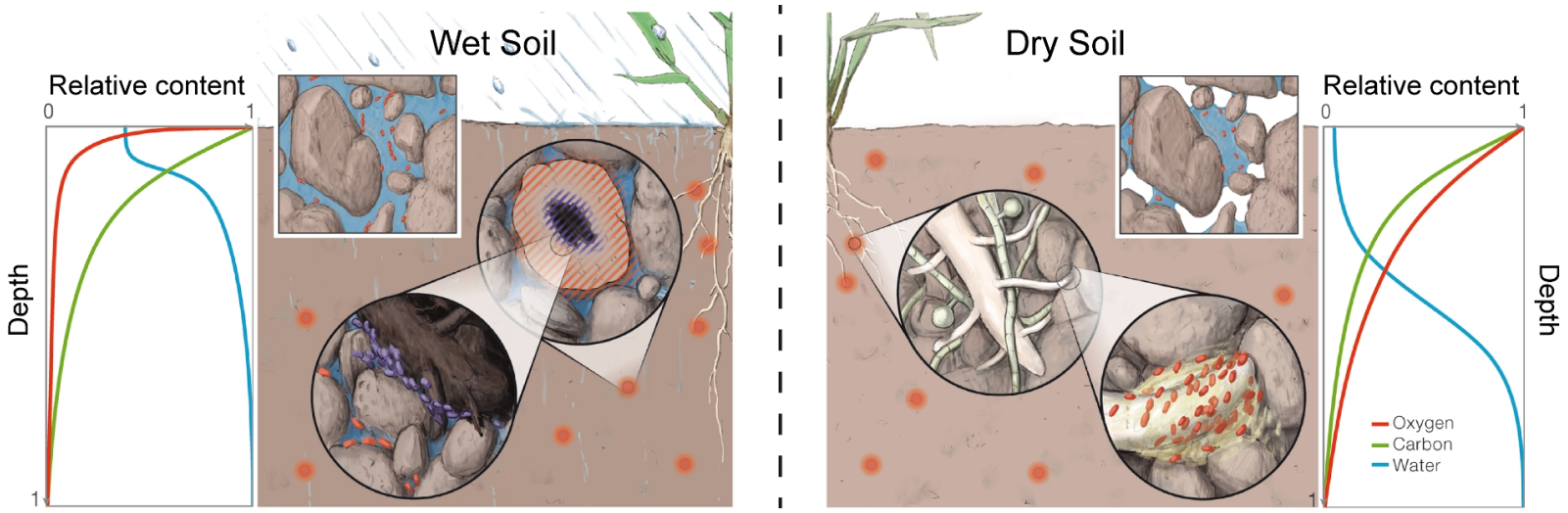
Barth F. Smets & Arnaud Dechesne – Technical University of Denmark - DK
Elena S. Crotti & Francesco Riva – University of Milan - IT

Dynamics of the Soil Resistome: Contribution of HGT

Presented at the Presidential Advisory Council on Combating Antibiotic-Resistant Bacteria Public Meeting, June 29-30, 2021

Soil: A 3-Dimensional Matrix with Microscale Features

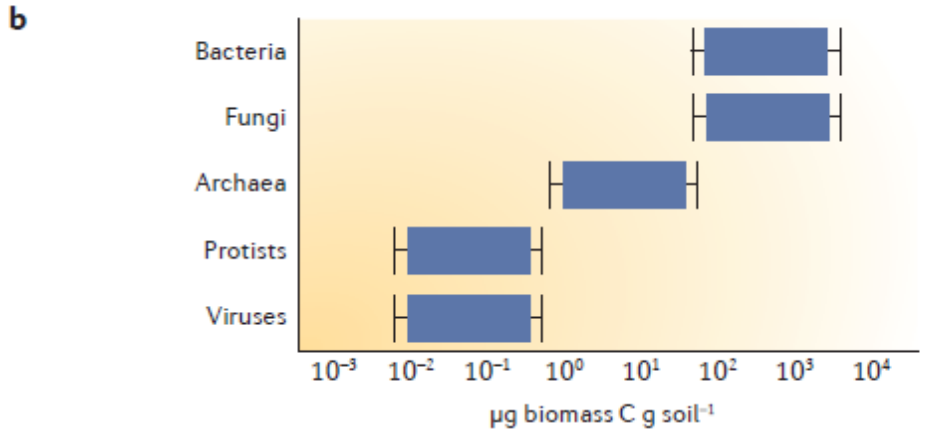


Tecon & Or. 2017 doi.org/10.1093/femsre/fux039

Spatial & temporal heterogeneity → hot spots of microbial activity!

Soil Microbiomes are Abundant!

