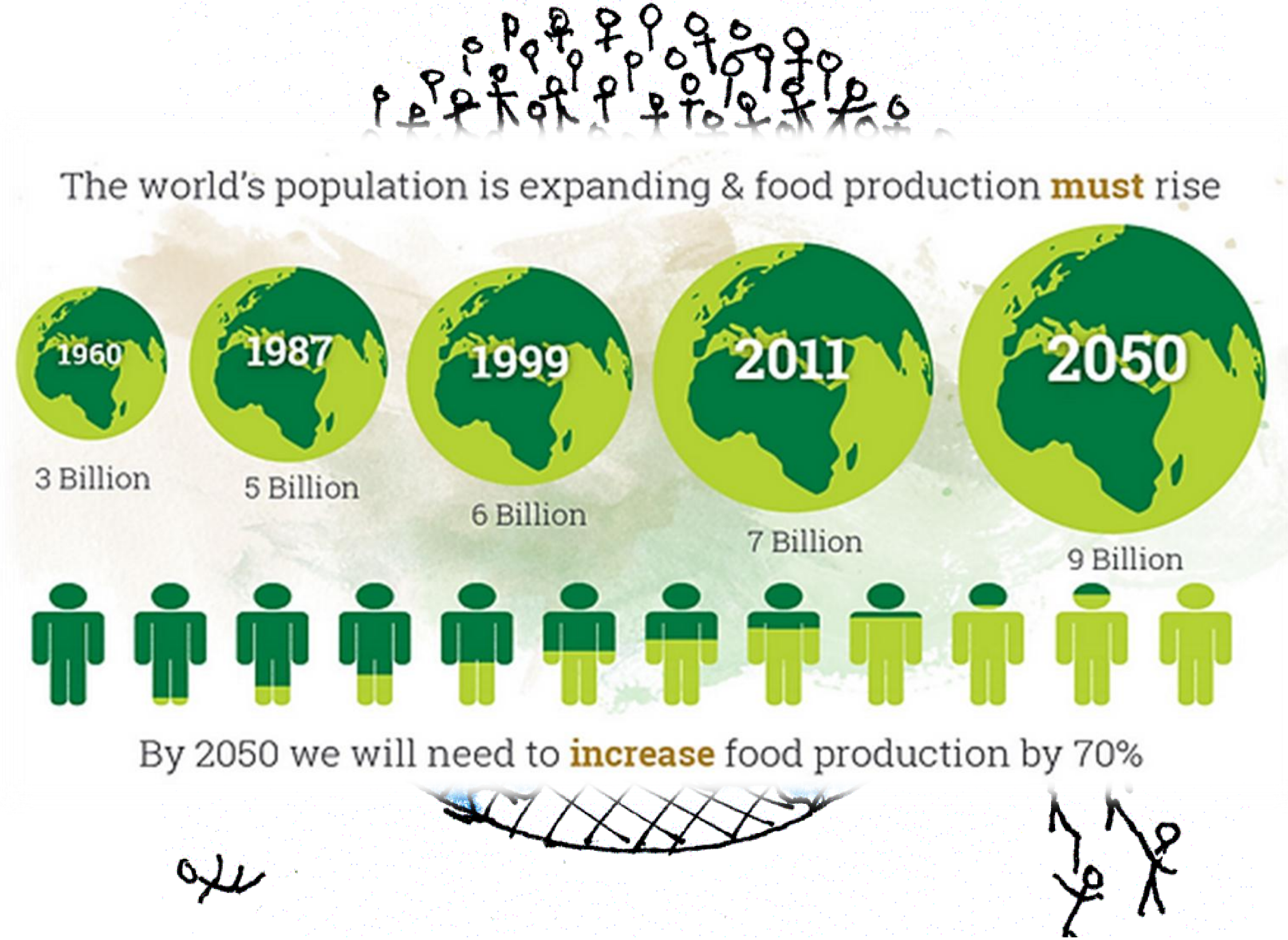
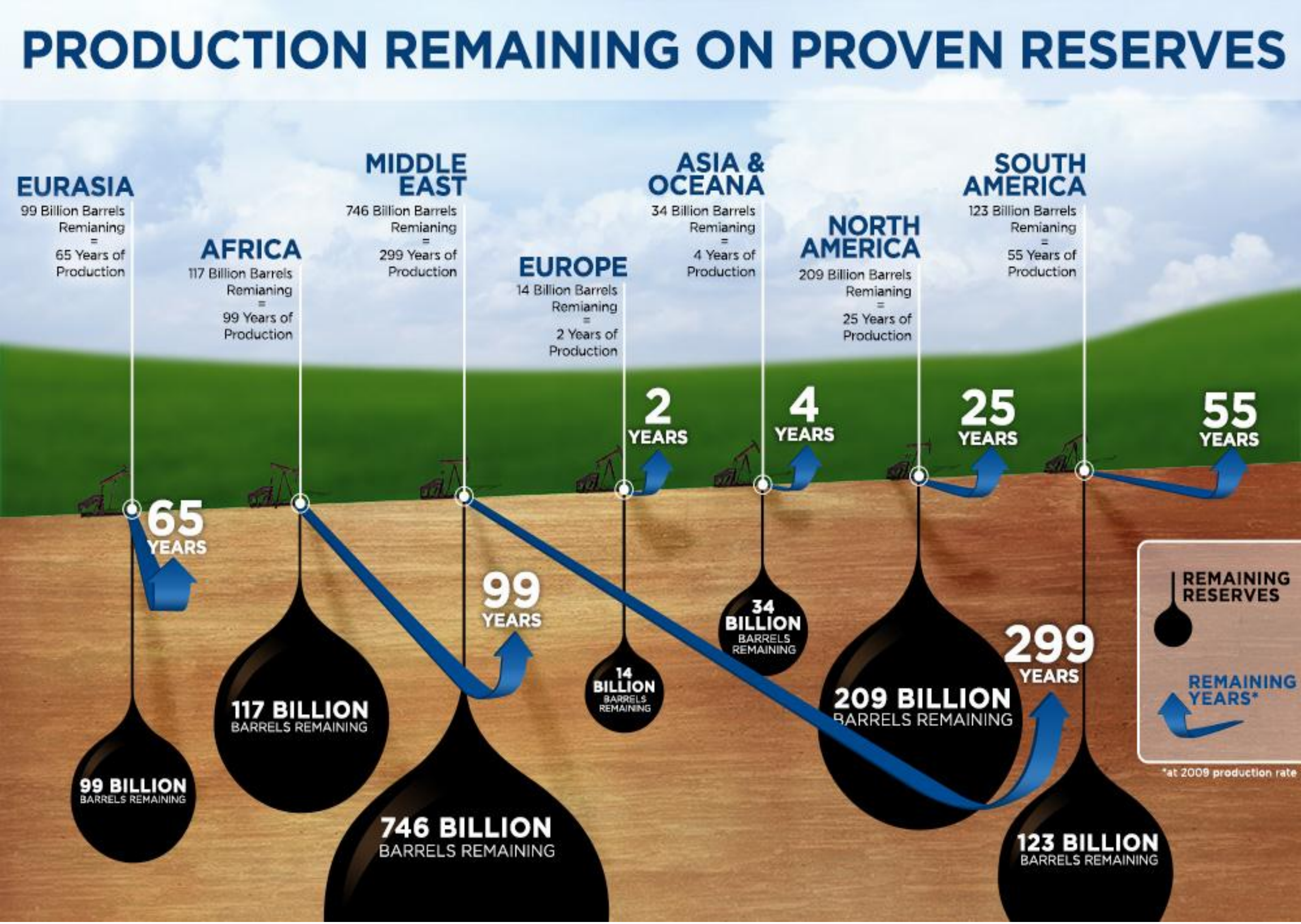
Does your soil have what it takes?

