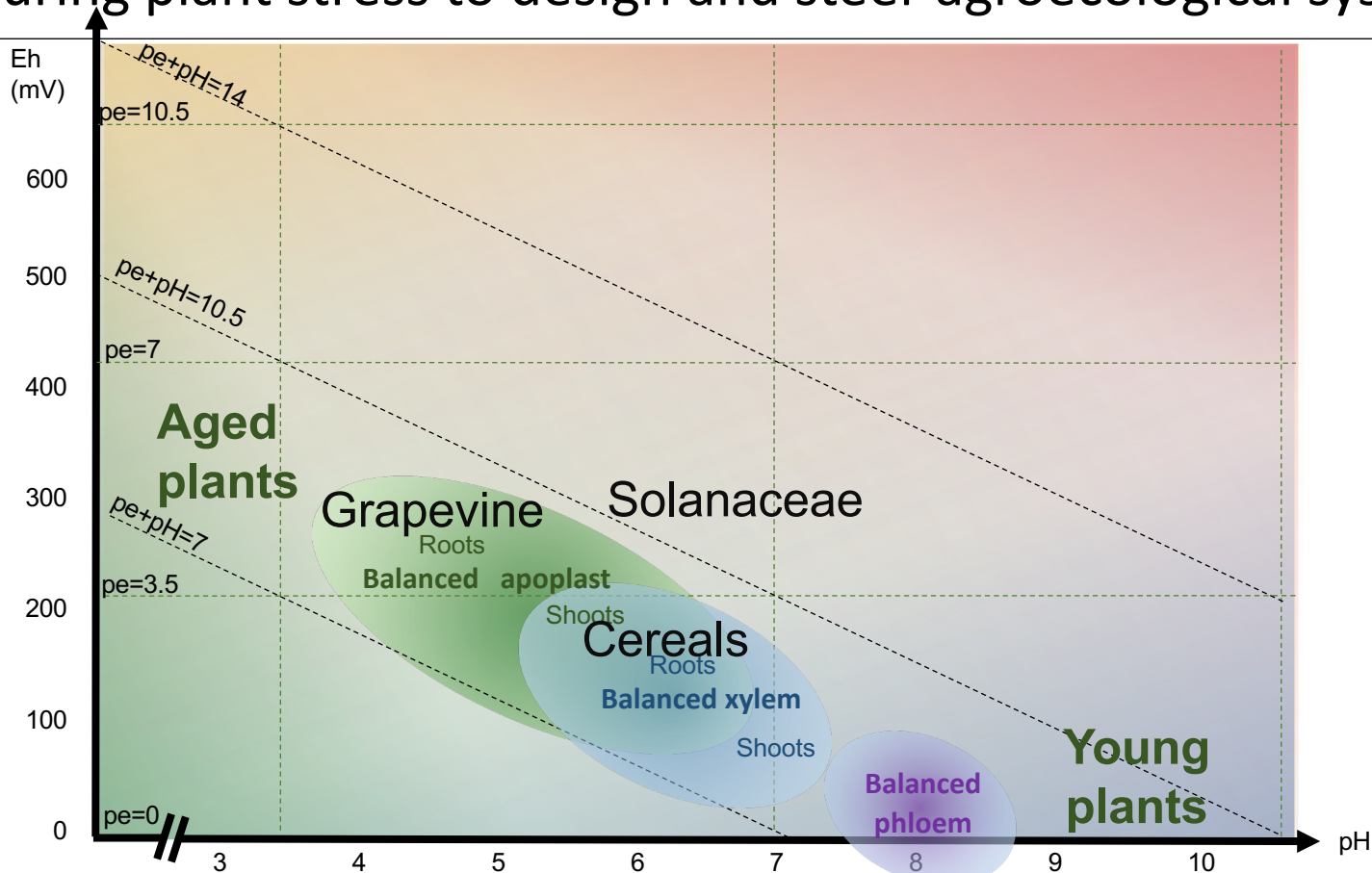


Phloem: Alkaline (pH 7.5-8.5) and reduced, strongly buffered

