


# Improving agricultural sustainability with symbiotic fungi



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The University  
Of Sheffield.



# Agricultural sustainability

- Unsustainable fertiliser use
- N fertiliser ecologically damaging
- P fertiliser finite + dwindling
- Fertiliser costs unstable
- Efficiency must be improved!



AHDB



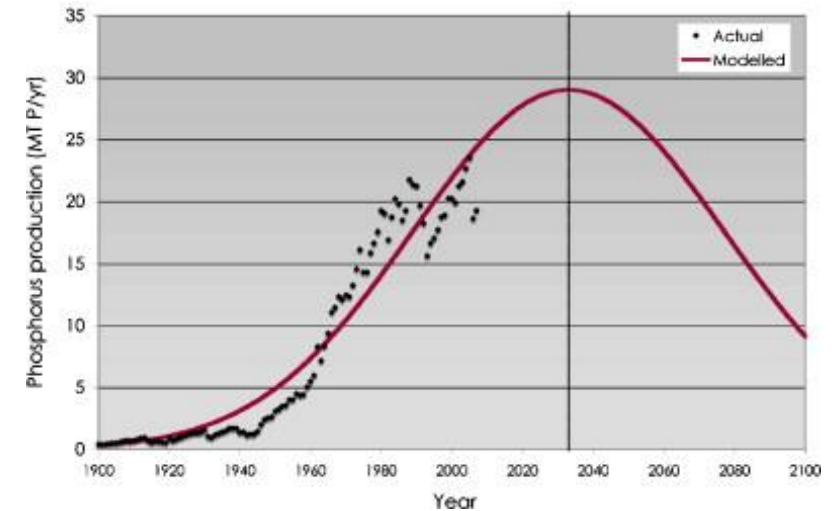
NASA/NOAA

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AHDB



Cordell et al 2009 *Global Env. Change*

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→ Can soil microbes help?



AHDB

	Aug-21 (£/tonne)	Aug-20 (£/tonne)	Change from previous year (%)
AN – UK produced (34.5% N)	346	218	58%
AN – Imported* (34.5% N)	324	202	61%
Granular Urea - Standard Specification (46% N)	N/a	260	N/a
UAN (30% N w/w kg per 100kg)	N/a	N/a	N/a
Muriate of Potash (MOP)	392	246	60%
Diammonium Phosphate (DAP)	567	N/a	N/a
Triple Super Phosphate (TSP)	482	247	95%

Source: AHDB

# Arbuscular mycorrhizal fungi

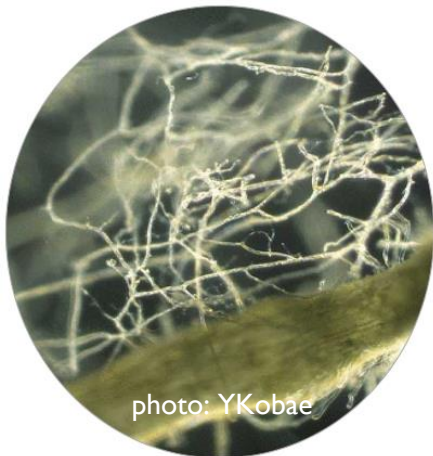
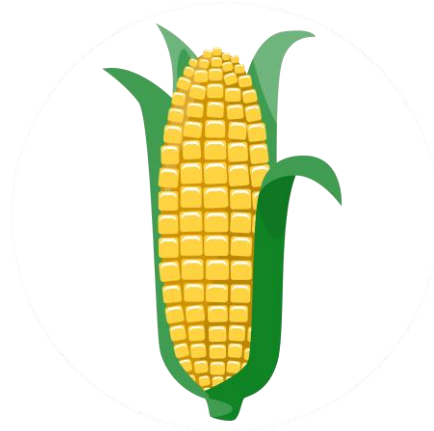