Adriana Navarro Borrell Ph.D.

Agriculture Sciences Program

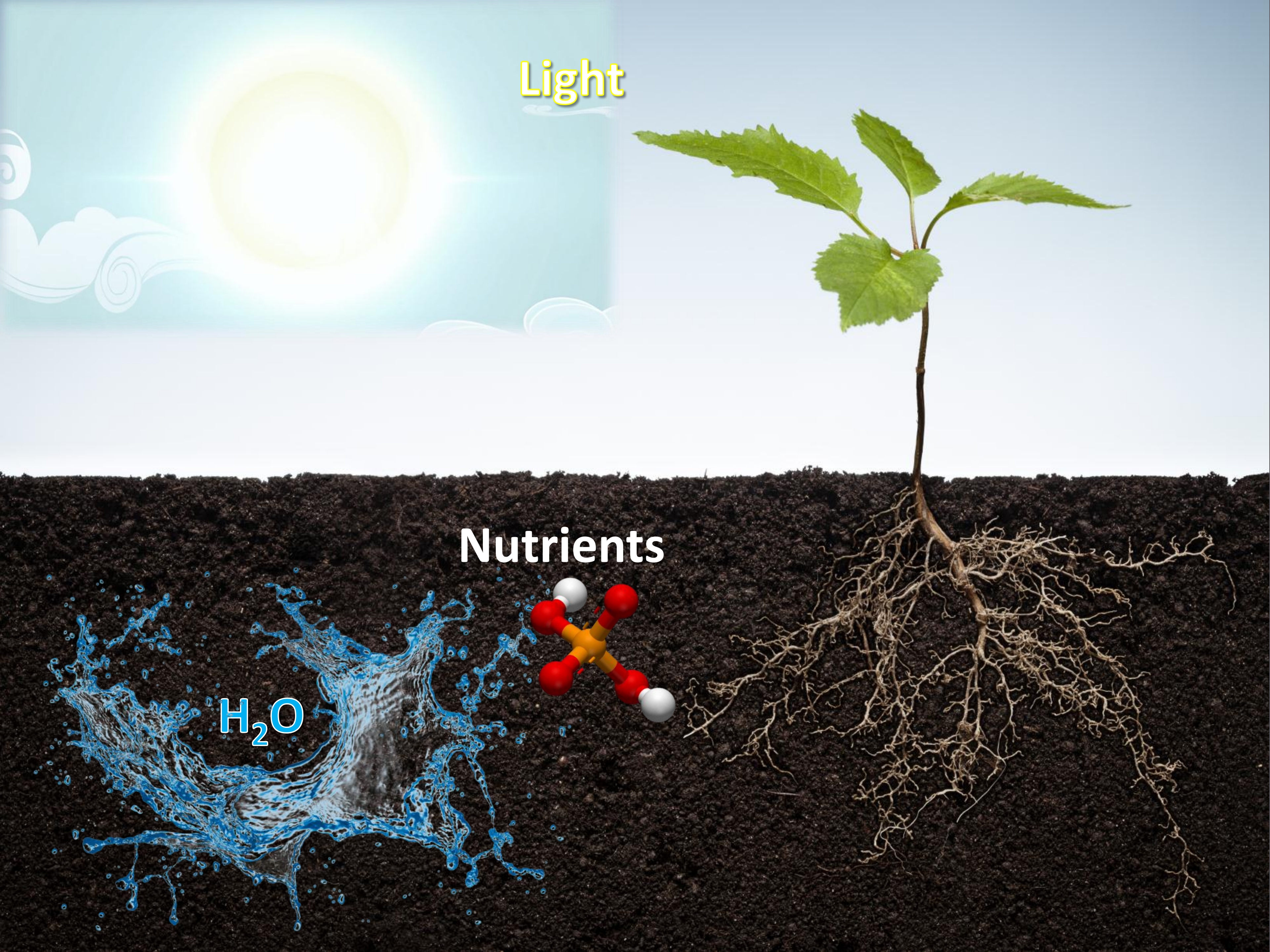


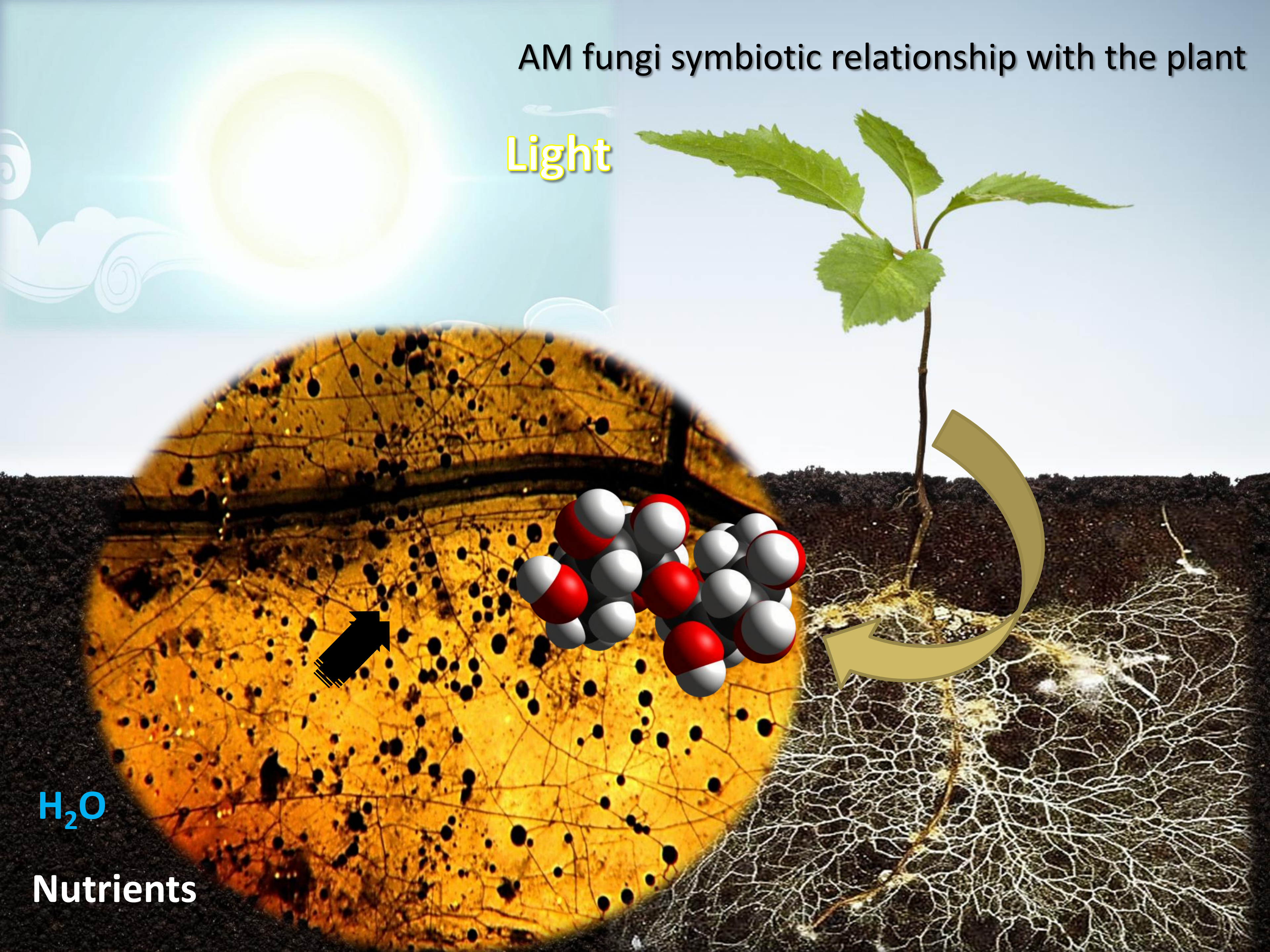
The world's population is expanding & food production must rise
1960
3 Billion
1987
5 Billion
1999
6 Billion
2011
7 Billion
2050
9 Billion
By 2050 we will need to increase food production by 70%

