Food and Agriculture Organization of the United Nations

International Plant Protection Convention

Department for Environment Food & Rural Affairs

Healthy Soil for Healthy Crops: A Role for Regenerative Agriculture in Assembling Disease-Suppressive Soils

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and Science Panel Member of the Sustainable Soils Alliance

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International Plant Health Conference

PROTECTING PLANTS PROTECTING LIFE

Increased knowledge of beneficial soil microbiomes

Disease suppressive soils protect plants against soil-borne pathogens including fungi, oomycetes, bacteria and nematodes.

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Deciphering the Rhizosphere Microbiome for Disease-Suppressive Bacteria

Rodrigo Mendes,[1]*† Marco Kruijt,[1]*‡ Irene de Bruijn,[1]§ Ester Dekkers,[1] Menno van der Voort,[1] Johannes H. M. Schneider,[2] Yvette M. Piceno,[3] Todd Z. DeSantis,[3,4] Gary L. Andersen,[3] Peter A. H. M. Bakker,[5] Jos M. Raaijmakers[1]¶

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Current Insights into the Role of Rhizosphere Bacteria in Disease Suppressive Soils

*Ruth Gómez Expósito[1,2], Irene de Bruijn[1], Joeke Postma[3] and Jos M. Raaijmakers[1,4]**

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TYPE Review
PUBLISHED 09 August 2022
DOI 10.3389/fpls.2022.952397

Development of plant systemic resistance by beneficial rhizobacteria: Recognition, initiation, elicitation and regulation

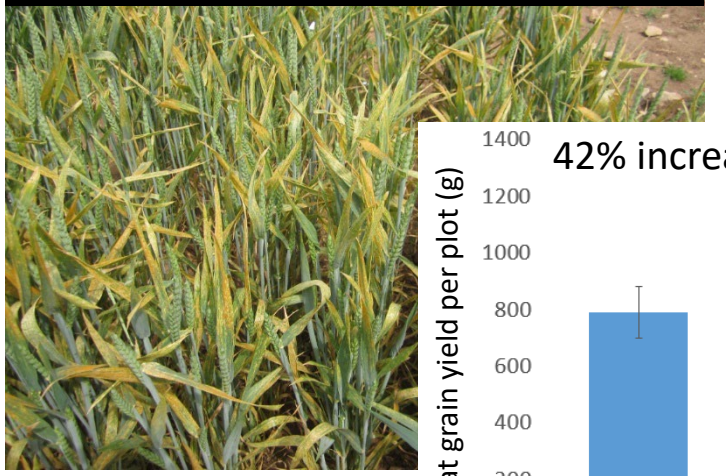
Lin Zhu[1,2], Jiameng Huang[1], Xiaoming Lu[1] and Cheng Zhou[1,3]*

Disease suppression by soil microbiomes. Key groups associated with disease-suppression include Proteobacteria, Firmicutes, and Actinobacteria.

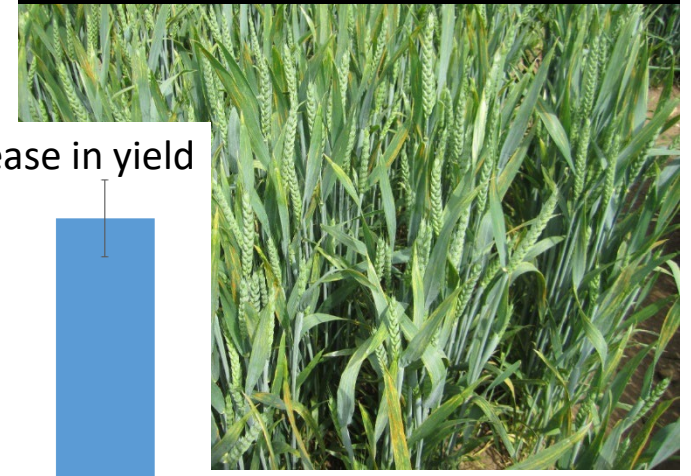
Induction of systemic resistance includes root and shoot pathogens.