photo: YKobae

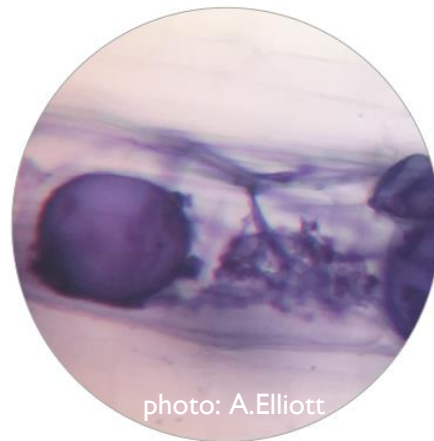
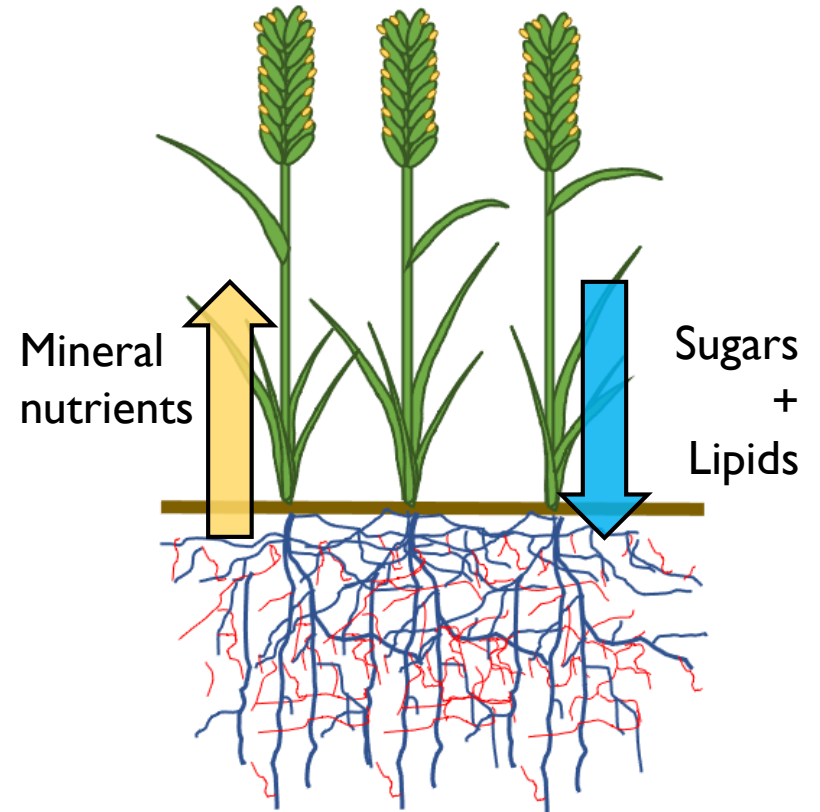


photo: A.Elliott

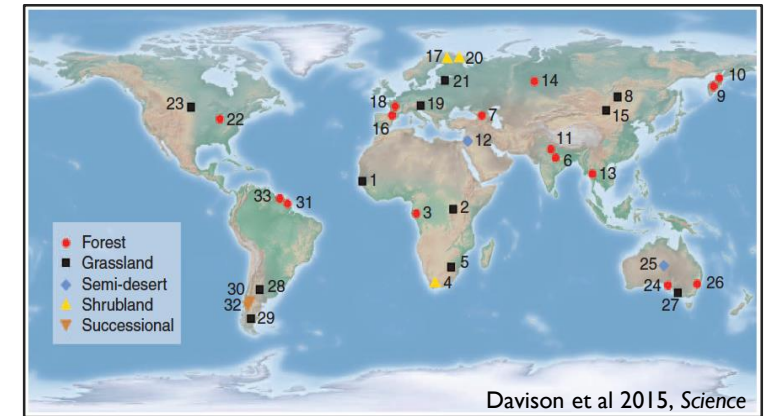
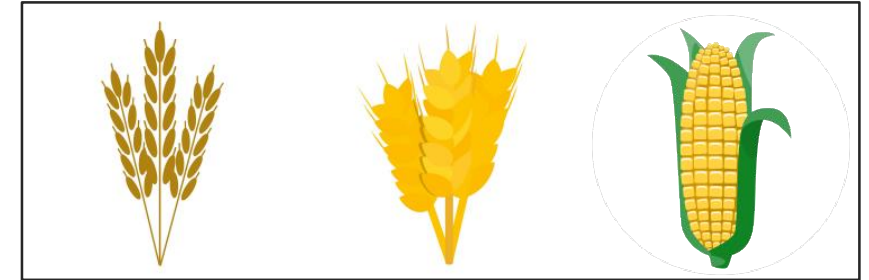


- Nutrient uptake
- Water uptake
- Plant defence
- Nutrient retention
- Soil structure
- GHG emissions

Keystone taxa / ecosystem engineers

# Mycorrhizal crops

- Most crops are mycorrhizal (inc. all cereals)
- Mycorrhizas are everywhere
- Effect on plants - *not* always beneficial
- Mechanisms not well understood