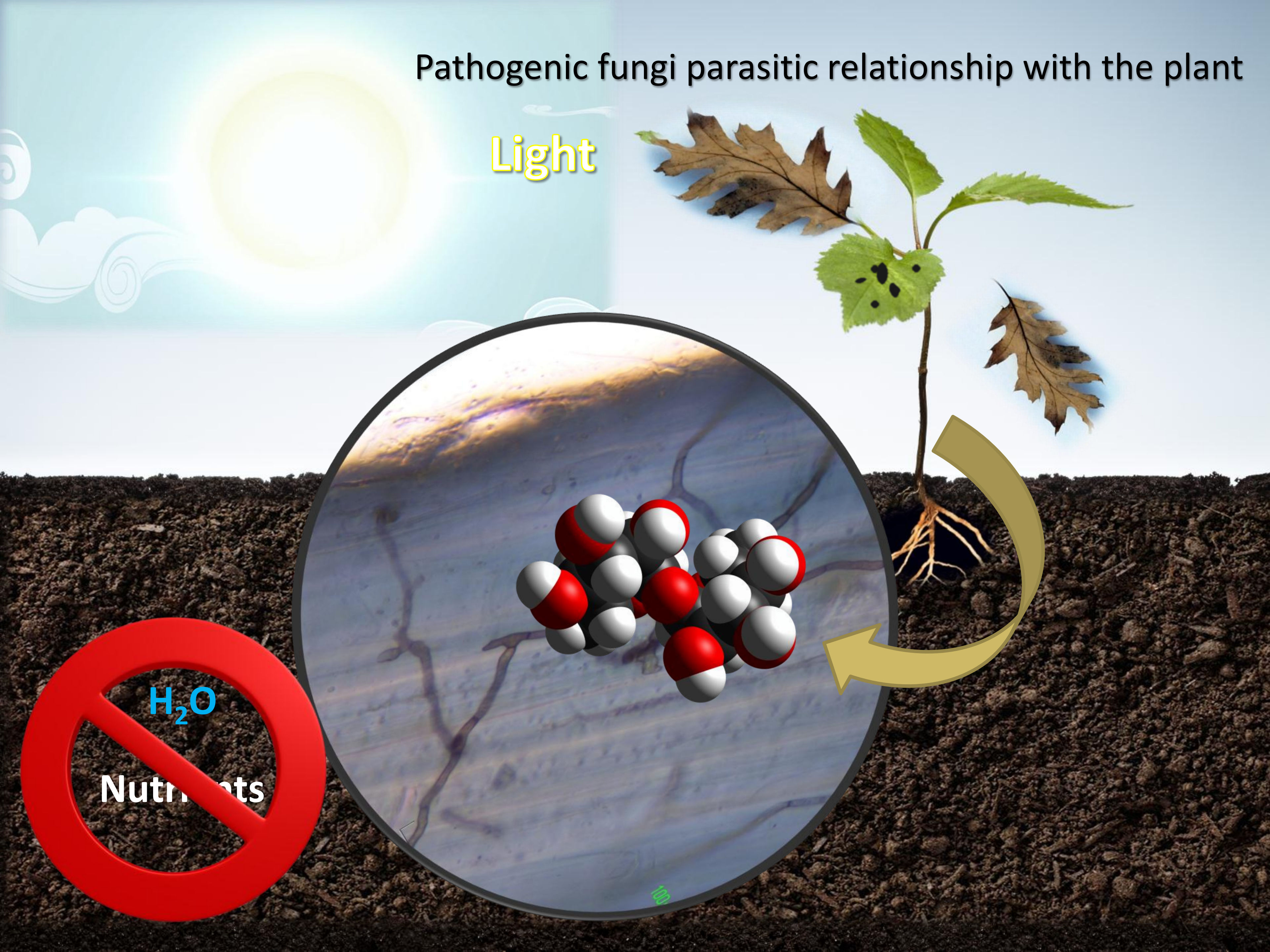


World Oil Reserves Infographic. .Photograph: Seismic Micro Technology (SMT)

As global change dictates the need for more efficient cropping systems, the management of beneficial fungi offers many opportunities.


Light
Nutrients
H_2O


AM fungi symbiotic relationship with the plant
Light
H_2O
Nutrients


Pathogenic fungi parasitic relationship with the plant
Light
H_2O
Nutr nts

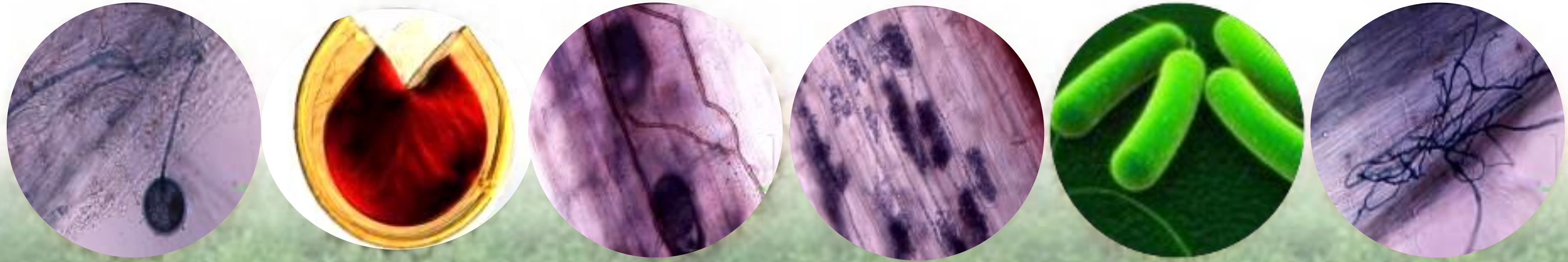
Crop rotation: sustainable agriculture

- Reduces weeds and herbicide requirements
- Increases yields
- Reduces the incidence of diseases
- Diversifies the microbial community