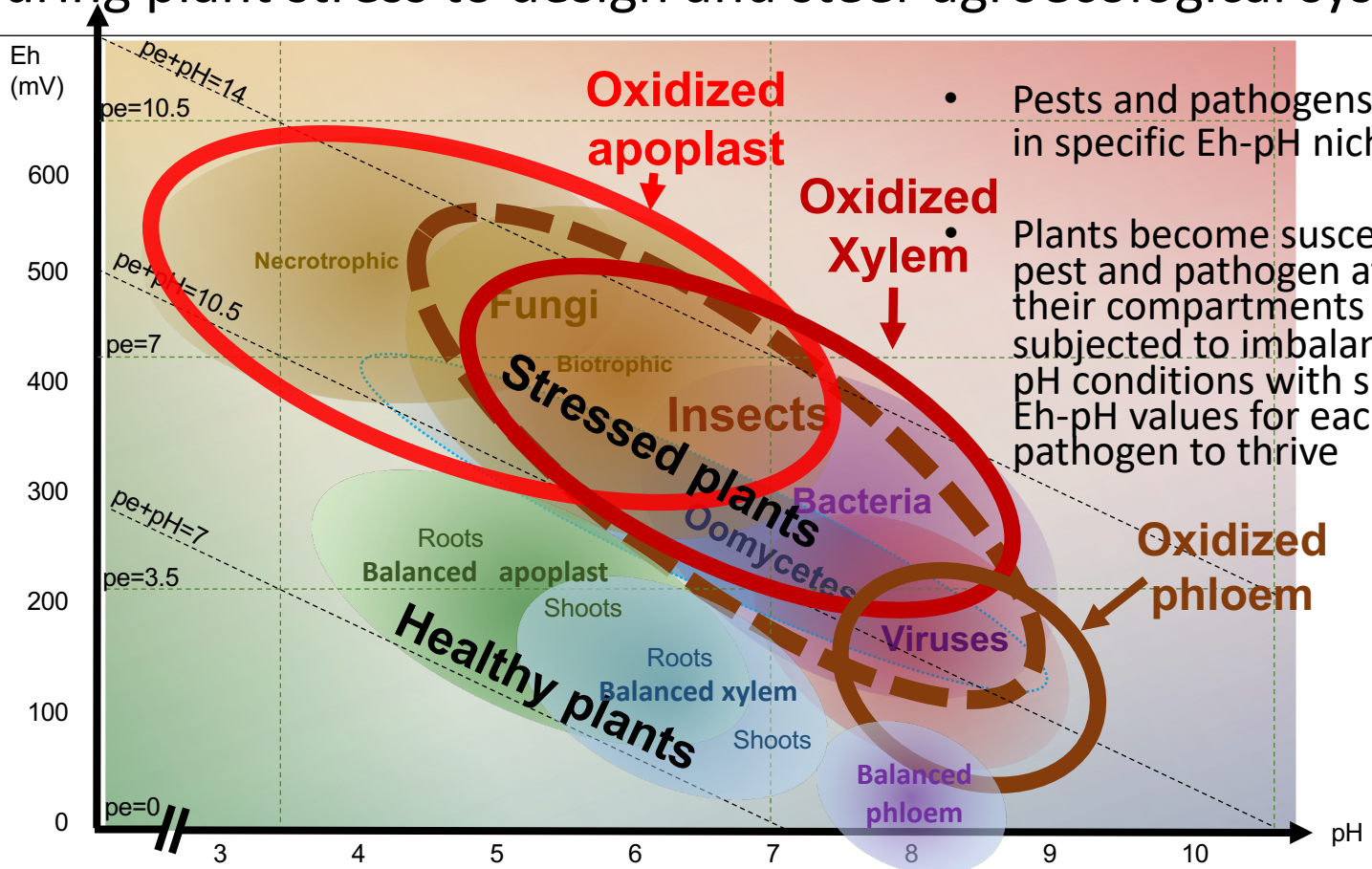
Xylem: More acidic (5-6) and less reduced, less buffered (influence of soil)