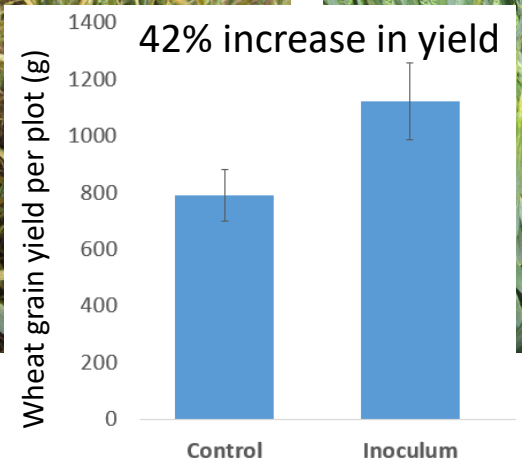
Suppression of yellow rust in wheat grown in long-term arable soil by addition of commercial mycorrhizal inoculum that contains bacteria and other microbes

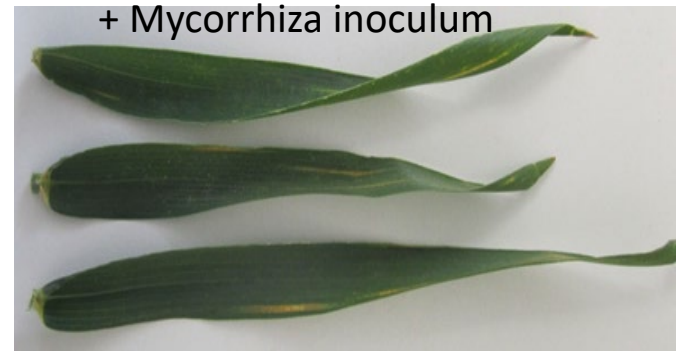
Severe wheat yellow rust



Microbially-induced resistance







Can disease-suppressive soil be developed from intensively cultivated arable land by regenerative agriculture approaches?

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TYPE Original Research
PUBLISHED 24 August 2022
DOI 10.3389/fpls.2022.95598

Experimental Evaluation of Biological Regeneration of Arable Soil: The Effects of Grass-Clover Leys and Arbuscular Mycorrhizal Inoculants on Wheat Growth, Yield, and Shoot Pathology.

Nichola Austen[1*], Stefanie Tille[2], Despina Berdeni[3], Leslie Firbank[4], Martin Lappage[4], Michael Nelson[5], Thorunn Helgason[6], Ewan Marshall-Harries[7], Bleddyn Hughes[8], Richard Summers[9], Duncan D. Cameron[10], Jonathan Leake[10*]