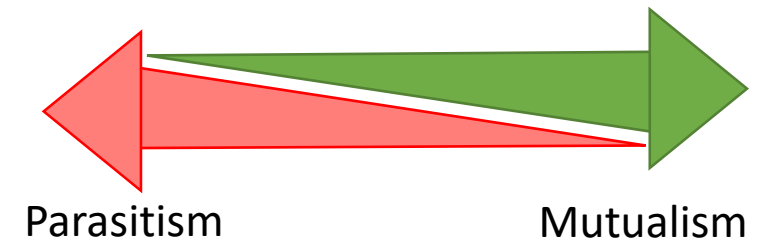


**burleigh dodds**  
SCIENCE PUBLISHING

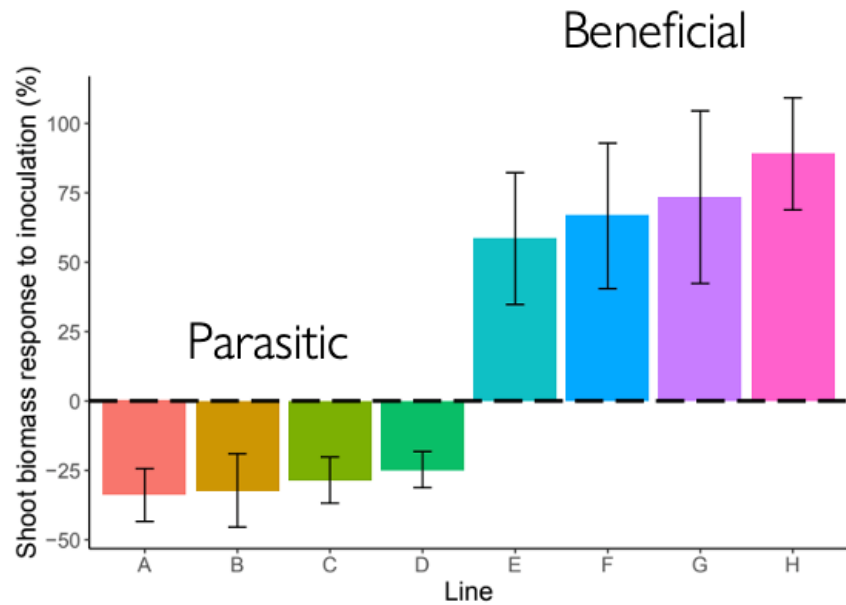
**Journal of Ecology**  
Journal of Ecology 2017, 105, 921–929 doi: 10.1111/1365-2745.12788

**MINI-REVIEW: ECOLOGICAL SOLUTIONS TO GLOBAL FOOD SECURITY**  
**Are mycorrhizal fungi our sustainable saviours?**  
**Considerations for achieving food security**

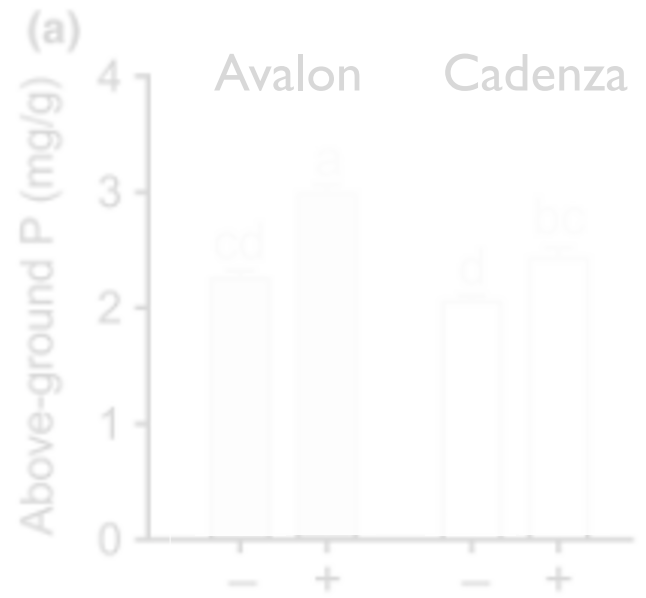
Thomas J. Thirkell\*, Michael D. Charters, Ashleigh J. Elliott, Steven M. Sait and Katie J. Field\*



# Crop identity impacts mycorrhizal function



Thirkell et al, *in prep*



Elliott, et al, 2020

Strong  
plant identity  
effect

→ Can we  
breed positive  
response into  
cereals?