Apoplast: Very low buffering, acidic and highest Eh

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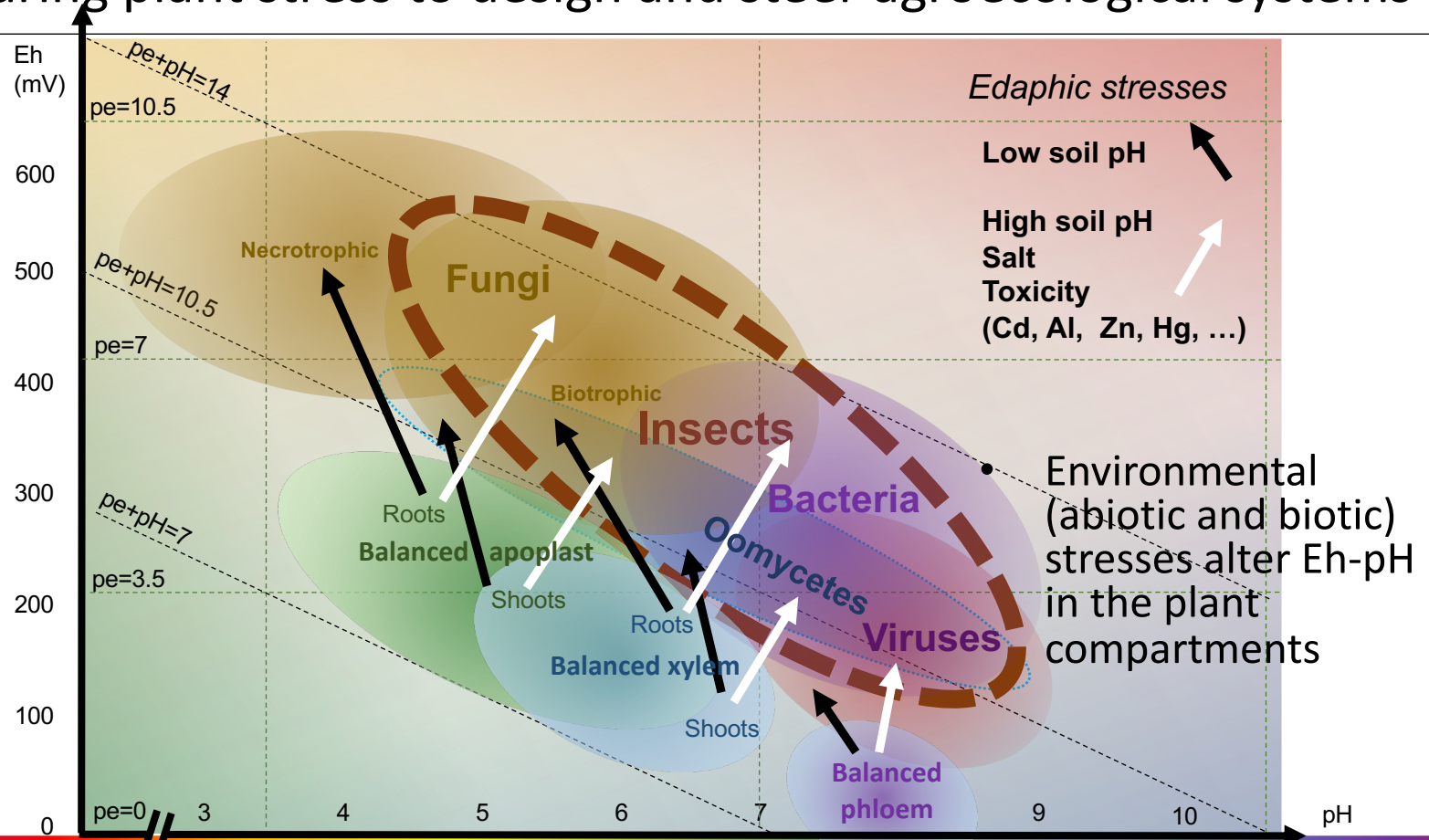
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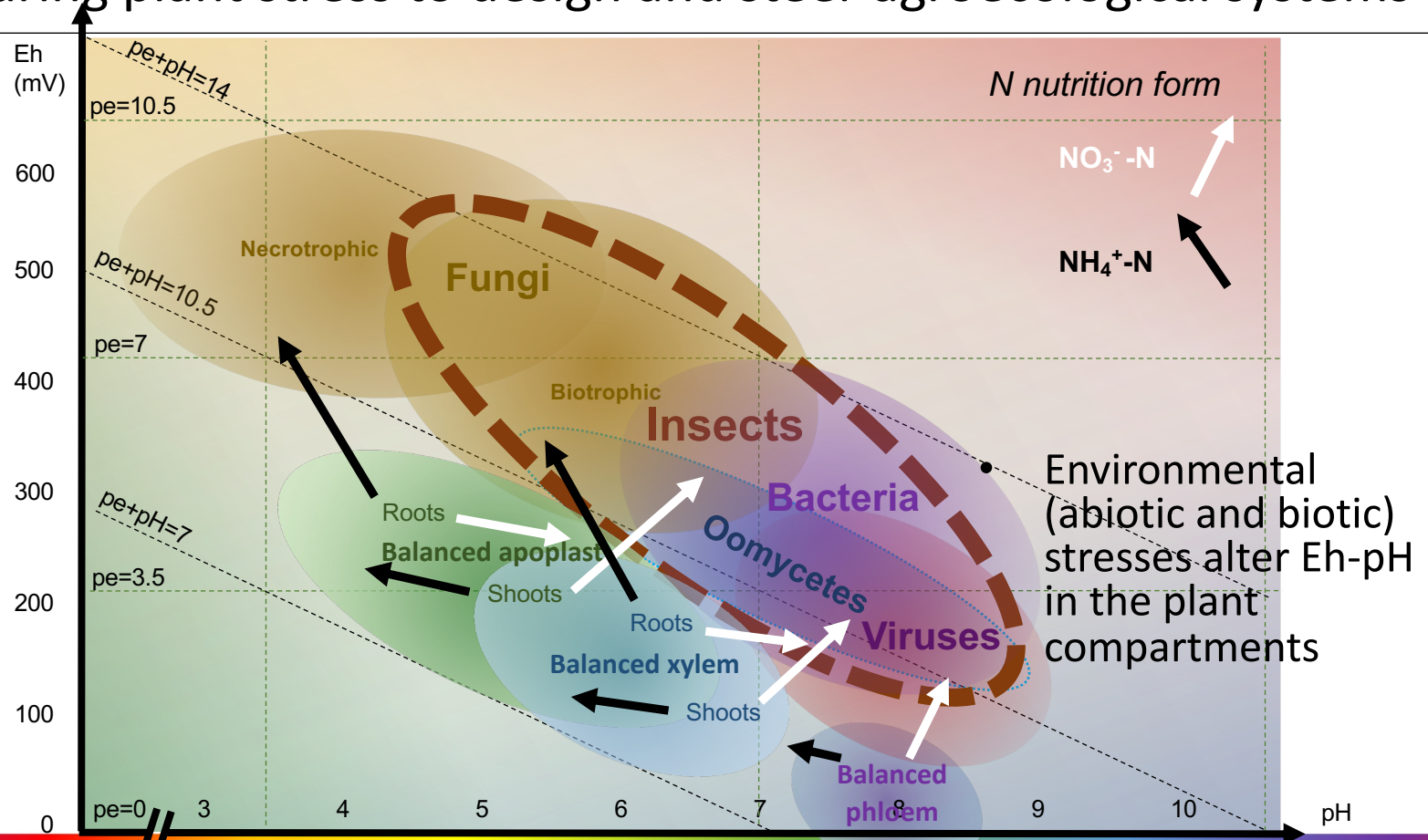