Sooty ear mould of wheat

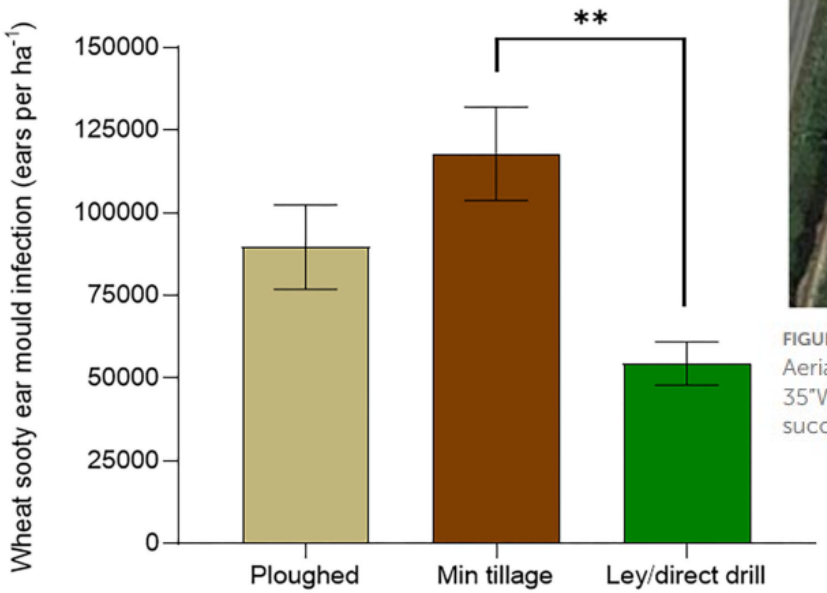