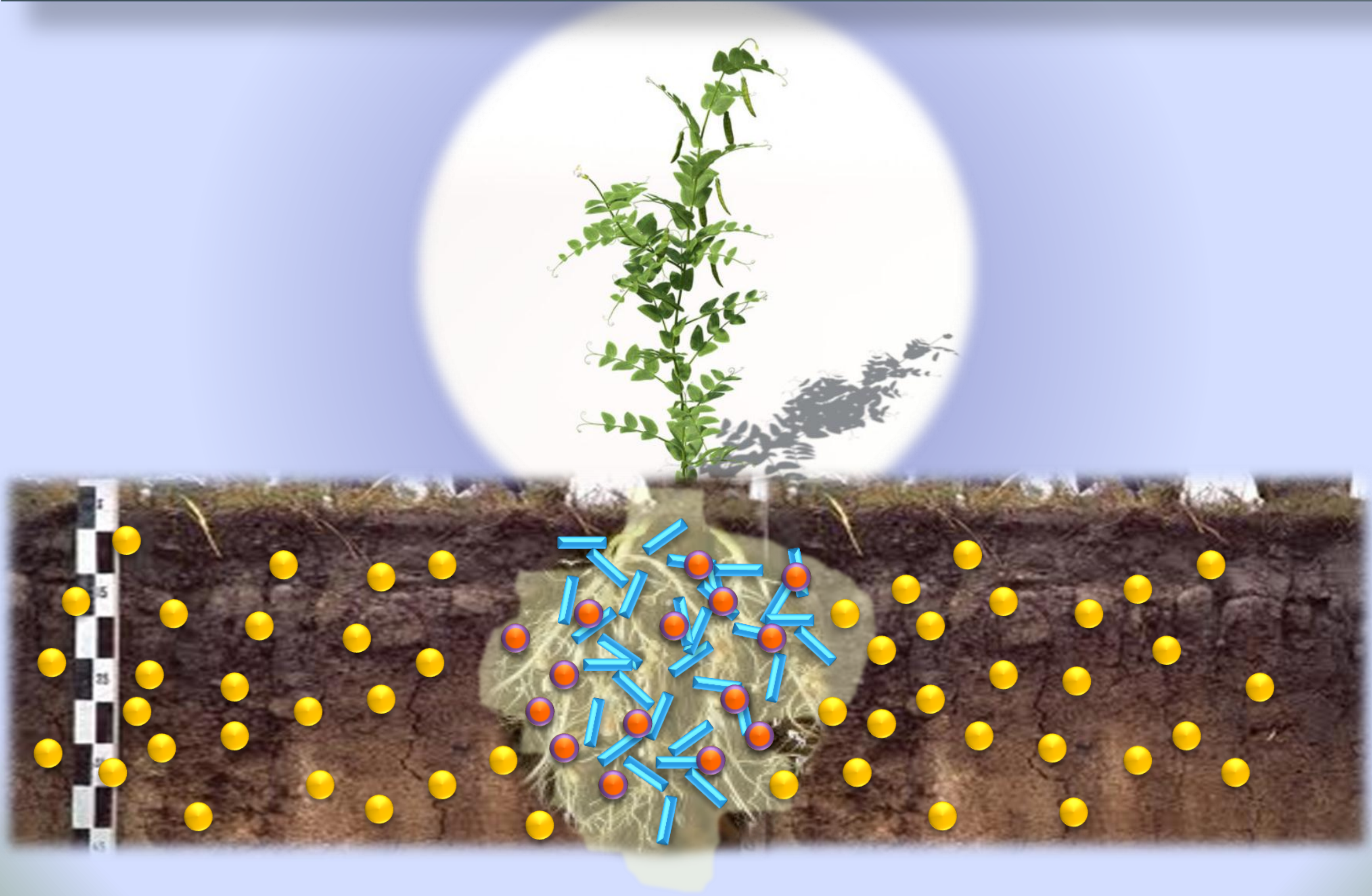
PULSE crops help to reduce summer fallow and fertilizer requirements

How do changes in sequence impact crop performance at a system level?

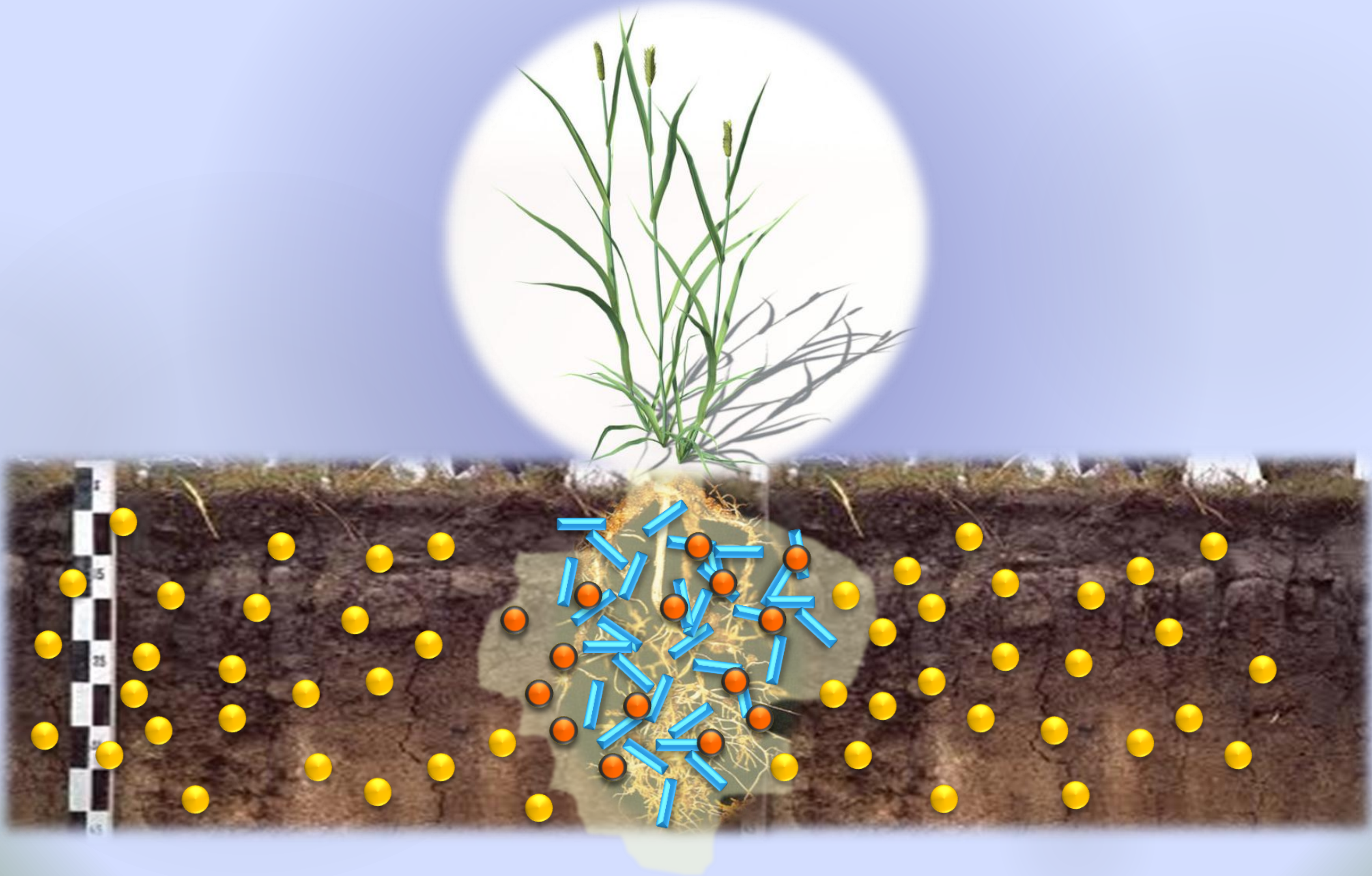
How this may affect microbial diversity?