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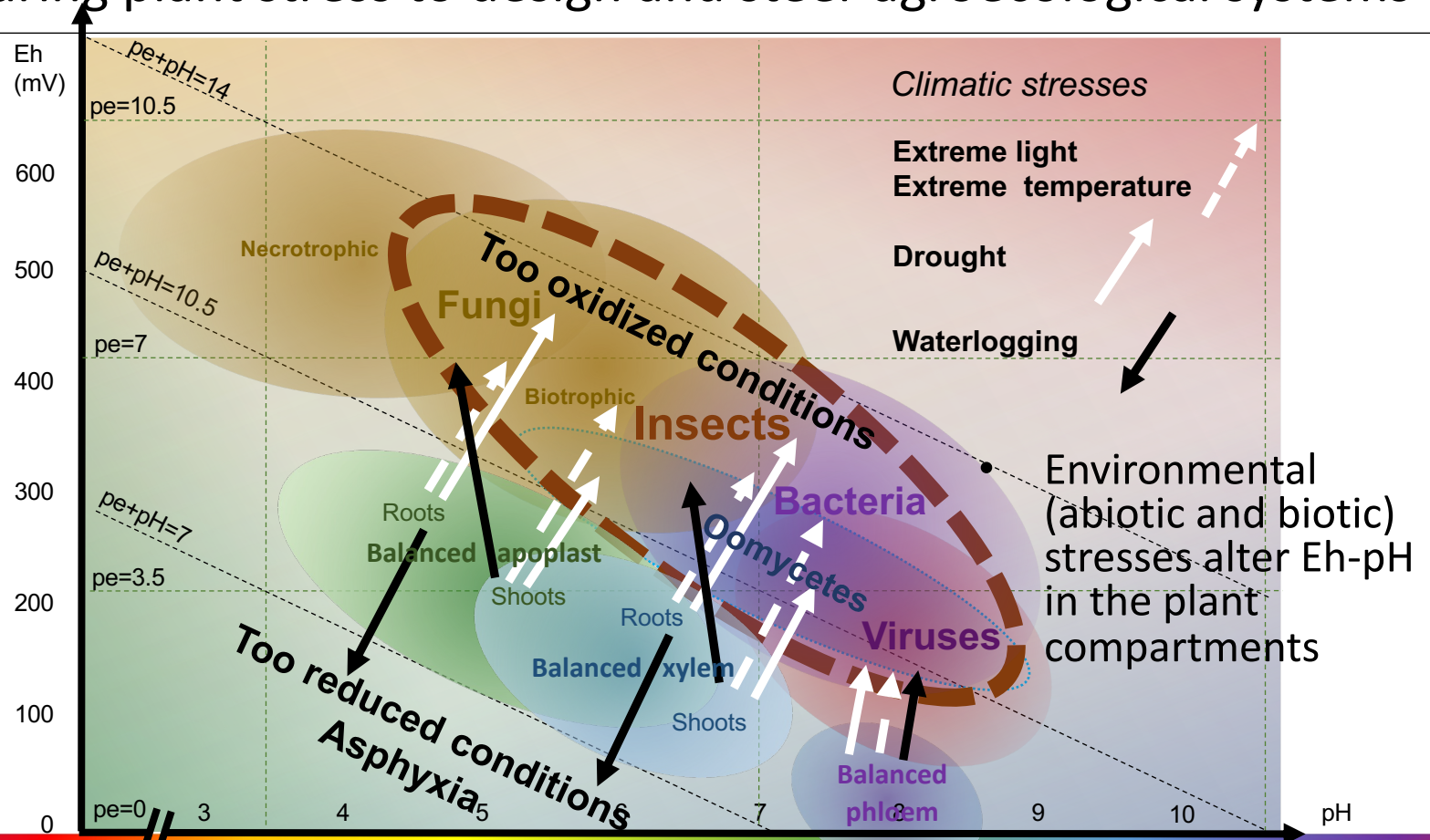