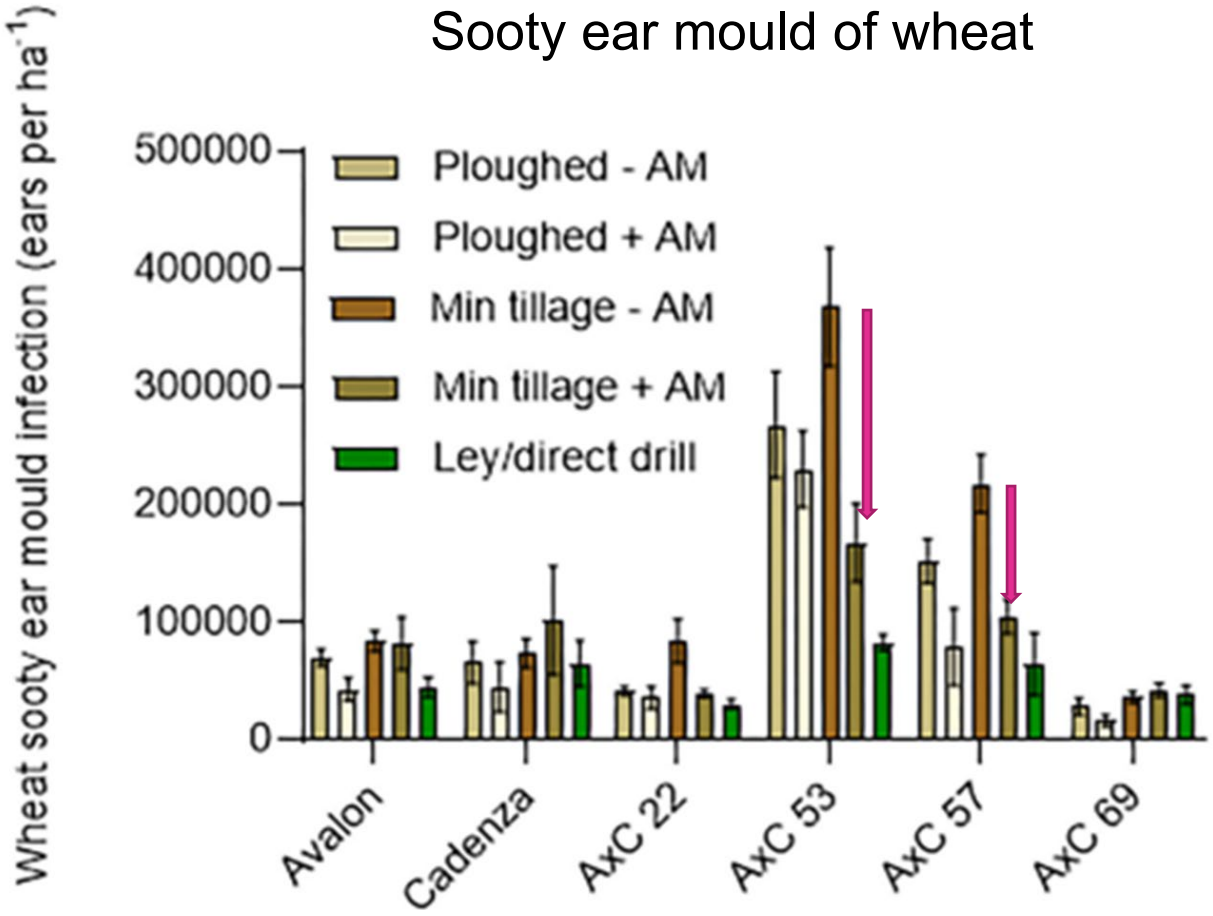
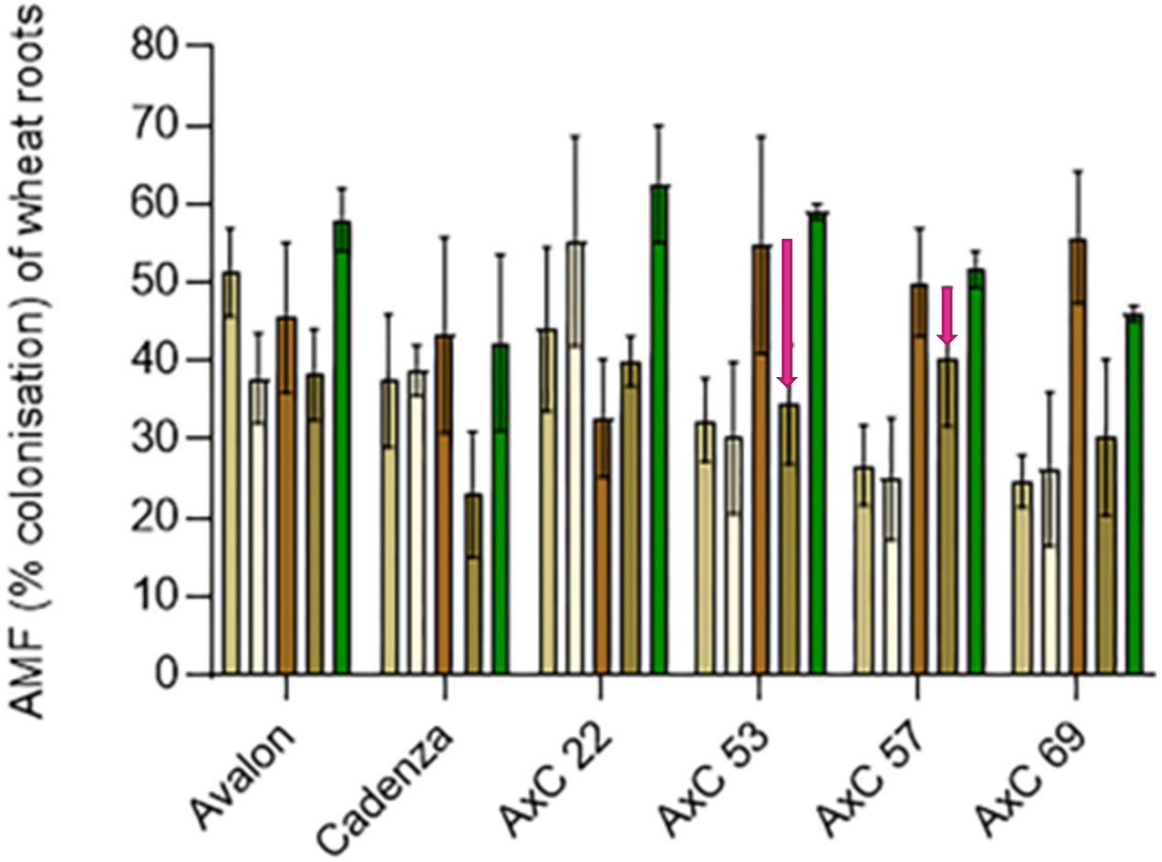


