Improving Soil Health; Potential Impact on Yield

Dr Simon Bowen

Soil Biology and Soil Health Partnership

Research and Knowledge Exchange

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What will the partnership do?

- Five years to deliver linked knowledge exchange and research on soil biology and soil health
- Improve on-farm understanding of soil health by sharing current academic and industry knowledge in usable formats
- Developing and validating indicators of soil biology and soil health in research trials and on-farm
- Building on work already carried out

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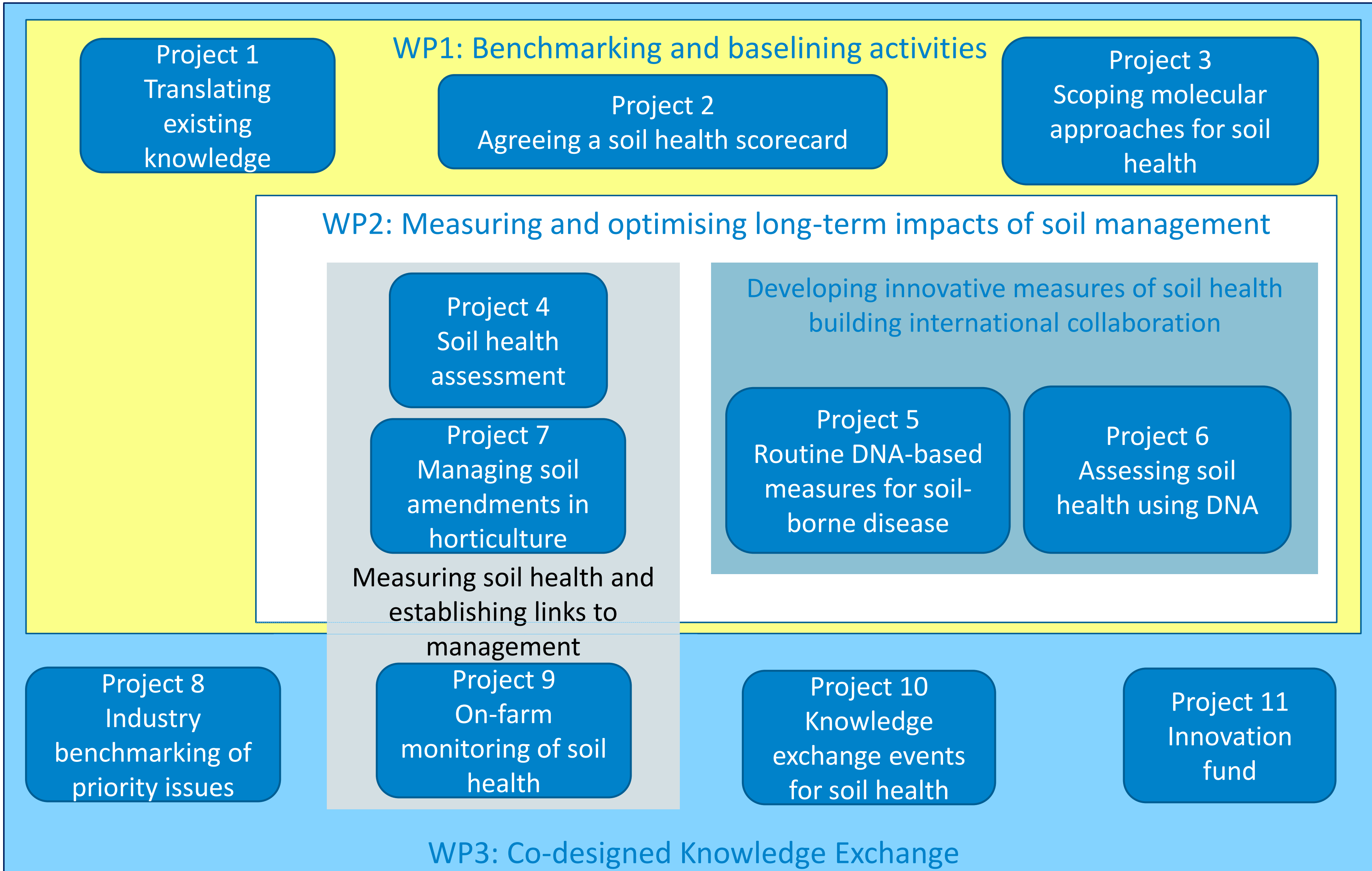