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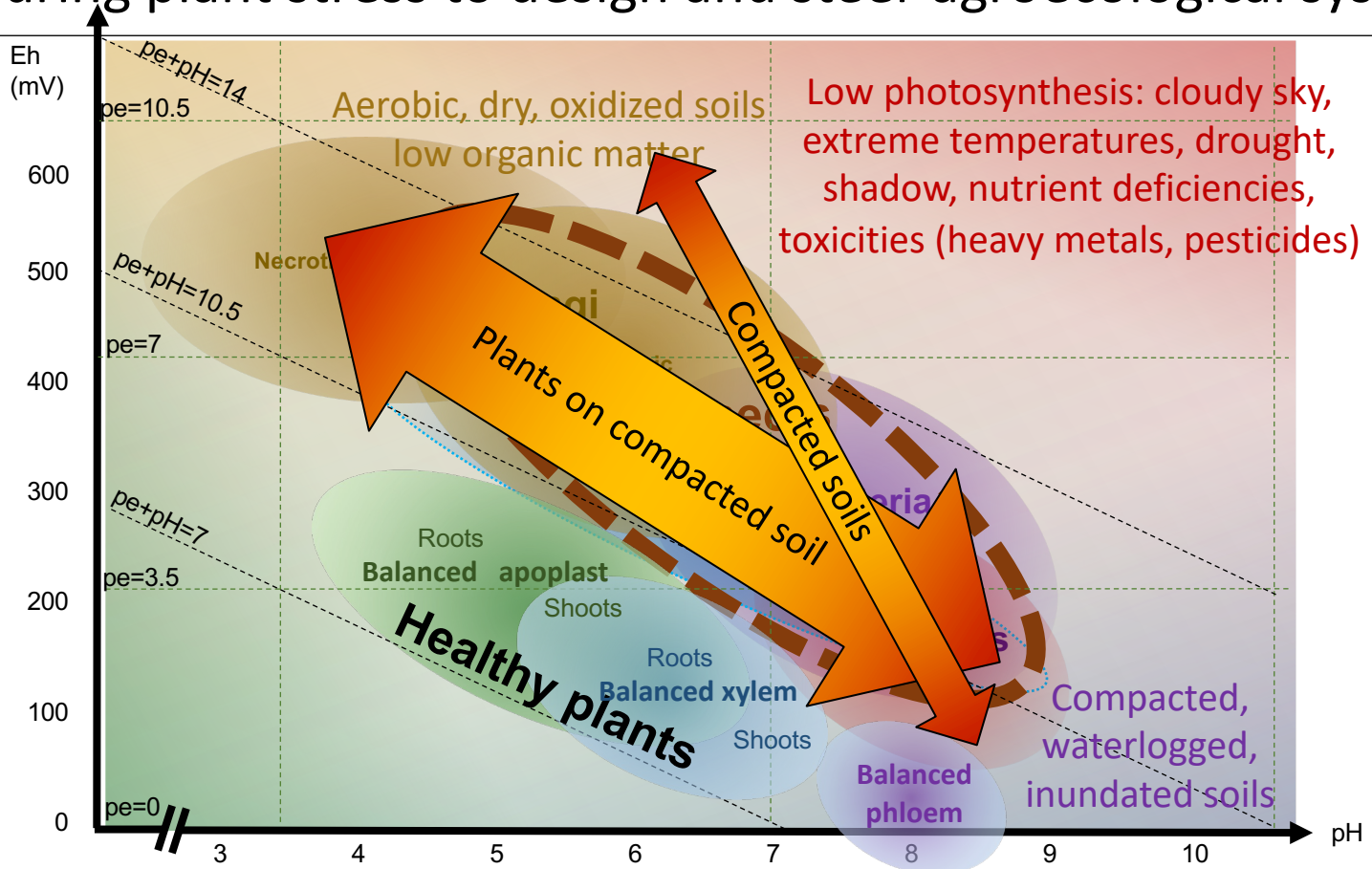