FIGURE 1
Aerial view (June 2018) of the experimental plots arranged in four blocks (A-D) running downslope at Spen Farm, Tadcaster (53° 51' 44" N; 1° 20' 35"W). The image shows the wheat direct drilled into a 3-year ley compared to plots that have been cultivated and cropped with wheat for 3 successive years, with Skyfall wheat guard rows and the surrounding field which is not part of the trial. Map data © 2018 Google.

Sooty ear mould of wheat



Mycorrhization of wheat

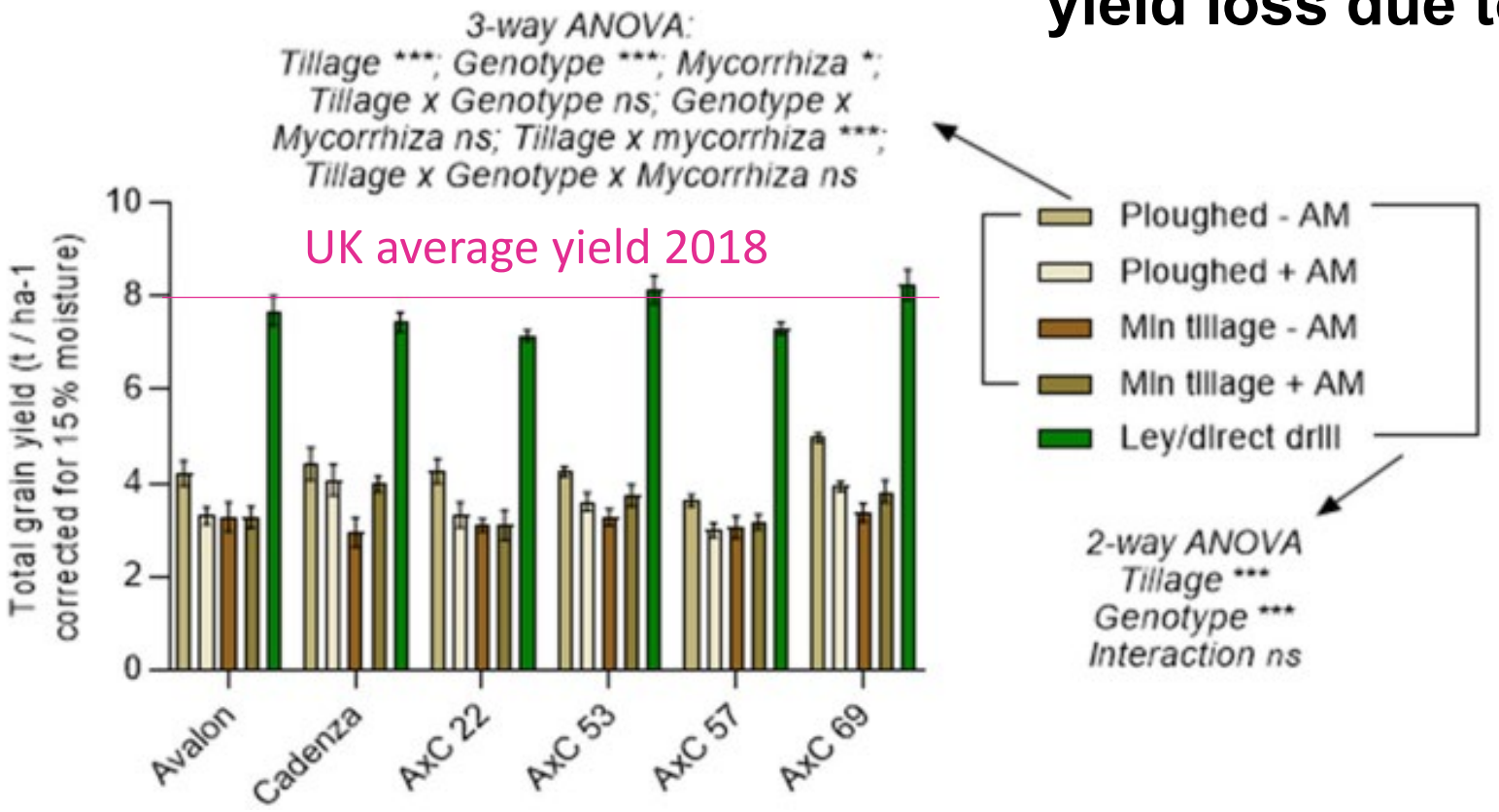


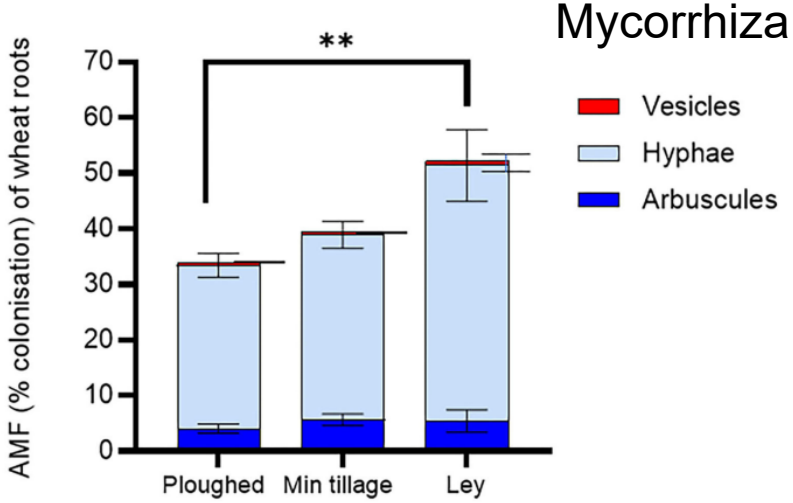