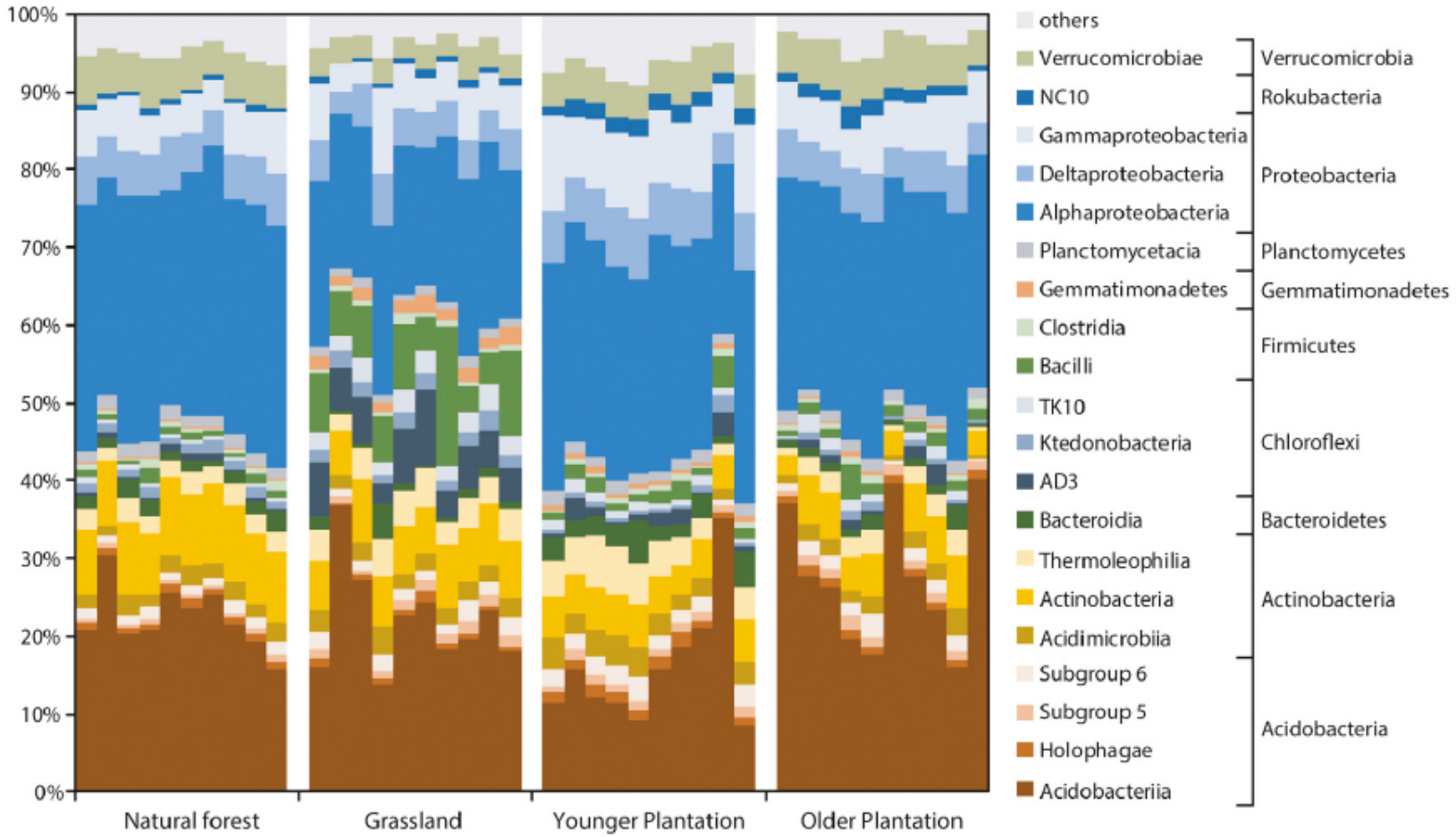
Global microbial biomass found in soil

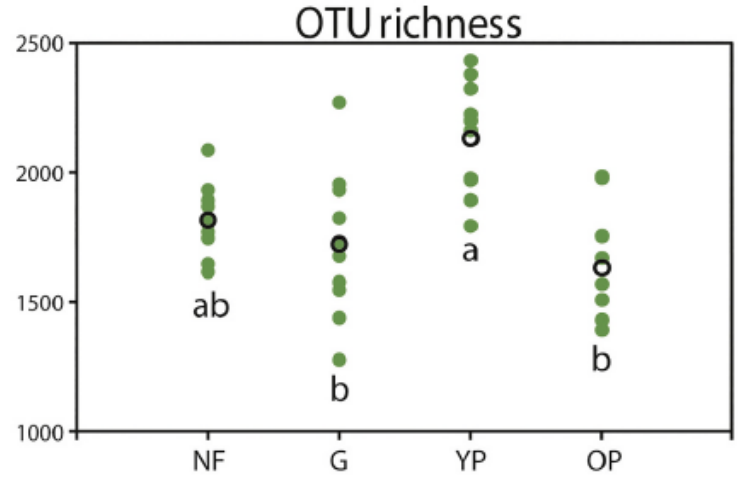


Fierer 2017 doi.org/10.1038/nrmicro.2017.87

10^{9}-10^{10} prokaryotic cells/g soil

Soil Microbiomes are Diverse

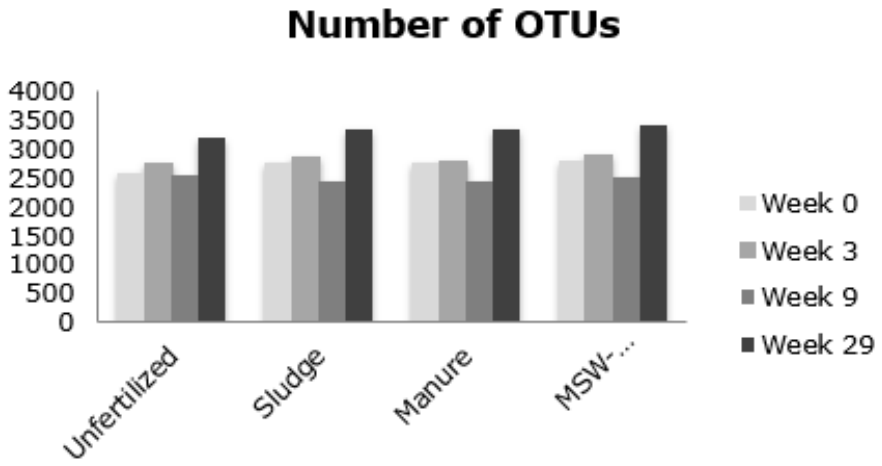