# Measuring plant stress to design and steer agroecological systems



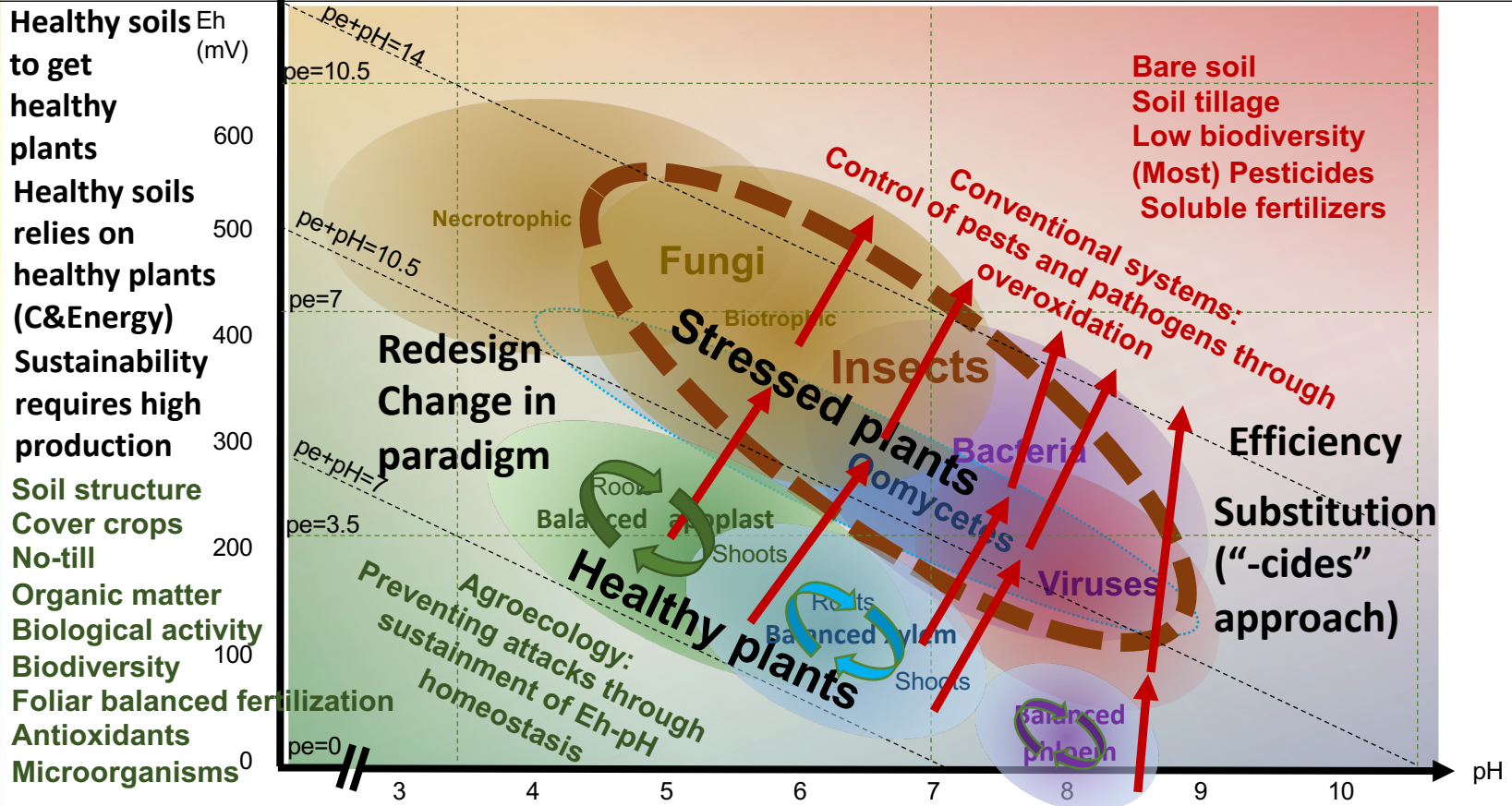
Environmental (abiotic and biotic) stresses alter Eh-pH in the plant compartments