Disease suppressiveness of commercial mycorrhizal inoculum not associated with improved mycorrhization- likely due to bacteria.

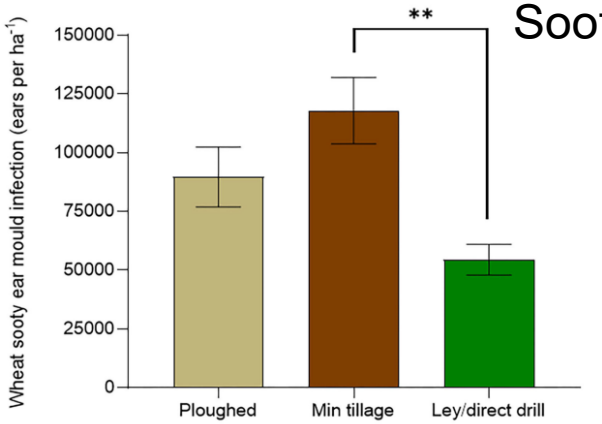
Austen *et al.*, 2022

Wheat grown with only 35 Kg N ha^{-1} rather than the average 137 Kg N ha^{-1}

Wheat yields in ley- no evidence of yield loss due to induced defences.



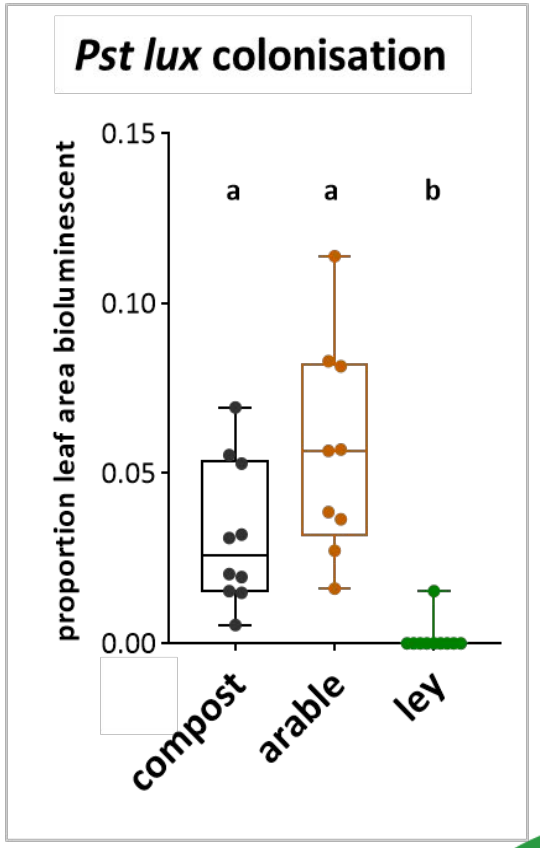


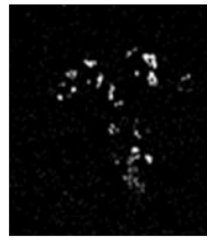


Changing arable to legume-rich ley improves mycorrhization, generates disease-suppressive soil and reduces N fertilizer requirements- regenerative agriculture.