The hypothesis:



The hypothesis:



CDC Meadow Yellow Field pea
Pisum sativum L.

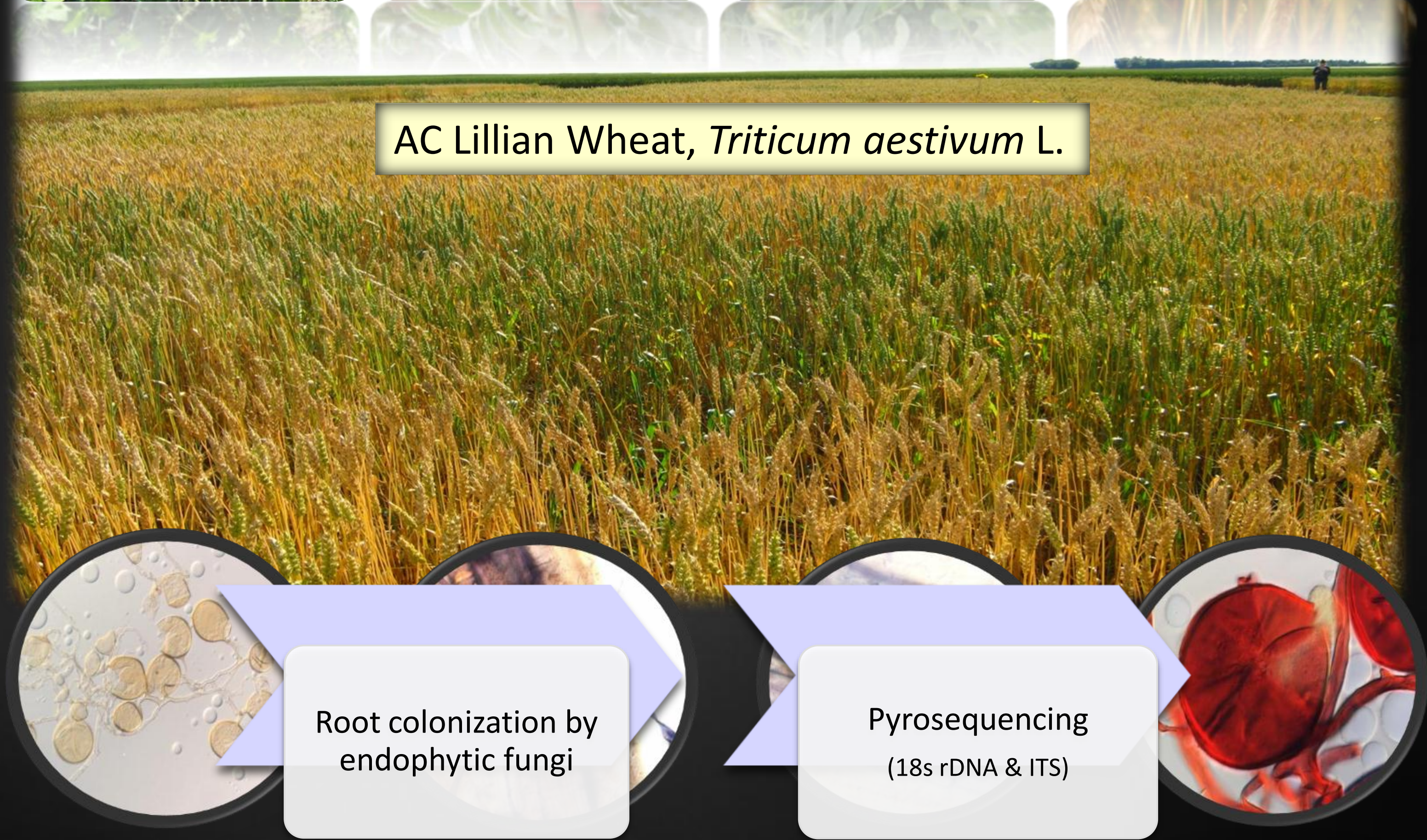
CDC Frontier Chickpea
Cicer arietinum L.

CDC Maxim CL Red Lentil
Lens culinaris L.

AC Lillian Wheat
Triticum aestivum L.