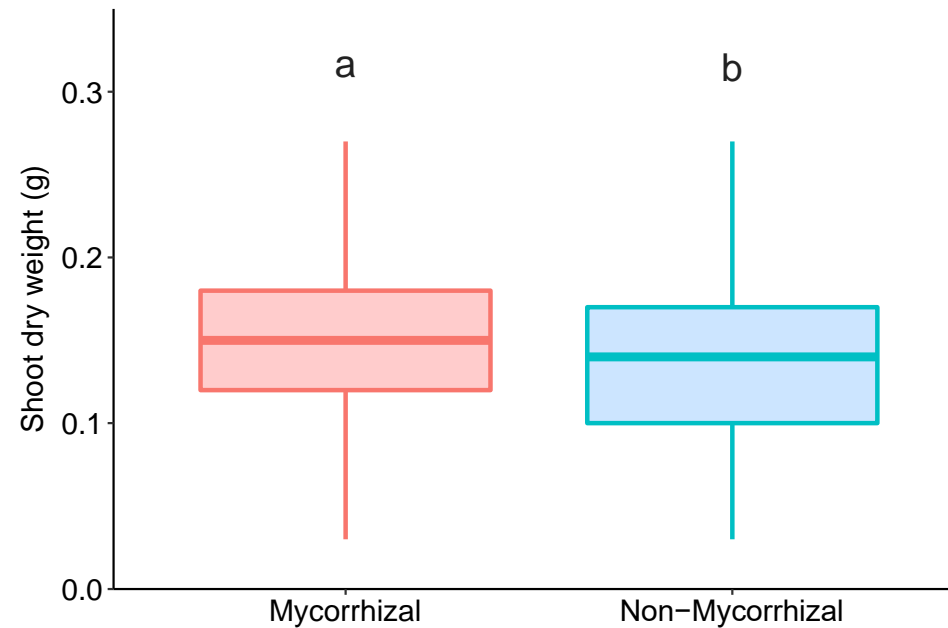
# “The genetic basis of mycorrhizal growth response in wheat”

- ⚙️ 99 wheat varieties
- ⚙️ Grown +/- mycorrhiza
- ⚙️ Simple growth media
- ⚙️ Harvest after 5 weeks
  