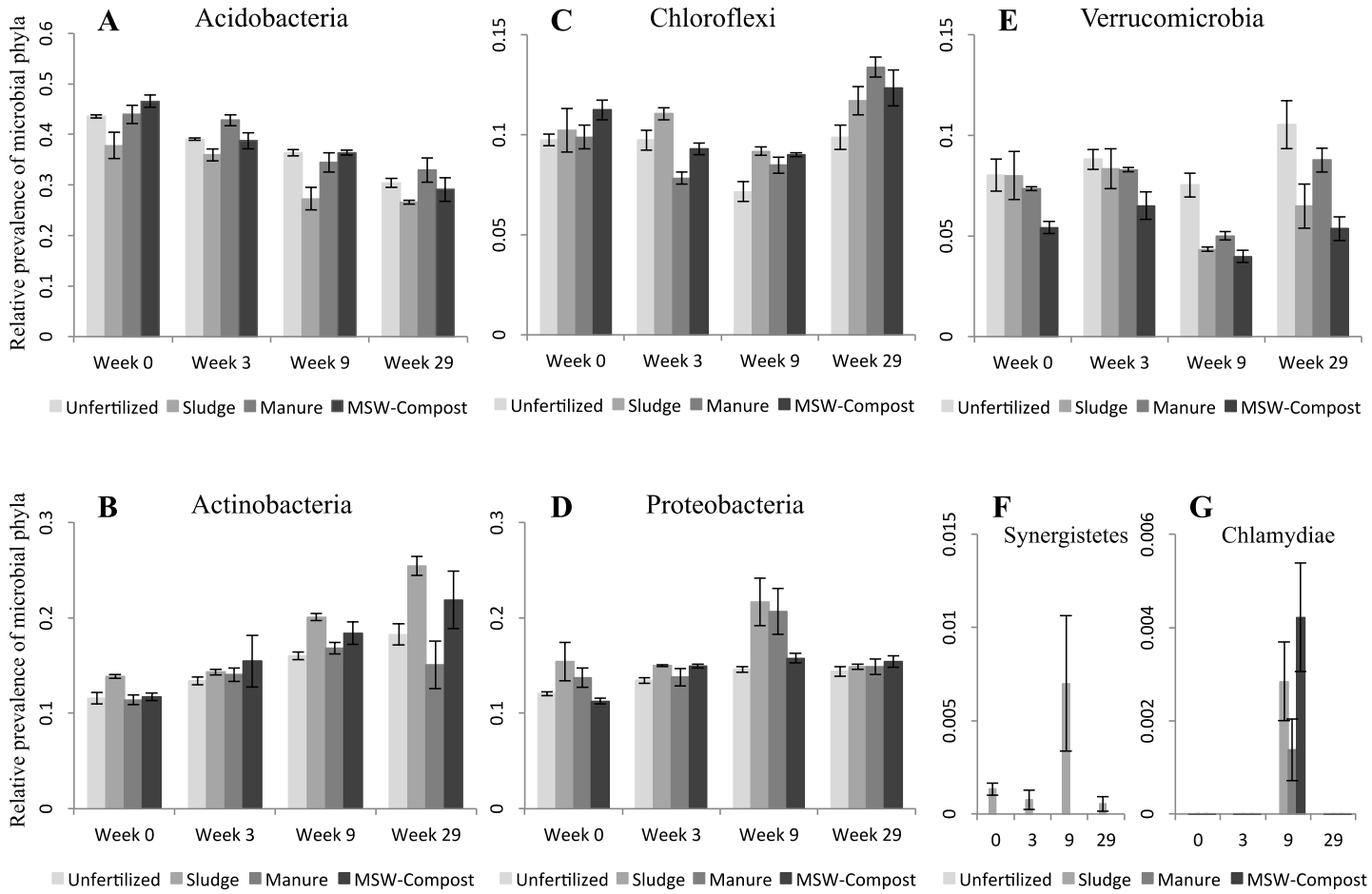


Chernov *et al*. 2021 doi.org/10.1016/j.apsoil.2021.103957

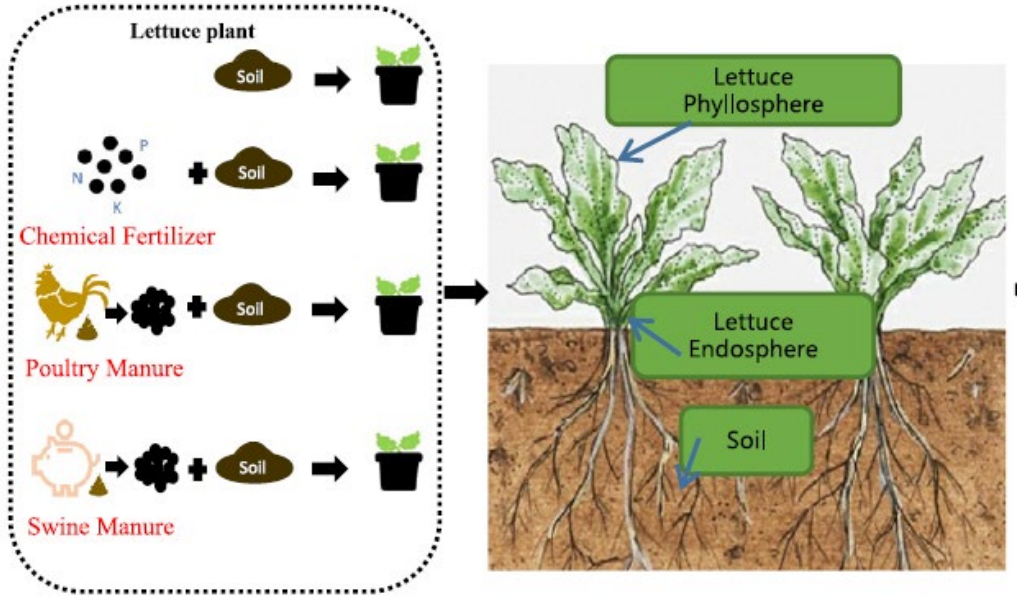
Soil Microbiomes are Seasonal yet Stable

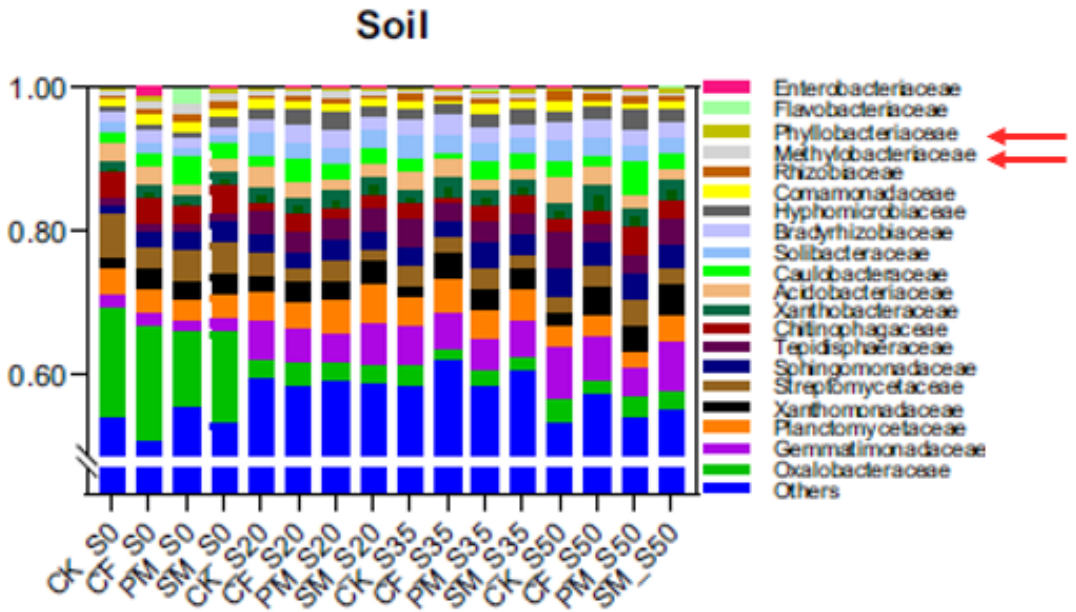
Riber *et al.* 2014 doi.org/10.1111/1574-6941.12403