Phase I

Phase II

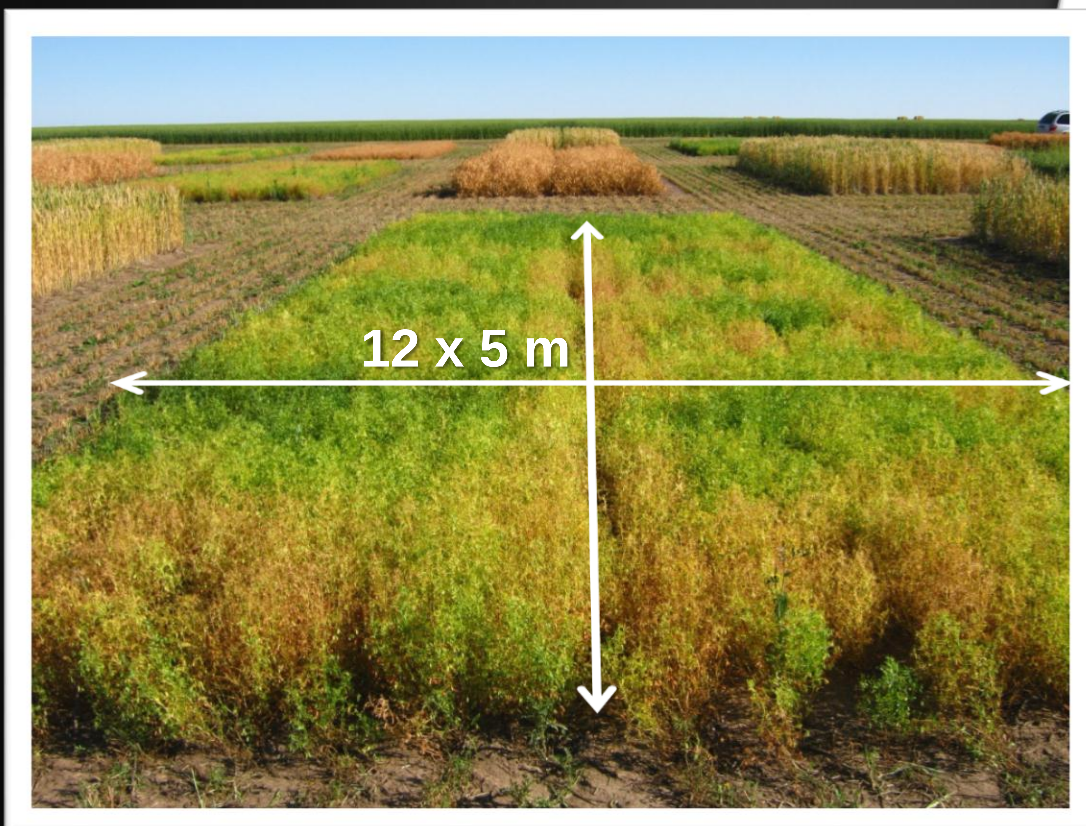


Field sites description
South Farm in SPARC/AAFC, Swift Current, SK

(latitude: 50°17'N; longitude: 107°41'W, elevation 825 m)

Conventional management
No tillage
Orthic Brown Chernozem soil
Silt loam texture
pH = 6.5

The top 0-15 cm layer of the soil contained 9 kg ha^{-1} mineral N, 36 kg ha^{-1} Olsen P, 326 kg ha^{-1} available K, and 53 kg ha^{-1} available S.



MAR-MAY

- Soil nutrient and water content analysis
- Seeding
- Fertilizer & pesticide applications

JUL

- Rizosphere soil and root sampling
- Root colonization
- Root fungal DNA analysis

AUG

- Agronomic data collection
- Disease/pest incidence evaluation
- Pesticide applications

SEPT-OCT

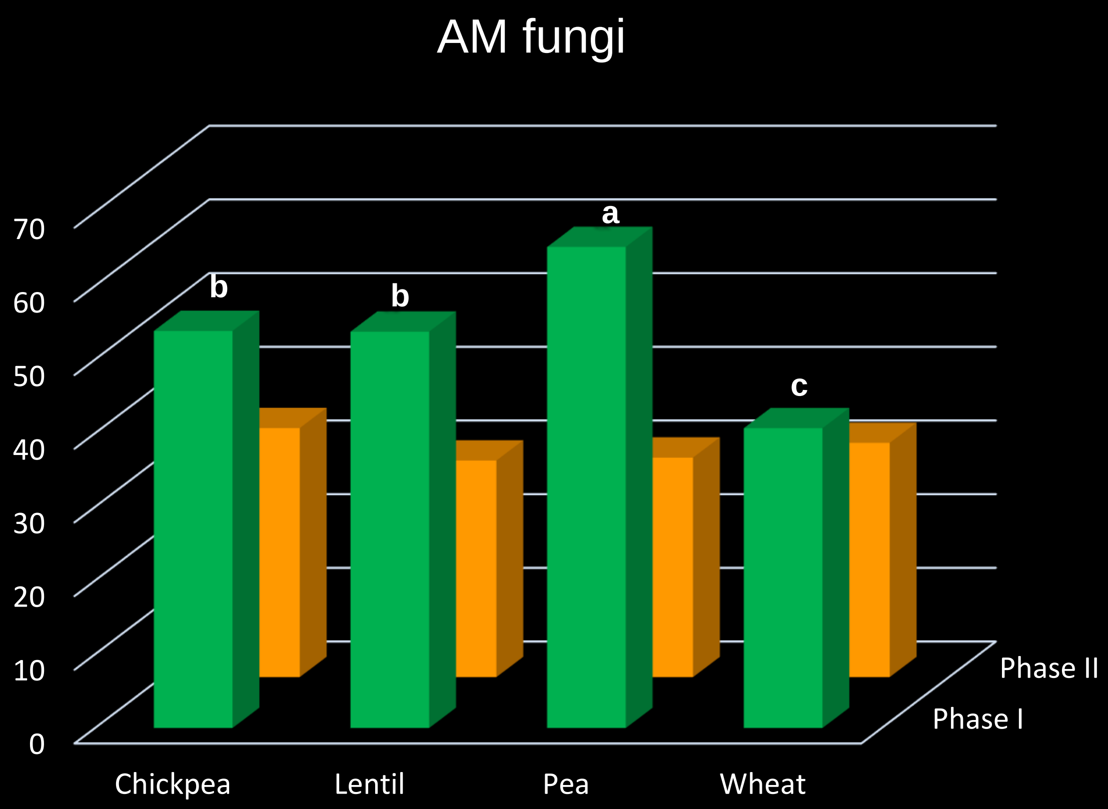
- Agronomic data collection
- Harvest
- Soil sampling
- Soil DNA analysis

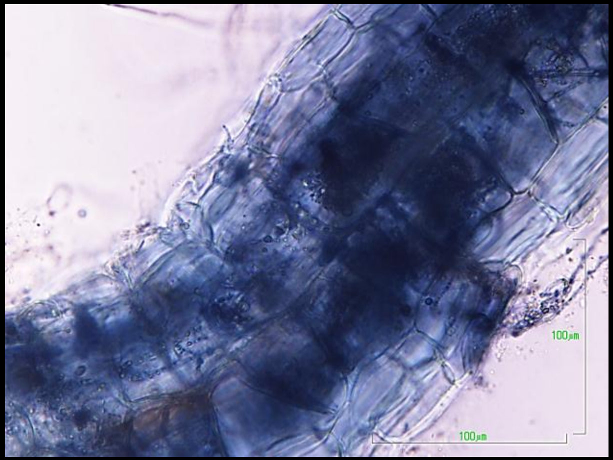
Productivity of wheat in phase II

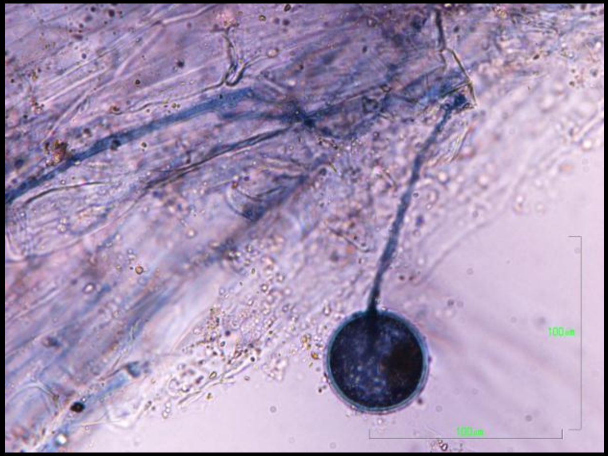
Crops rotations	Plant density (plant m^{-2})	Mature plant biomass (g m^{-2})	Yield (kg ha^{-1})	Seeds $plant^{-1}$	Wheat heads (heads m^{-2})	Seed N (mg g^{-1})
Chickpea-Wheat	128 **a**	677 **ab**	2706 **a**	65.3 **b**	347 **bc**	24.5 **a**
Lentil-Wheat	103 **b**	749 **a**	2707 **a**	88.6 **a**	422 **a**	21.9 **b**
Pea-Wheat	94 **b**	726 **a**	2615 **a**	92.2 **a**	394 **ab**	22.0 **b**
Wheat-Wheat	105 **b**	573 **b**	2121 **b**	70.0 **b**	317 **c**	22.0 **b**
***p* value**	***0.0092***	***00127***	***0.0004***	***0.0097***	***0.0028***	***0.0331***