WP1: Benchmarking and baselining activities
Project 1 Translating existing knowledge
Project 2 Agreeing a soil health scorecard
Project 3 Scoping molecular approaches for soil health
WP2: Measuring and optimising long-term impacts of soil management
Project 4 Soil health assessment
Project 7 Managing soil amendments in horticulture
Measuring soil health and establishing links to management
Developing innovative measures of soil health building international collaboration
Project 5 Routine DNA-based measures for soil-borne disease
Project 6 Assessing soil health using DNA
Project 8 Industry benchmarking of priority issues
Project 9 On-farm monitoring of soil health
Project 10 Knowledge exchange events for soil health
Project 11 Innovation fund
WP3: Co-designed Knowledge Exchange

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All Year 1 work complete and reported

- Literature review
- Industry consultation

www.ahdb.org.uk/greatsoils
or
https://cereals.ahdb.org.uk/shp

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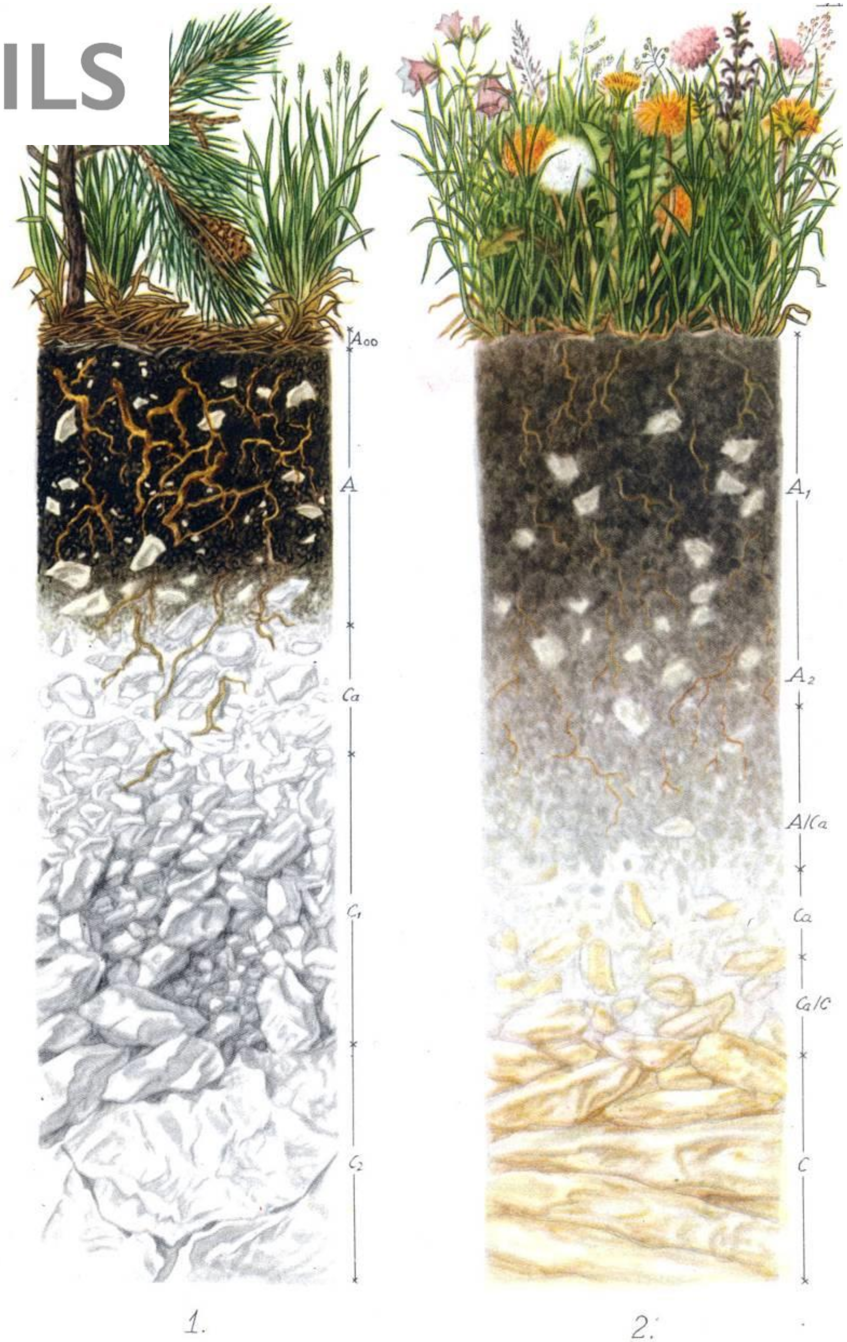
All land is unique