# Measuring plant stress to design and steer agroecological systems





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Olivier Husson





# Measuring plant stress to design and steer agroecological systems

The need to measure:

Assessing plant stress level : Eh-pH as indicators

⇒ Steering cropping practices, evaluate the risk of pest or disease attack, nutrition balance and need for adjustment

Assessing the impact of cropping practices/systems

⇒ Adjustment of cropping practices, products, treatments, etc.

⇒ Redesign of cropping systems

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The difficulties in measurement:

Electrochemical methods

⇒ Difficult to replicate: differences between equipment, electrode aging, electromagnetic perturbations, high variability, etc.

⇒ When mastered, time consuming, laborious.

Hardly applicable in farm condition



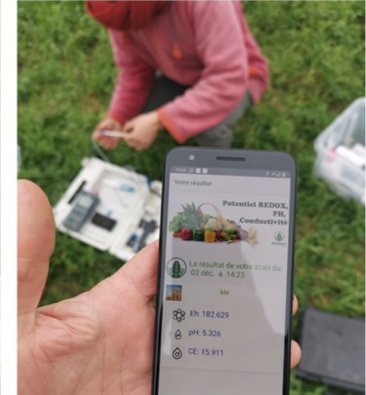
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The difficulties in measurement:

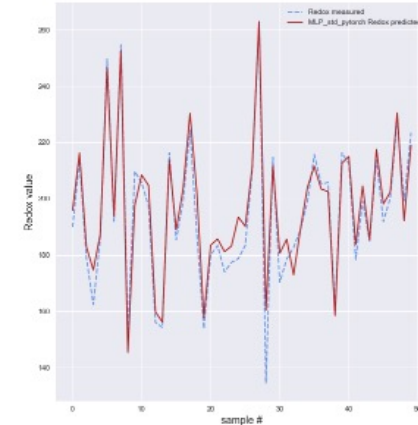
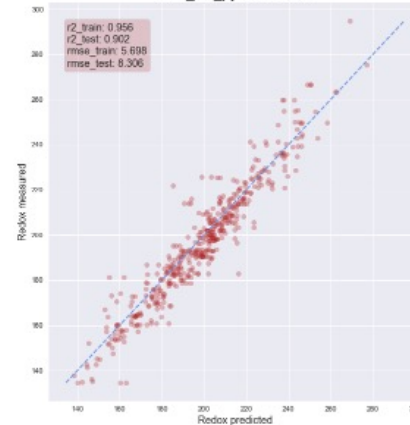
Next generation: Portable Near Infra-Red Spectrometry + AI (Deep-Learning)

⇒ Fast (Eh-pH-EC in a few seconds), accurate, cheap

⇒ Needs calibration. Done for wheat and rapeseed, under development for other crops (Senseen, Ver de Terre Production, multiple partners)