Transient Response to Microbiome Additions

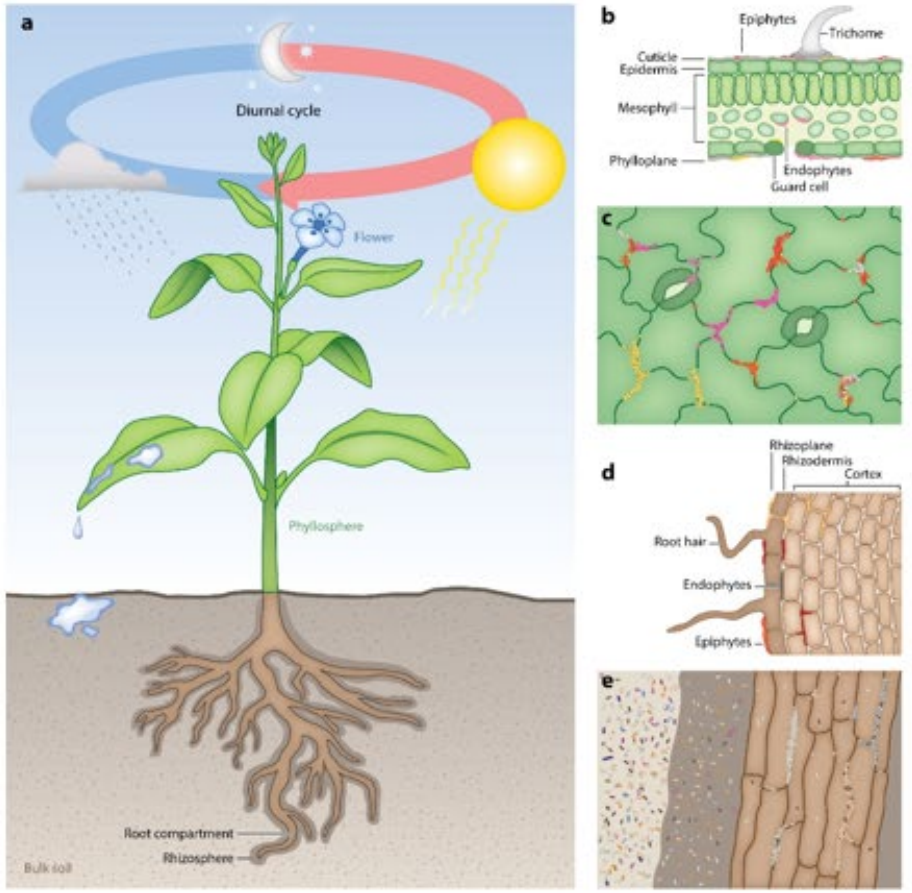




Bacterial community fractions (family level) in the soil following different treatments (no, chemical, manure) after 0, 25, 35, 50 days

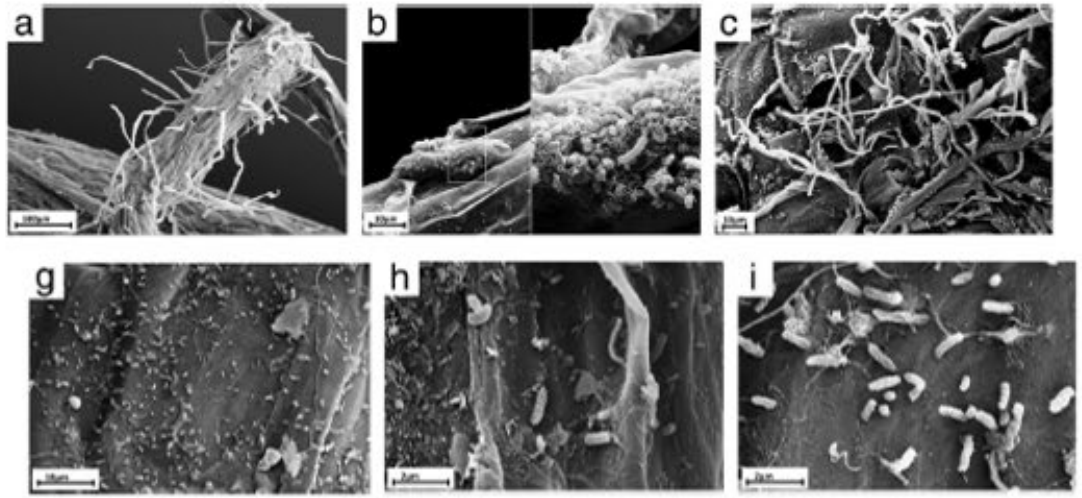
Huang *et al*. 2021 doi.org/10.1016/j.scitotenv.2021.147667

Plants in Soil: Different Compartments



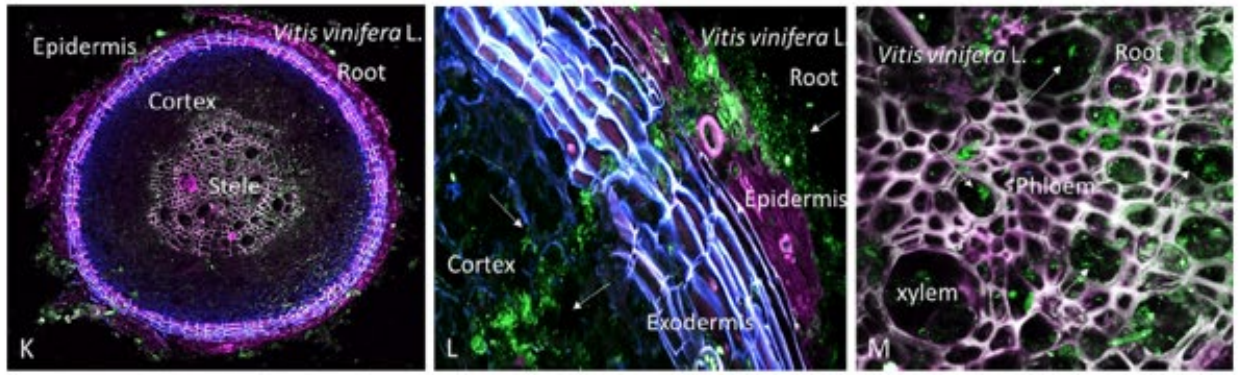
Müller DB, et al. 2016.
Annu. Rev. Genet. 50:211–34

E.g., **on** the roots of *Arabidopsis thaliana*



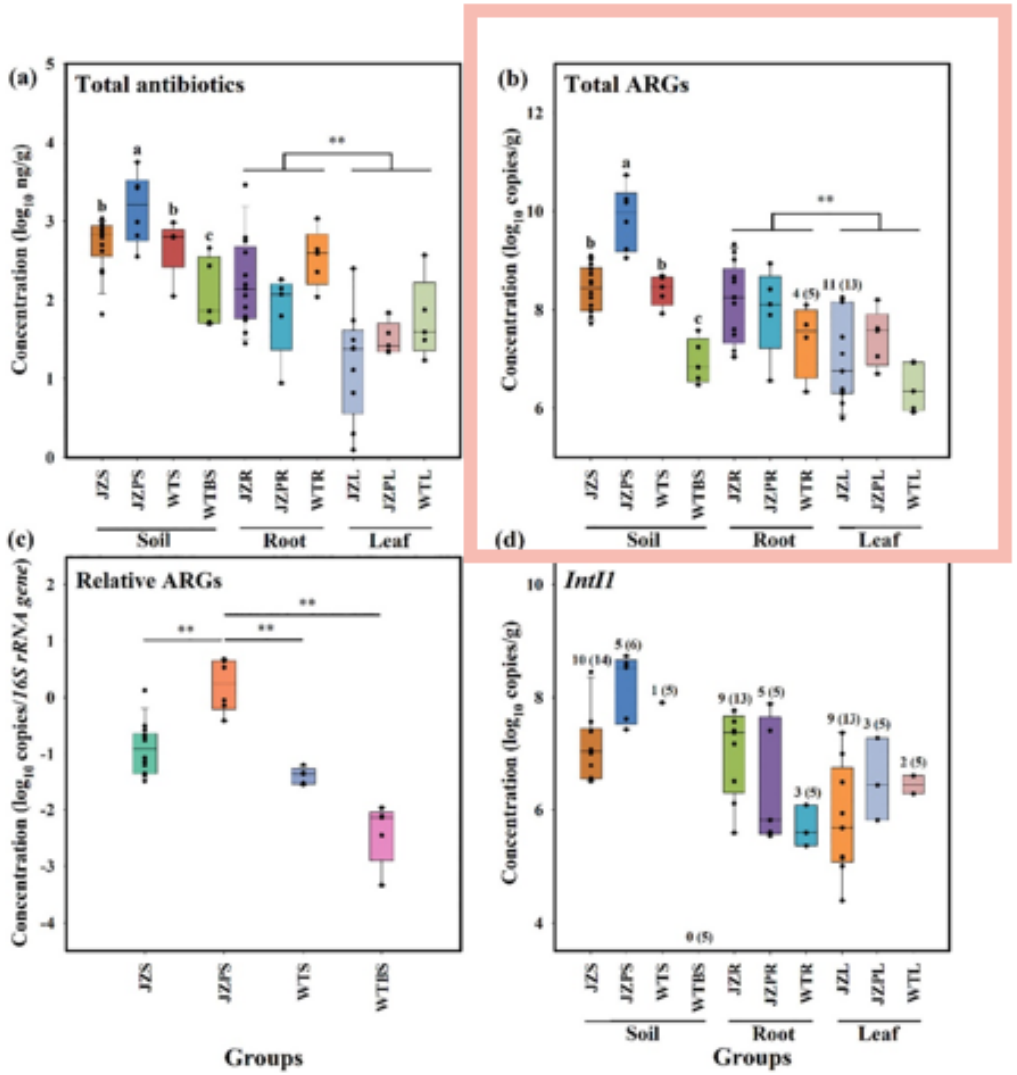
Hassani et al. 2018 doi.org/10.1186/s40168-018-0445-0