Identifying and transferring resistance-inducing microbes from ley soils

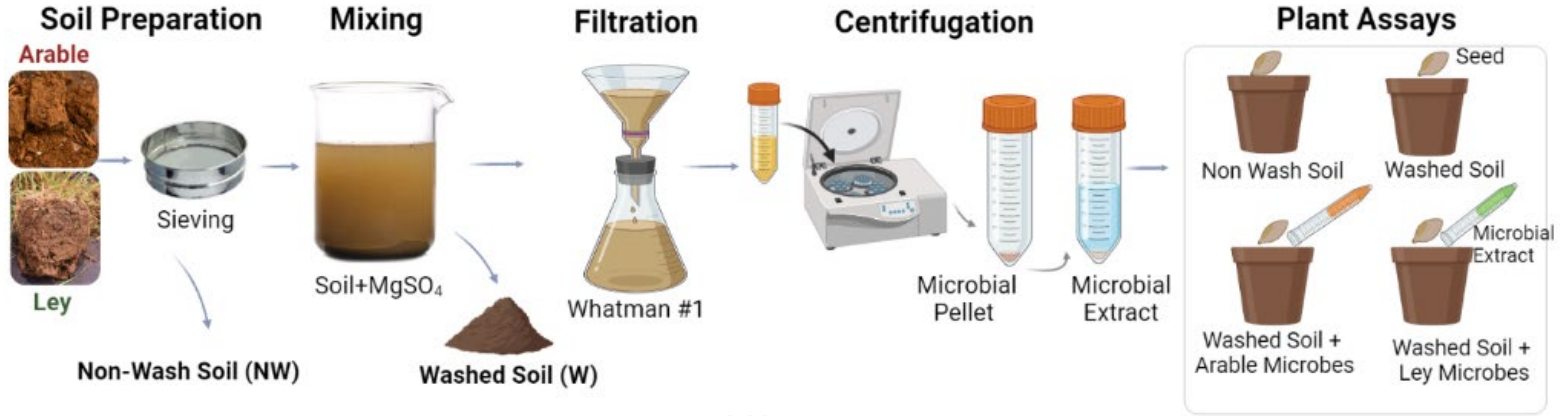
Nancy Muringai, Prof. Jurriaan Ton, Dr. Anna Krzywoszynska*, Prof. Stephen Rolfe,
School of Biosciences, The University of Sheffield, UK, (*now at University of Twente)





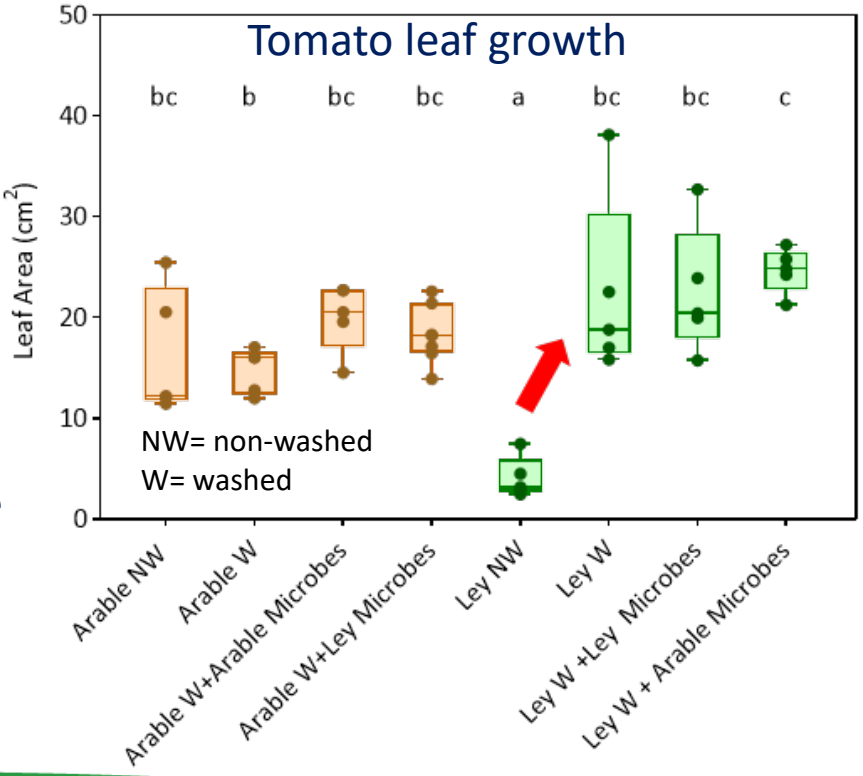
Ley soil induced tomato resistance to *Pseudomonas syringae*, but with lower growth rate.