- ⚙️ Plant height, P content, biomass
- ⚙️ Calculate mycorrhizal responsiveness



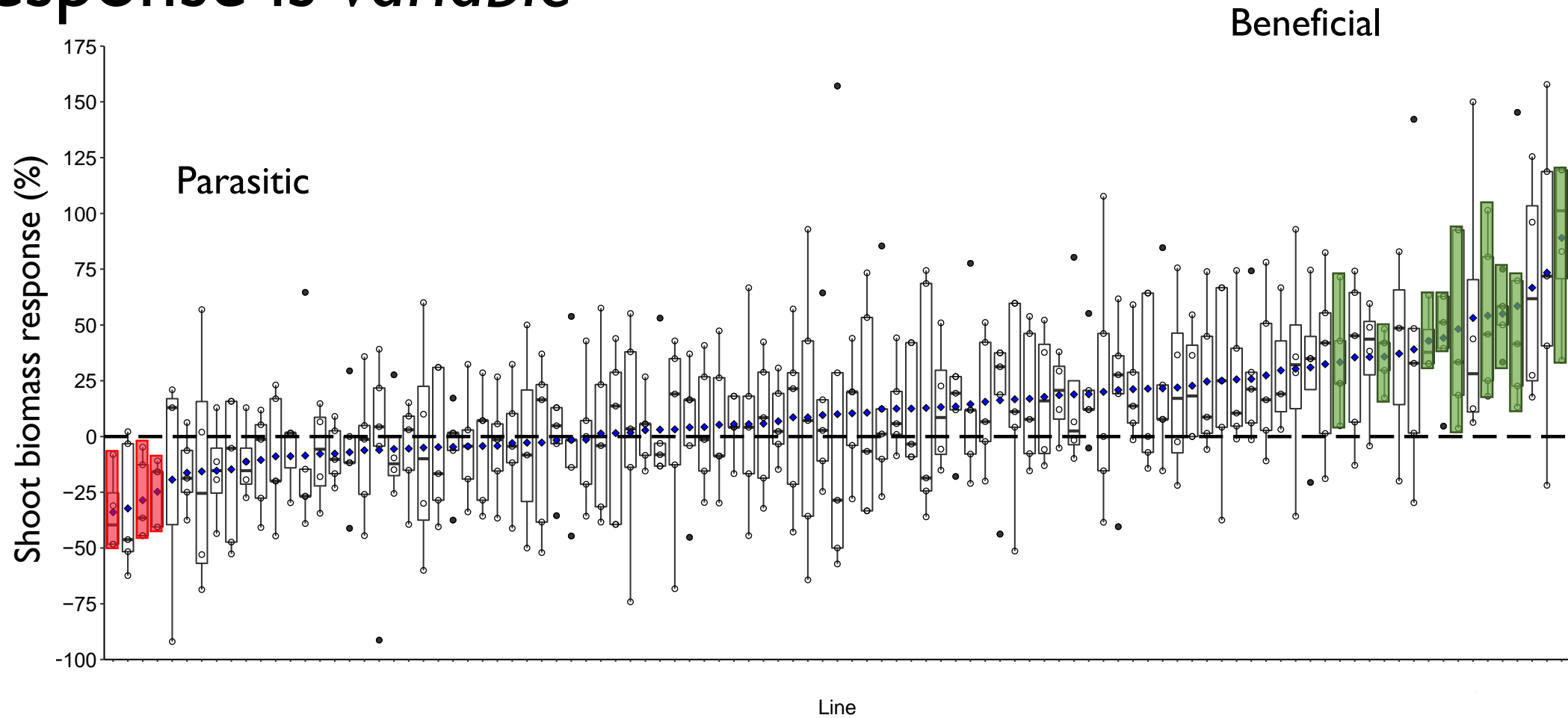


# Overall, mycorrhizas increased shoot growth 10.5%

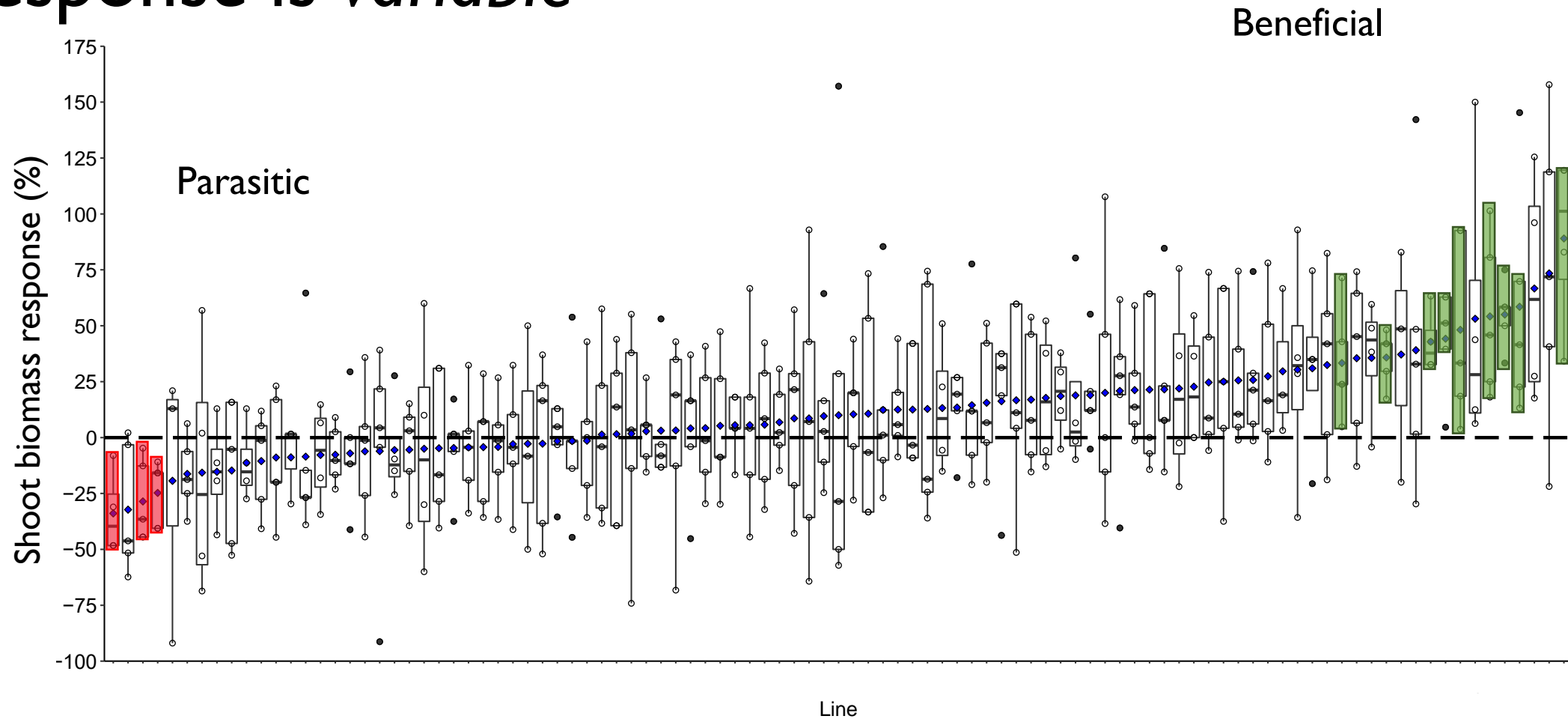


Shoot P content  $\uparrow$  13.9%      Root : shoot ratio  $\downarrow$  4.5%  
Shoot height  $\uparrow$  3.8%      Root biomass similar