E.g., **in** the root of *Vitis vinifera*

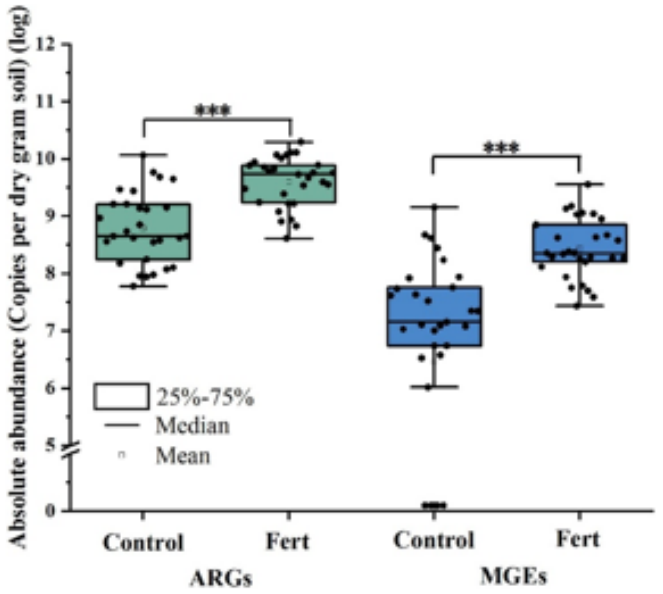


Compant et al. 2021 doi:10.1111/1462-2920.15240

Yet: Evidence of ARG accumulation in Soil/Microbiome with manure application

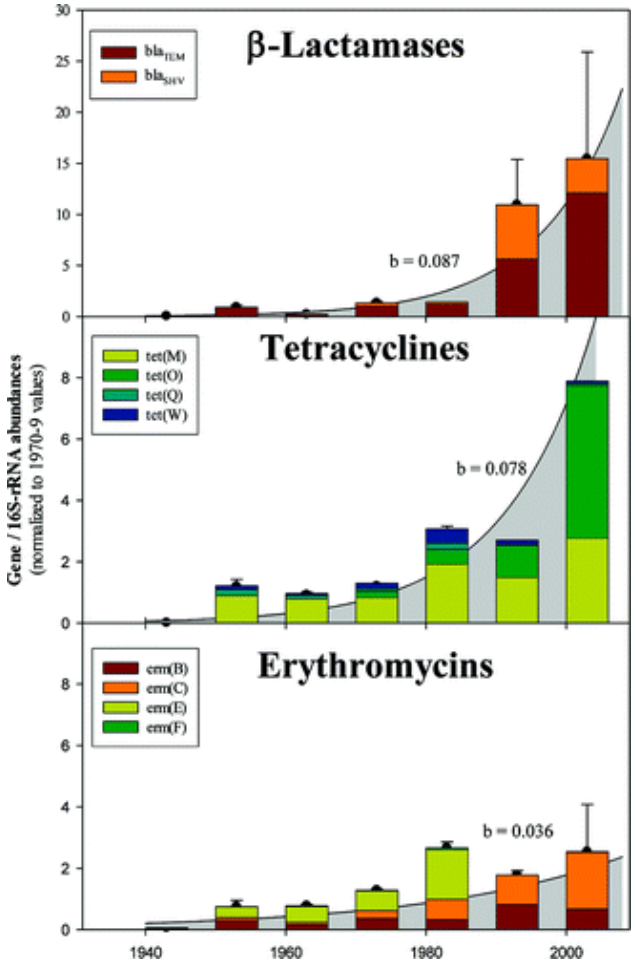


Gao et al. 2020, doi.org/10.1016/j.scitotenv.2020.140482



Pu et al. 2020 doi.org/10.1016/j.jhazmat.2020.122267

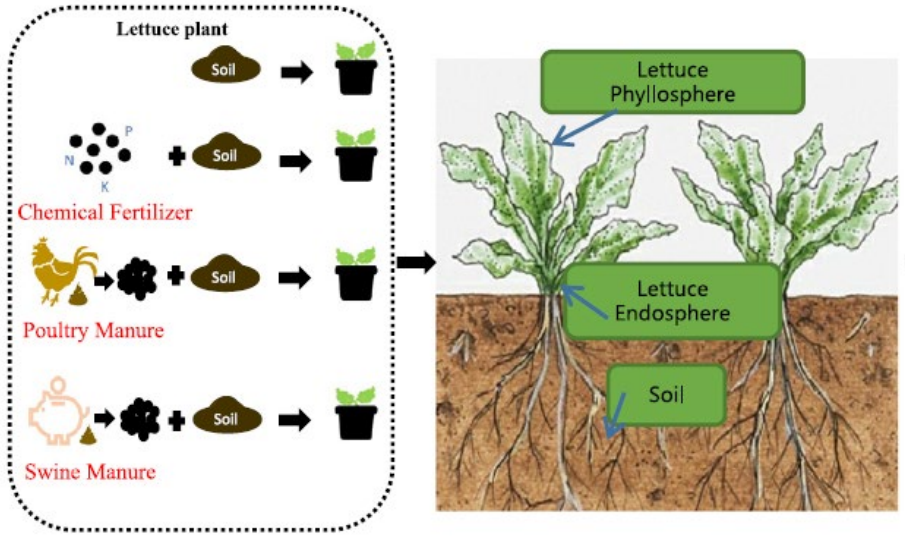
Caution: ARGs are endemic to soils!