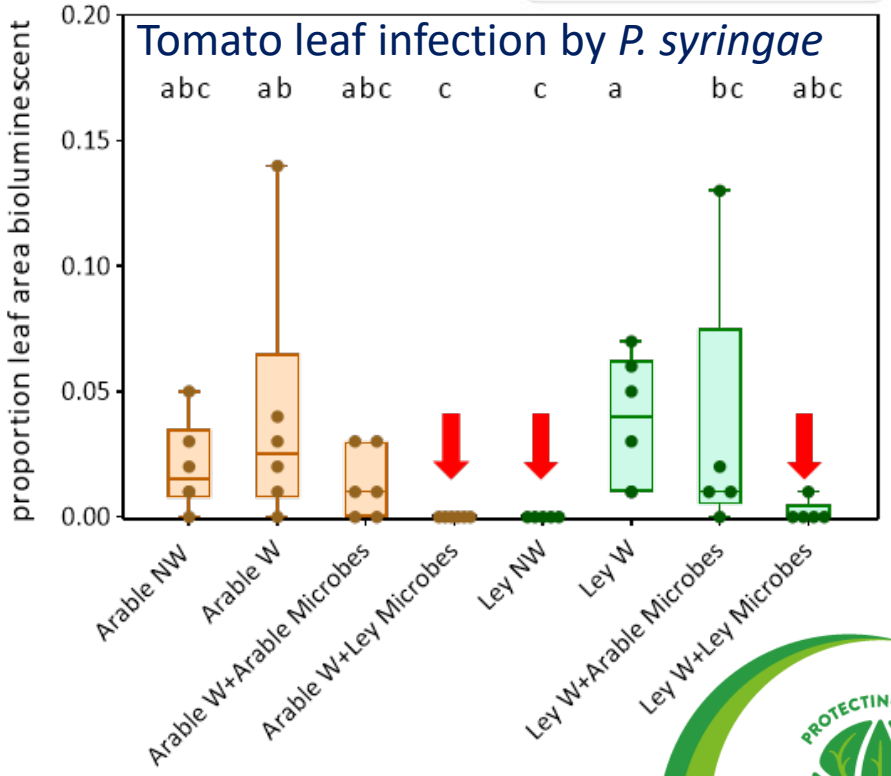
Extraction and inoculation of disease-suppressive microbiomes from ley soil to arable soil.



Tomato growth on ley soils increased after soil washing (W).
Re-addition of microbes had no further effect on plant growth.

Washing (W) removed resistance-inducing microbes but they could be restored by re-adding ley microbes to washed arable or ley soils.





Take-home messages

Leys rest soil from disturbance, increase diversity, keep soil covered, and maintain year-round living roots feeding the soil with carbon and nitrogen.

Healthy Soil for Healthy Crops:
A Role for Regenerative Agriculture in Assembling Disease-Suppressive Soils

- Arable soil health can be regenerated by reintroducing legume-rich leys.
- Leys can develop soil microbiomes that suppress plant diseases – including shoot pathogens.
- Locally adapted soil microbiomes can be extracted from leys and inoculated into arable soil in pot experiments to deliver disease suppressive soils.
- Regenerative agriculture approaches such as reintroducing leys into arable rotations has the potential to improve soil and crop health and reduce reliance on chemical fertilizers and pathogen controls.

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