May have similar constraints

But not the same field by field or even within a field



Soil type sets inherent limits to physical properties

Management modifies properties

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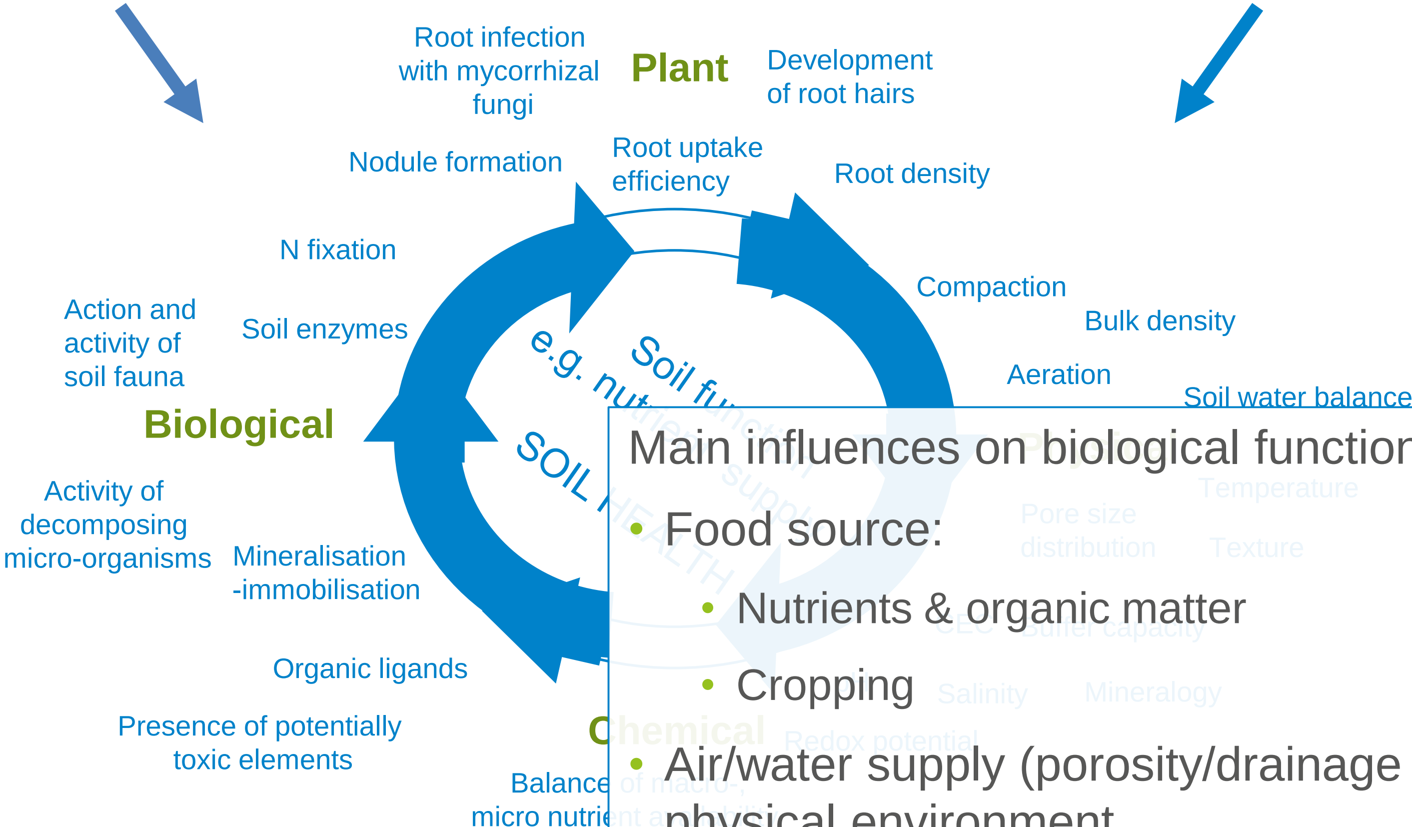
CLIMATE
Temperature, rainfall, evaporation
Where impact is mediated by
both amount and seasonality

NUTRIENT INPUTS
Fertiliser, manure, deposition etc
where availability is mediated
by many of the same factors



Main influences on biological function

- Food source:
  - Nutrients & organic matter
  - Cropping
- Air/water supply (porosity/drainage status) – physical environment
- Chemical environment – pH (& PTE's)

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KNOW YOUR SOILS; principles to improve soil health

Biological

- Feed the soil regularly through plants and OM inputs
- Move soil only when you have to
- Diversify plants in space and time

Chemical

- Maintain optimum pH
- Provide plant nutrients – right amounts in the right place at the right time
- Know your textures and minerals – buffering capacity, free supply!