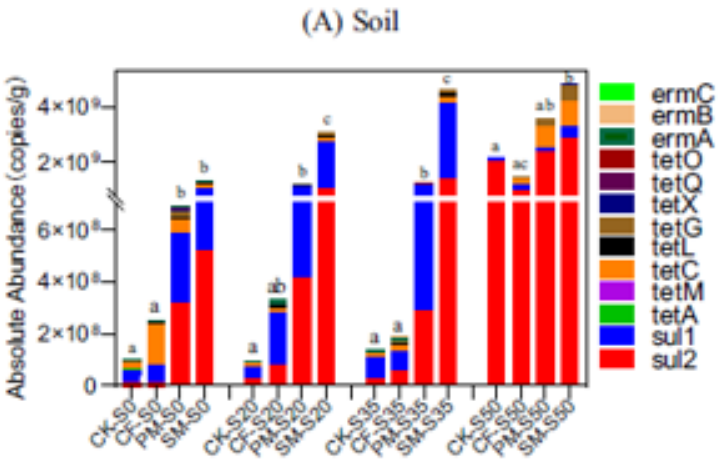


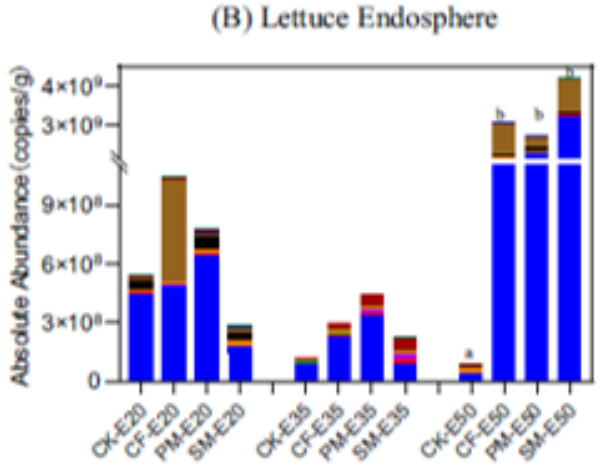
Knapp *et al.* 2010 doi.org/10.1021/es901221x

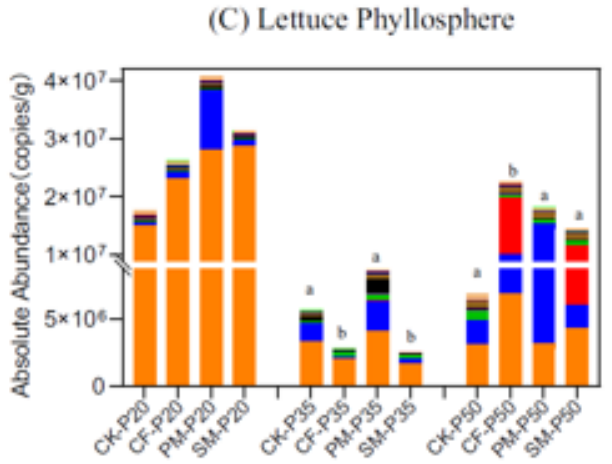
Need for t_0 or reference soils to make inference re. ARG increases!

Yet: Evidence of ARG accumulation in Plant/Microbiome





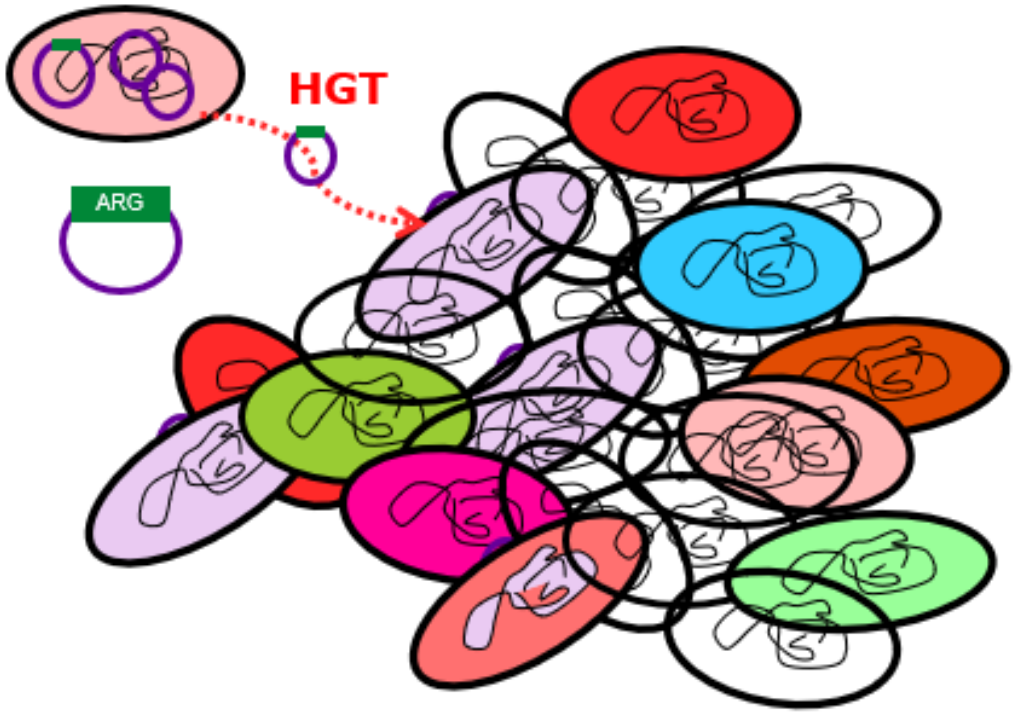




Huang *et al*. 2021 doi.org/10.1016/j.scitotenv.2021.147667

Reasons for persistence of ARGs?

- Survival of the original hosts ?
- Selection for the ARGs ?
- Dissemination of the ARGs ?



Horizontal dissemination of ARGs to Soil Microbiomes

Klumper *et al*. 2014 doi.org/10.1038/ismej.2014.191

Donor Strains:

E. coli

P. putida

***Kluyvera* sp.**

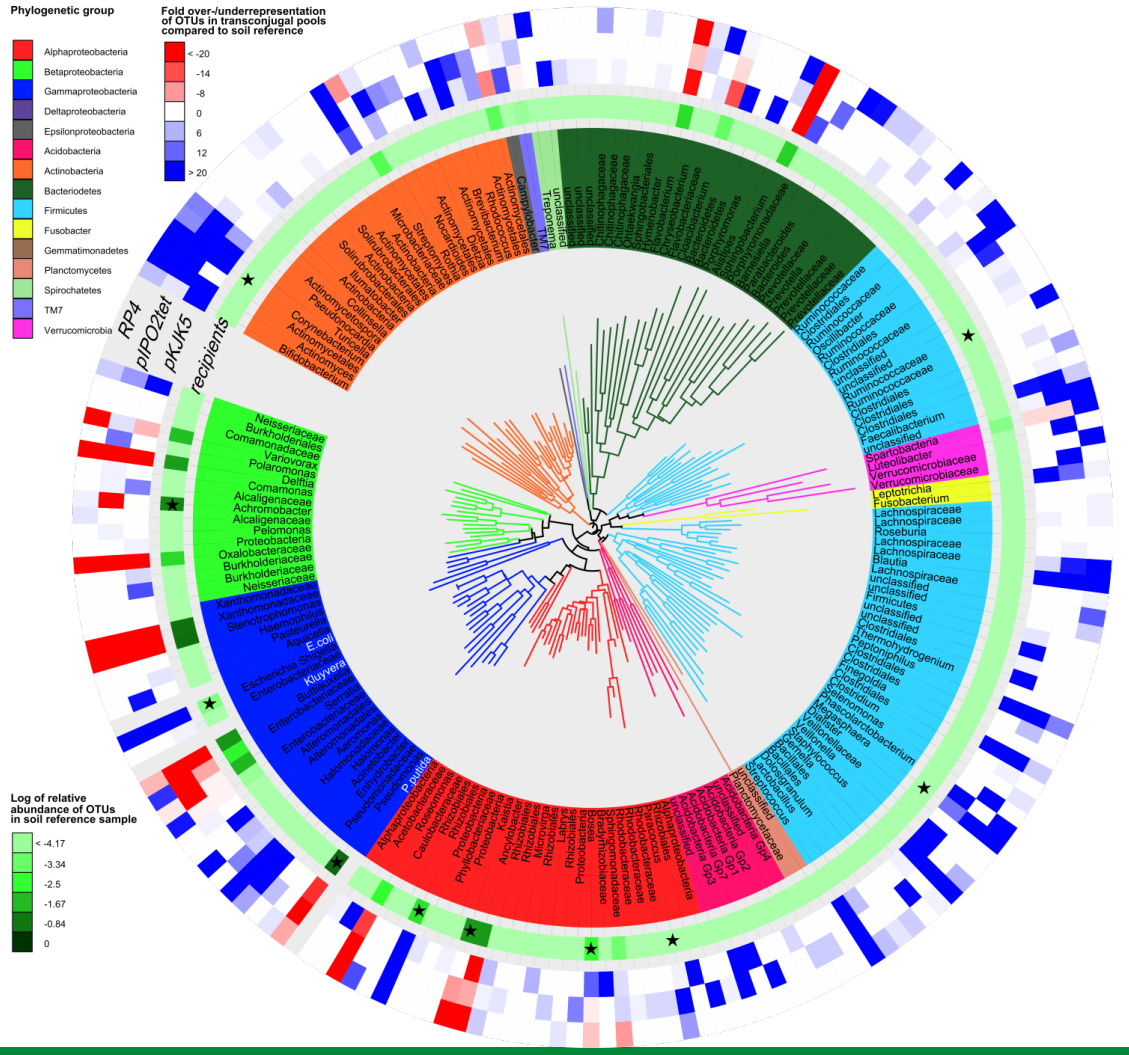
ARG Plasmids

RP4 (Kan, Amp, Tet)

pIPOtet (Tet)

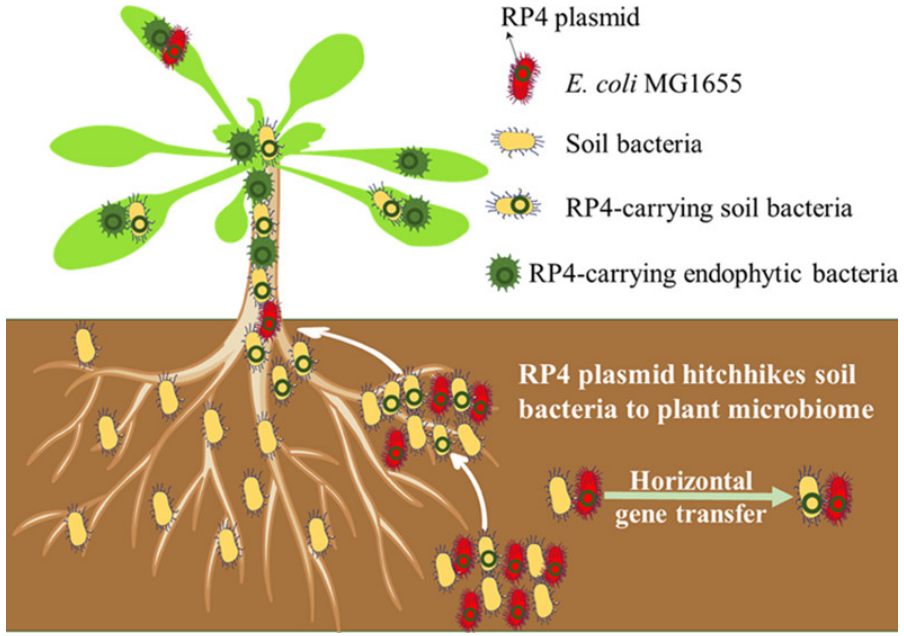
pKJK5 (Trim)