# Response is *variable*

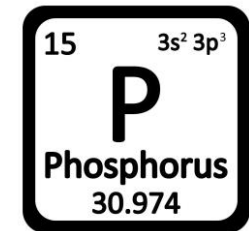


# Response is *variable*

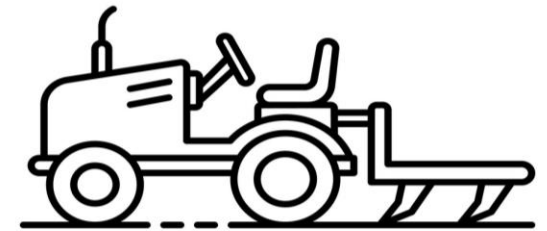


Next steps – find the genes causing these trends

# Can mycorrhizas *actually* be beneficial in agriculture?

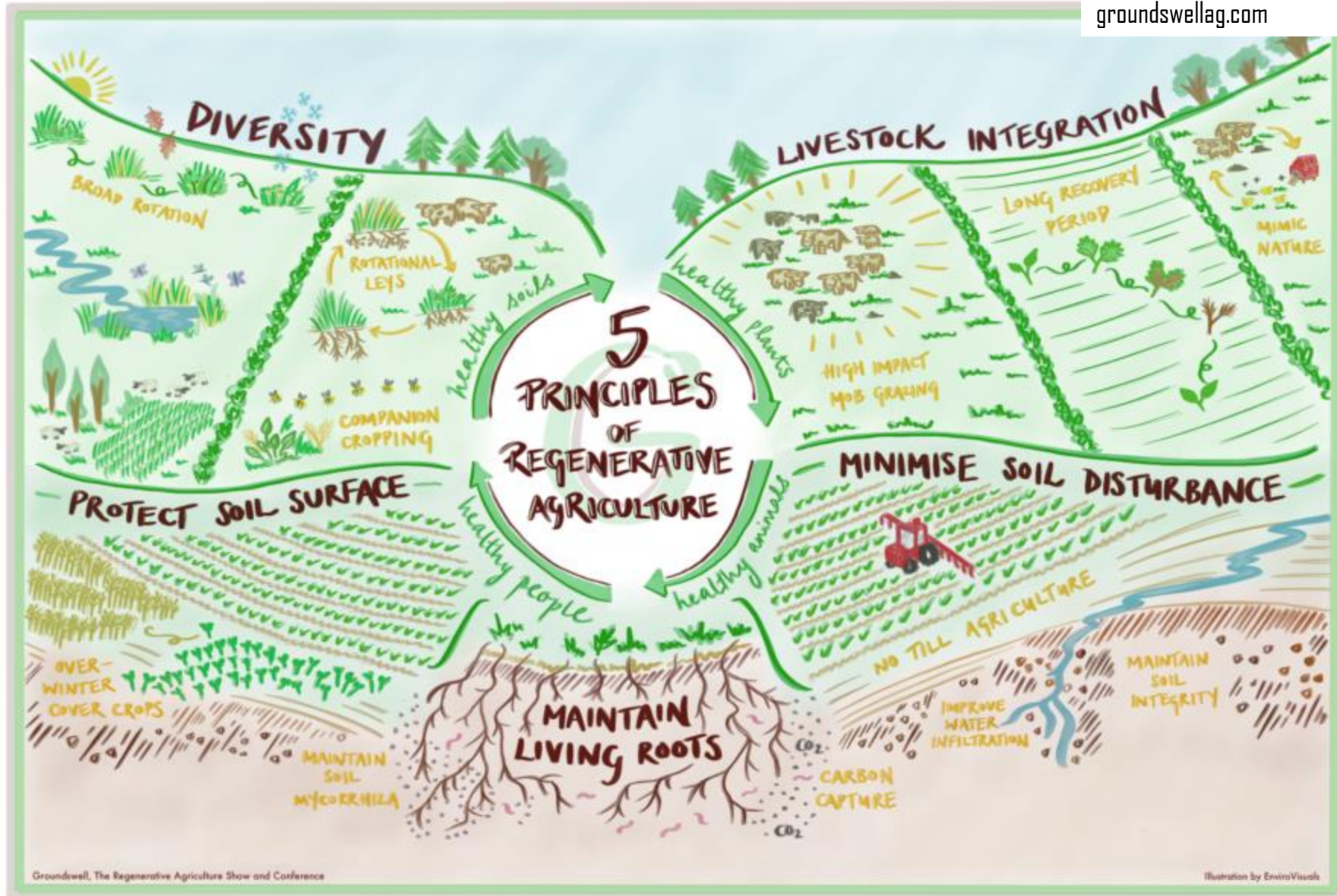


- Conventional agriculture – high input, high disturbance = bad for mycorrhizas
- Breeding crops for fungi that aren't there?
- Using mycorrhizas in agriculture will need changes in genetics *and* management