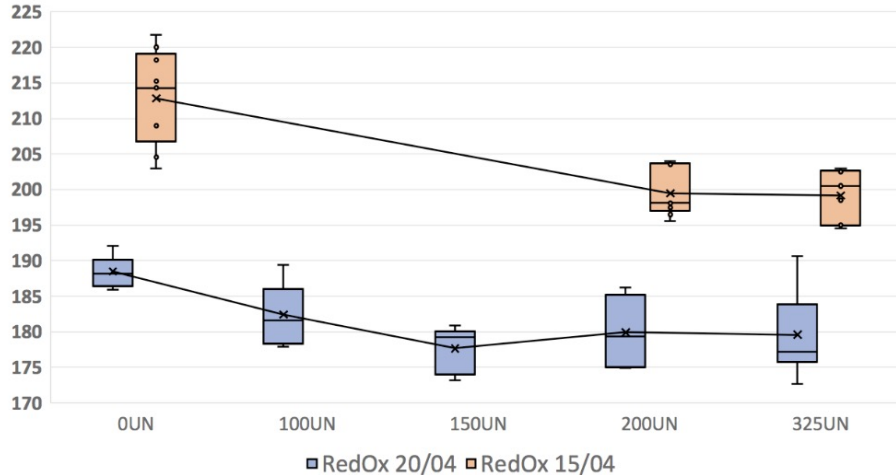


MLP\_std\_pytorch model



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## Assessing the impact of cropping practices/systems



Wheat leaves Eh as a function of N fertilization.  
Metsulfuron-methyle and thifensulfuron-méthyle on 13/04



Testing products before large scale application

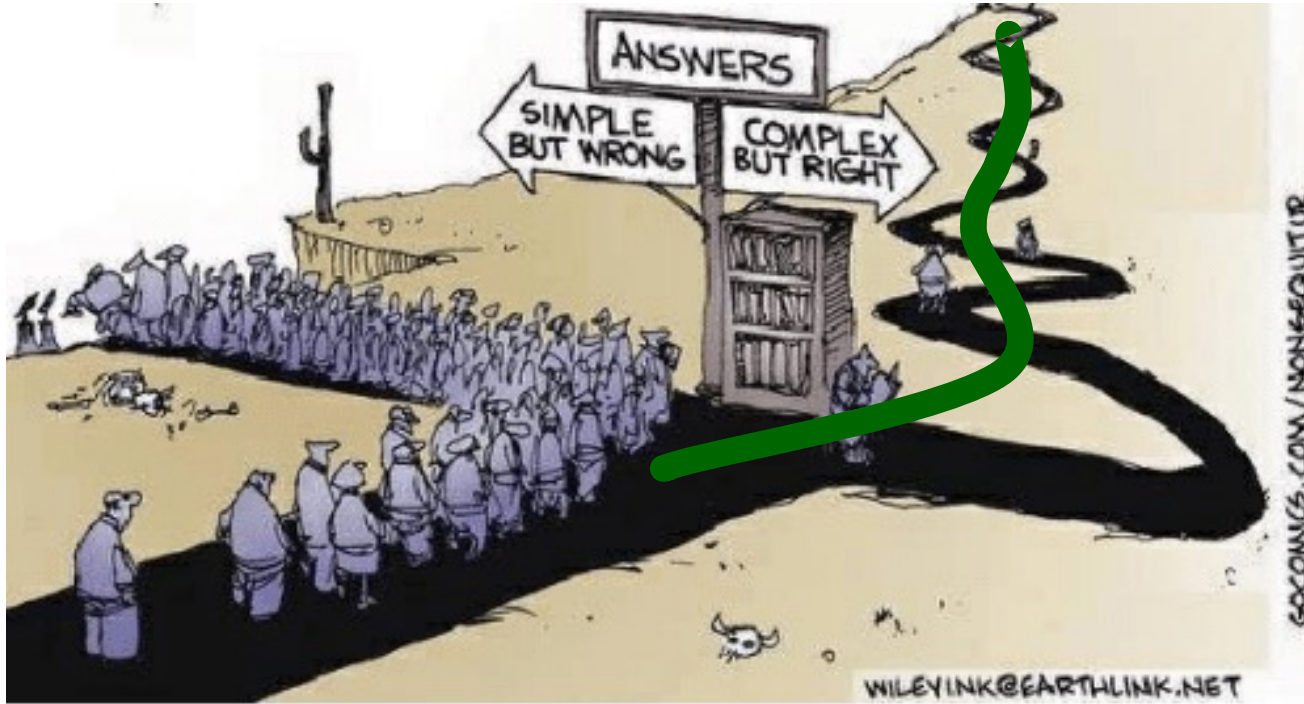
Opening new avenues for agroecology



# Measuring plant stress to design and steer agroecological systems

We had no map and no compass!

We have a first map and will soon get a GPS!



Thanks for your attention!