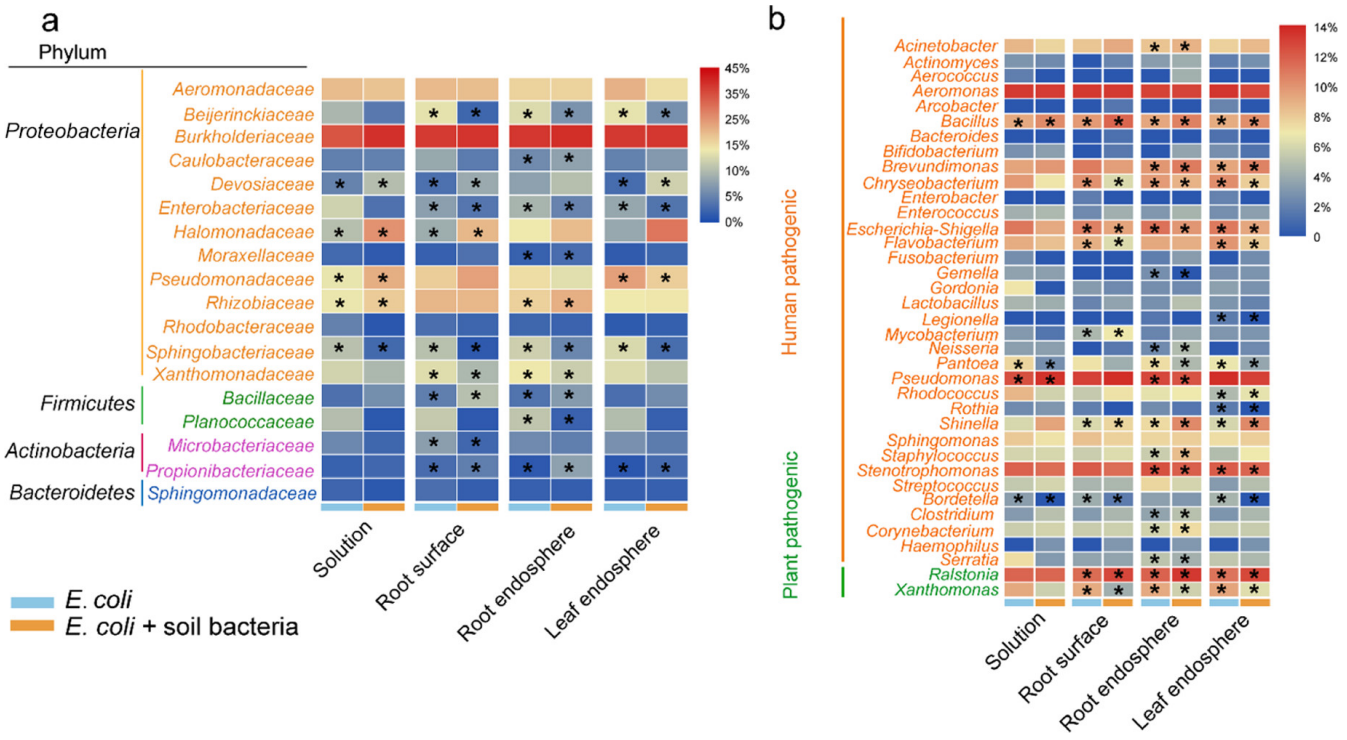
T/R ca. 1/10,000



Horizontal dissemination of ARGs – to Plant Endophytes

Xu *et al*. 2021 doi.org/10.1021/acs.est.1c01615





Proteobacteria (incl. Enterobacteriaceae) are typical members of the plant endosphere (Hardoim 2015 doi.org/10.1128/MMBR.00050-14

Cautionary Summary

- The soil microbiome is diverse, abundant, yet stable with seasonal dynamics.
- External microbiome additions → transient community-level, longer lasting ARG abundance responses in soil *and* plant microbiome.
- Horizontal transfer of ARGs from exogenous donors → to the soil microbiome → to plant endosphere microbiome is possible
- Precaution is warranted when applying ARG containing materials to agronomic soils.

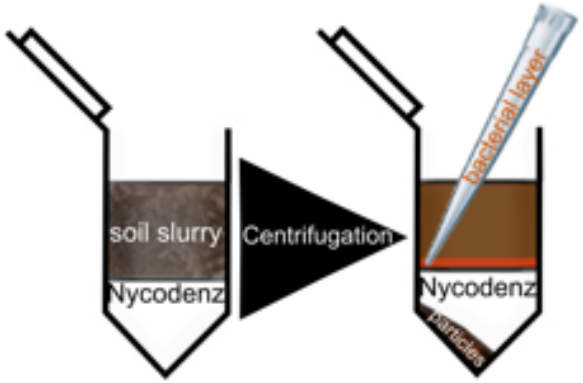
Acknowledgement & Contact Information

P-Transplant (EC–FP7)

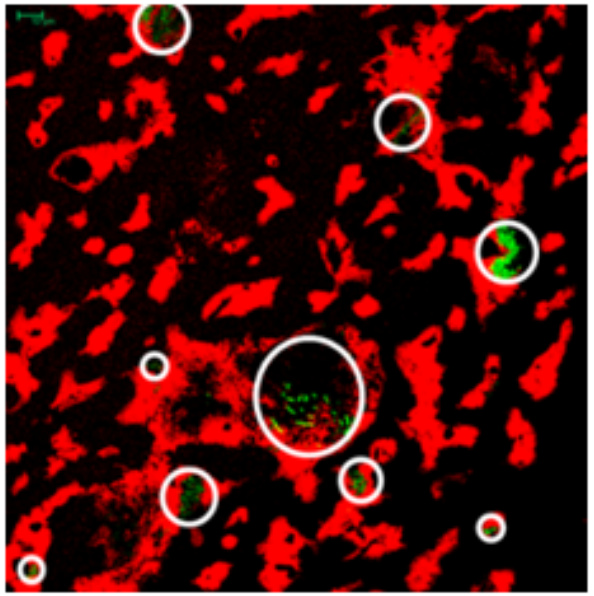
@metlab_dtu
bfsm@env.dtu.dk

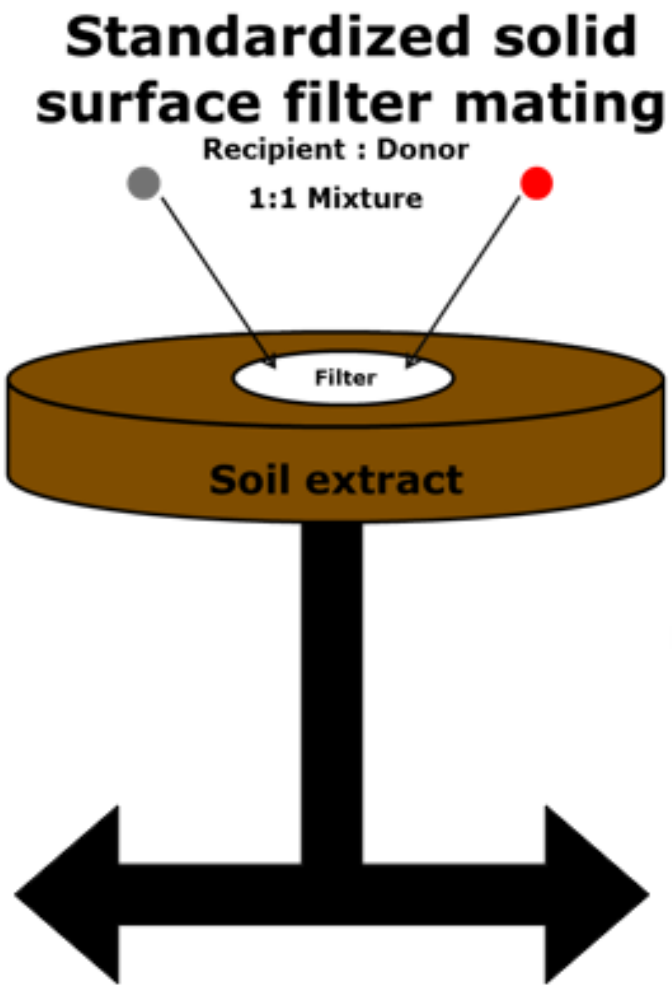
With FACS: high throughput *isolation* of transconjugants

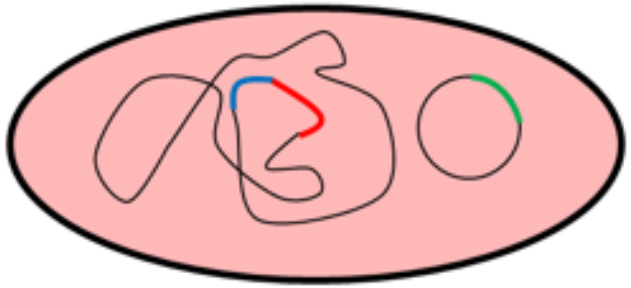
Klumper *et al*. 2014 doi.org/10.1038/ismej.2014.191



Fluorescent Microscopy: to Quantify Transfer Events







Donor/Plasmid
Transconjugants