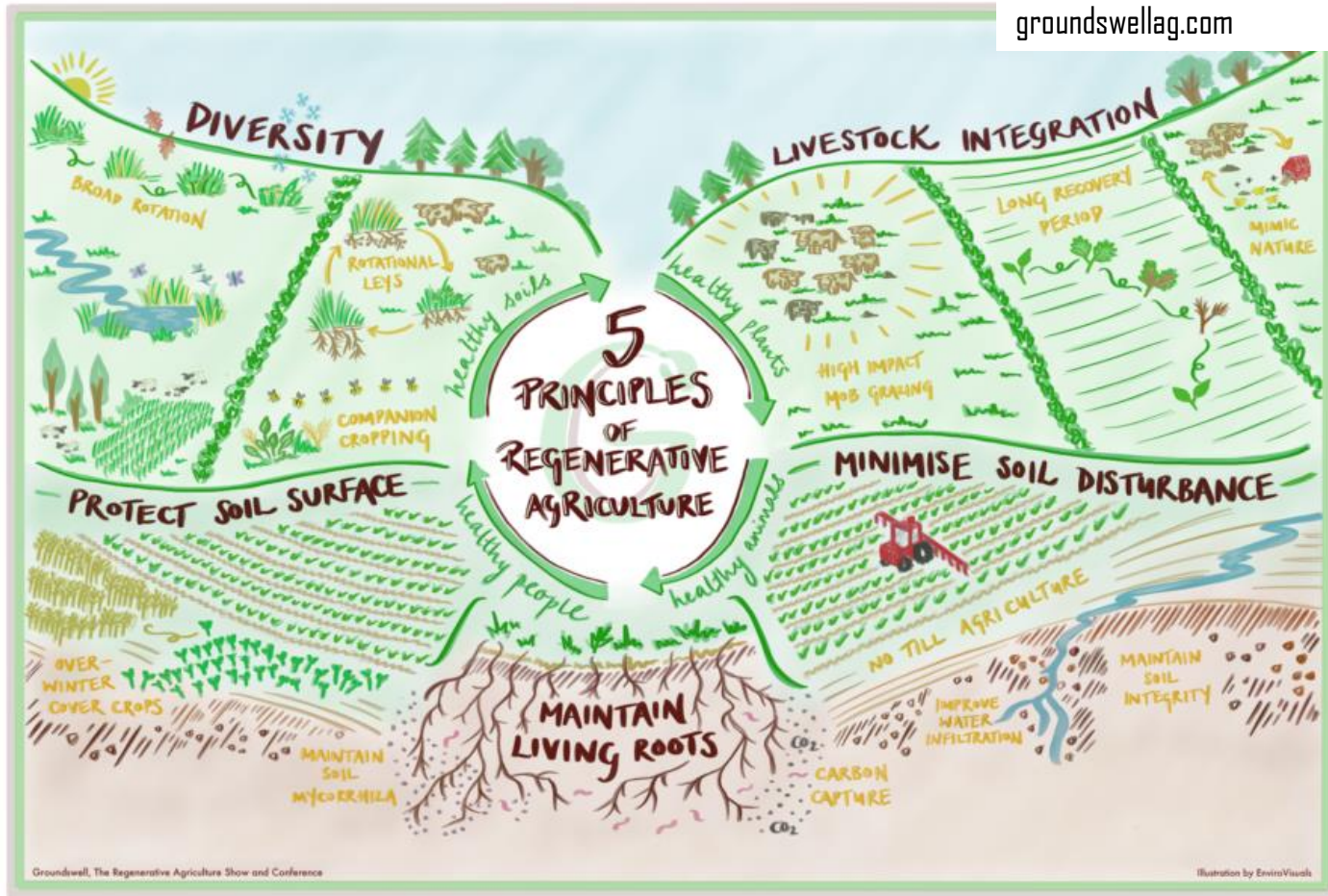


# Regenerative agriculture – integrating mycorrhizas

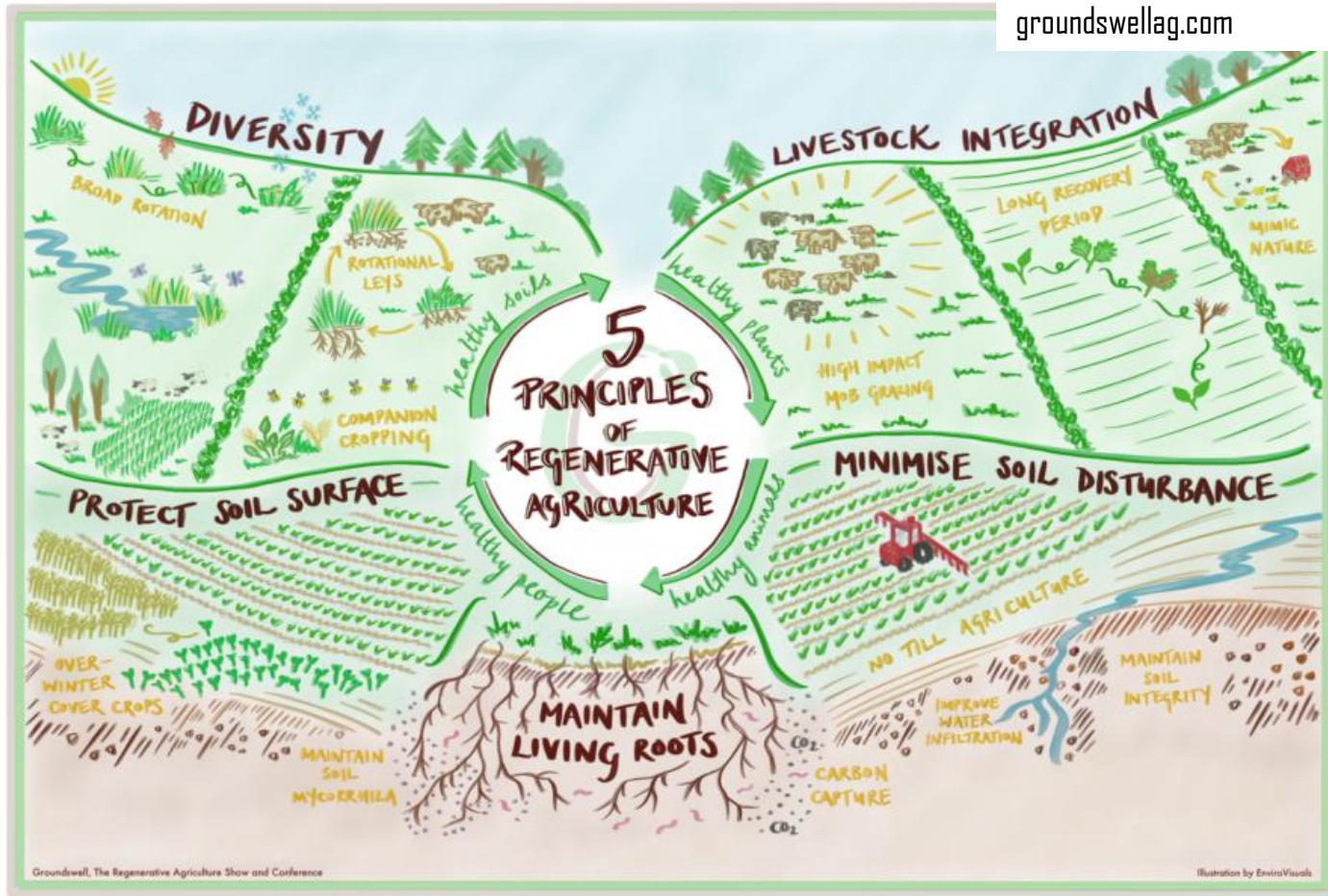
groundswellag.com



# Regenerative agriculture – integrating mycorrhizas



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Legume N-fixing + mycorrhizal P uptake = reduced fertiliser input

# Conventional vs Regenerative agriculture

→ Are mycorrhizas more beneficial in regenerative agriculture systems?

- Experimental network across UK
- Paired field trial sites
- Paired soil type, land history, climate etc





# Thanks for listening!



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