Wheat monoculture was the less productive system

Level of root colonization by AM fungi
Phases I & II

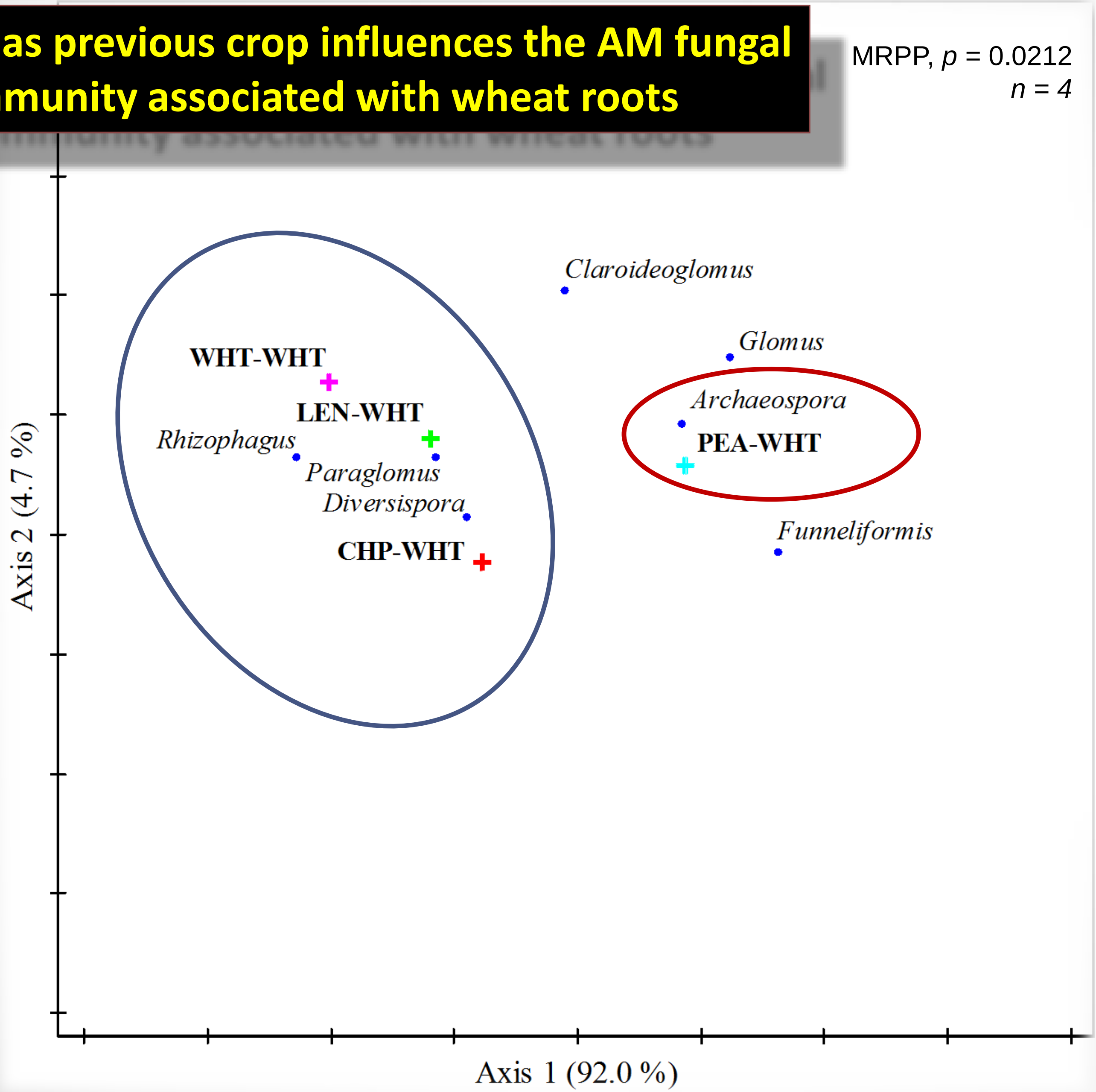




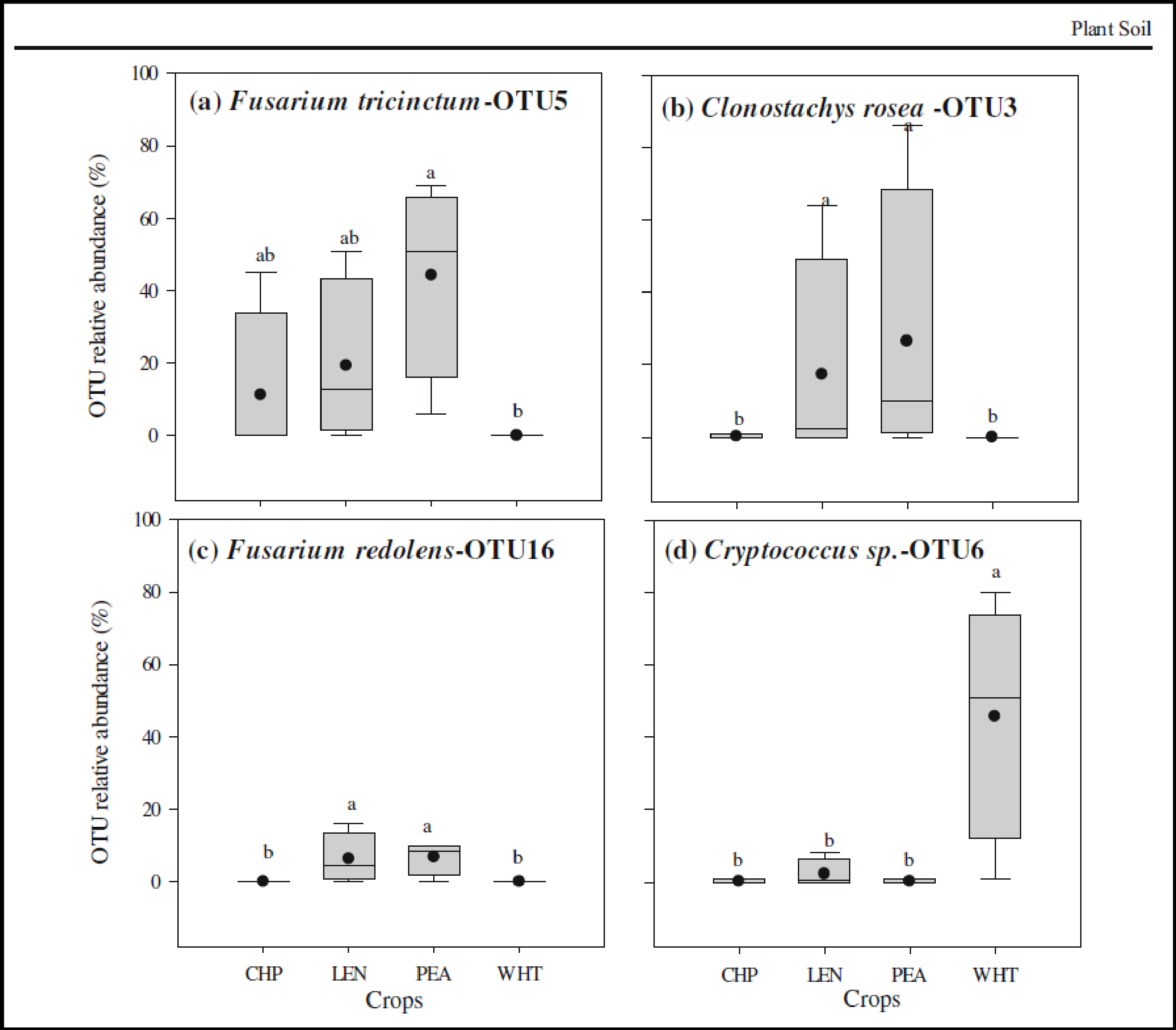


Pulses had higher levels of AM root colonization than wheat in phase I

Pea as previous crop influences the AM fungal community associated with wheat roots



Relative abundance of fungi in the roots of crops

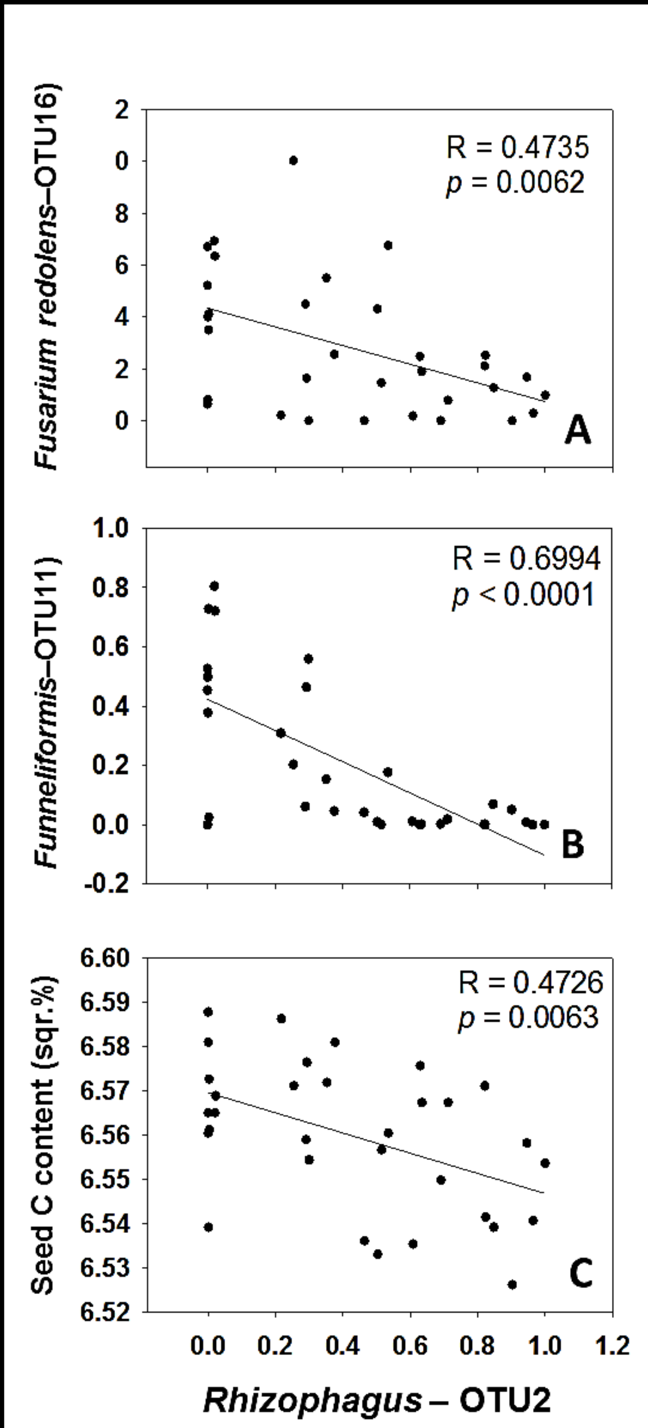


Borrell *et al*., 2016

Relationship between fungi, wheat productivity and soil properties

Table 7 Significant ($\alpha = 0.05$) Spearman correlations among the agronomic data, soil N and water availability in spring, and the relative abundance of AM and general fungal genera in roots and soil of phase II wheat ($N = 32$)[†]

Roots	Plant density	Plant biomass	Harvest index	yield	soil mineral N	soil water
Claroideoglomus	-0.13	0.11	-0.02	0.1	0.46*	-0.17
Diversispora	-0.39*	-0.07	0.04	-0.23	0.15	-0.31
Funneliformis	-0.42*	-0.05	-0.37*	-0.12	-0.24	-0.05
Paraglomus	0.25	-0.12	0.39*	-0.02	-0.44*	0.4*
Rhizophagus	0.39*	-0.08	0.47**	0.1	0.07	0.29
Periconia macrospinosa (OTU1)	0.59***	0.05	0.36*	0.18	-0.06	0.47**
Microdochium bolleyi (OTU2)	0.62***	0.2	0.35	0.36	-0.13	0.63***
Fusarium redolens (OTU16)	-0.38*	-0.27	-0.45*	-0.29	0.14	-0.52**
Thielaviopsis basicola (OTU38)	0.57***	0.23	0.52*	0.22	0.04	0.69***



Relationship between fungal OTUs in phase II

Possible antagonism between fungal phylotypes?

F. redolens shows its pathogenic nature

Take home message

- ✓ The identity of the crops shapes the root-associated fungal community, with a significant distinction between pulses and wheat.
- ✓ Pea may influence the structure of AM fungal community associated with the roots of the subsequent wheat crop.
- ✓ *Fusarium redolens* could be a risk to wheat production and the risk is greater in rotations with lentil and pea than chickpea.
- ✓ *Rhizophagus* could be playing a protective role by antagonizing with *Fusarium redolens* in wheat roots.
- ✓ The changes in fungal communities induced by crop rotation or environmental factors such as water availability could influence wheat productivity.

Reference

Plant Soil
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CrossMark

REGULAR ARTICLE

Fungal diversity associated with pulses and its influence on the subsequent wheat crop in the Canadian prairies

A. Navarro Borrell · Y. Shi · Y. Gan · L. D. Bainard · J. J. Germida · C. Hamel

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Abstract
Background and aims Variations in root-associated fungal communities contribute to the so-called 'crop rotation benefit' on soil productivity. We assessed the effects of chickpea, lentil, and pea in wheat-based rotations, as roots and rhizosphere soil in a field experiment and agronomic data were collected.
Results Pulses influenced only the structure of the non-mycorrhizal fungal community of roots. *Fusarium tricinctum*, *Clonostachys rosea*, *Fusarium redolens*,

THANK YOU!

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Saskatchewan Pulse Growers

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