Physical

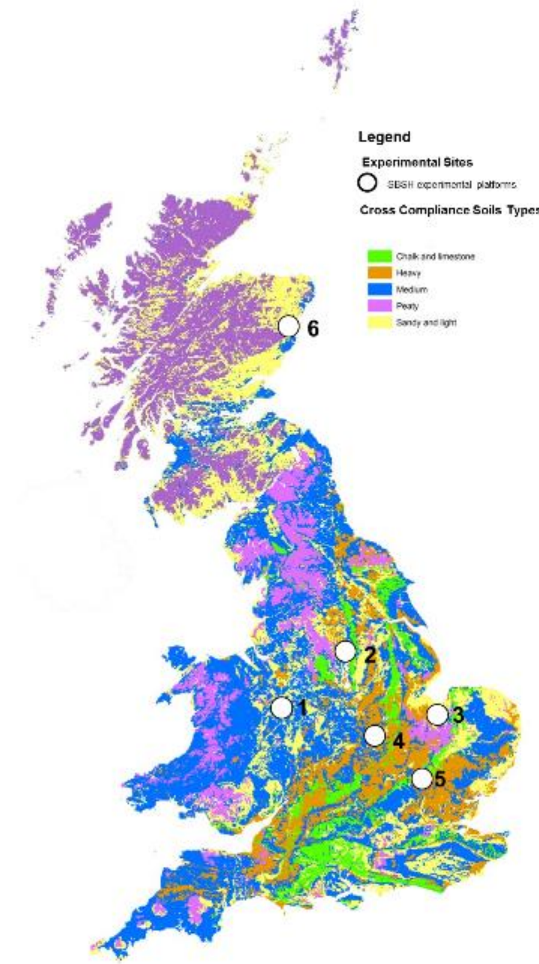
- Know your textures and understand limits to workability, trafficability
- Optimise water balance through drainage if necessary
- Improve soil structure – effective continuous pore space

P4 Soil health assessment sites: Arable & ley/arable rotations

1. Harper Adams
2. Terrington
3. Gleadthorpe

10-20 yrs of repeated organic material additions (sites 1–3)

4. Loddington - Tillage
5. Boxworth - Drainage
6. Craibstone
    a. Crop rotation x fertiliser; 90+yrs
    b. Crop rotation x pH; 60+yrs.



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Components of soil health

Physics ⇄ Biology ⇄ Chemistry ⇄ Physics

Putting it all together will need a different approach to sample collection – linking physical observation and soil samples sent for testing

Current soil reports
pH
Routine nutrients

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Soil Health Assessments

- Timing: post harvest/pre-cultivation
  - *Soil needs to be moist, so sampling may need to be delayed to post-cultivation/drilling of winter crops, but leaving a gap of at least 1 month post soil disturbance (& c. 3 months since organic material additions).*
- Measurements:
  - Bulk soil sample for:
    - Chemistry: *NRM soil health index*; SOC & total N; potentially mineralisable N
    - Biology: earthworms, microfauna, nematodes; microbial biomass/respiration
    - DNA/eDNA (projects 5 & 6) – co-ordinated by FERA
    - Physics: VESS, Bulk density, penetrometer resistance
    - Archive sample
- Establish relations with:
  - Yield & crop quality
  - Disease & weeds

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FYM treated plot

Control plot

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Initial 'scorecard' results

Samples taken October 2017 in 2 year G/C ley before spraying & cultivation for WW in 2018

Attribute	Control	FYM (23yrs)	Slurry (23 yrs)	Green compost (13 yrs)	Green/food compost (6 yrs)	Food-based digestate (9 yrs)	*P*
pH	6.4	7.0	6.4	7.0	6.2	6.5	*<0.001*
Ext. P (mg/l)	56	73	53	60	59	65	*<0.05*
Ext. K (mg/l)	80	311	194	187	140	167	*<0.001*
Ext. Mg (mg/l)	44	87	75	63	66	48	*<0.001*
LOI (%)	3.0	4.1	3.6	4.0	3.7	3.4	*<0.01*
Bulk density (g/cm^3)	1.40	1.34	1.40	1.29	1.46	1.43	*NS*
VESS score	1.2	1.4	1.3	1.1	1.3	1.5	*NS*
Microbial biomass (mg/kg)	598	671	537	534	574	592	*NS*
PMN (mg/kg)	29.8	90.2	23.8	43.1	37.7	45.5	*<0.01*

High risk – need to investigate urgently

Moderate risk – need to investigate further

Low risk – continue to monitor

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Project 5+6 – Assessing soil health using DNA

- Can we replace many of the biological assays with analysis of a single DNA sample
- Issues being addressed initially – representative sample size, cost and interpretation
- Sample size and cost being evaluated in a comparative experiment (details on next slide)
- Interpretation by analysing the same samples as the 'traditional' assays.

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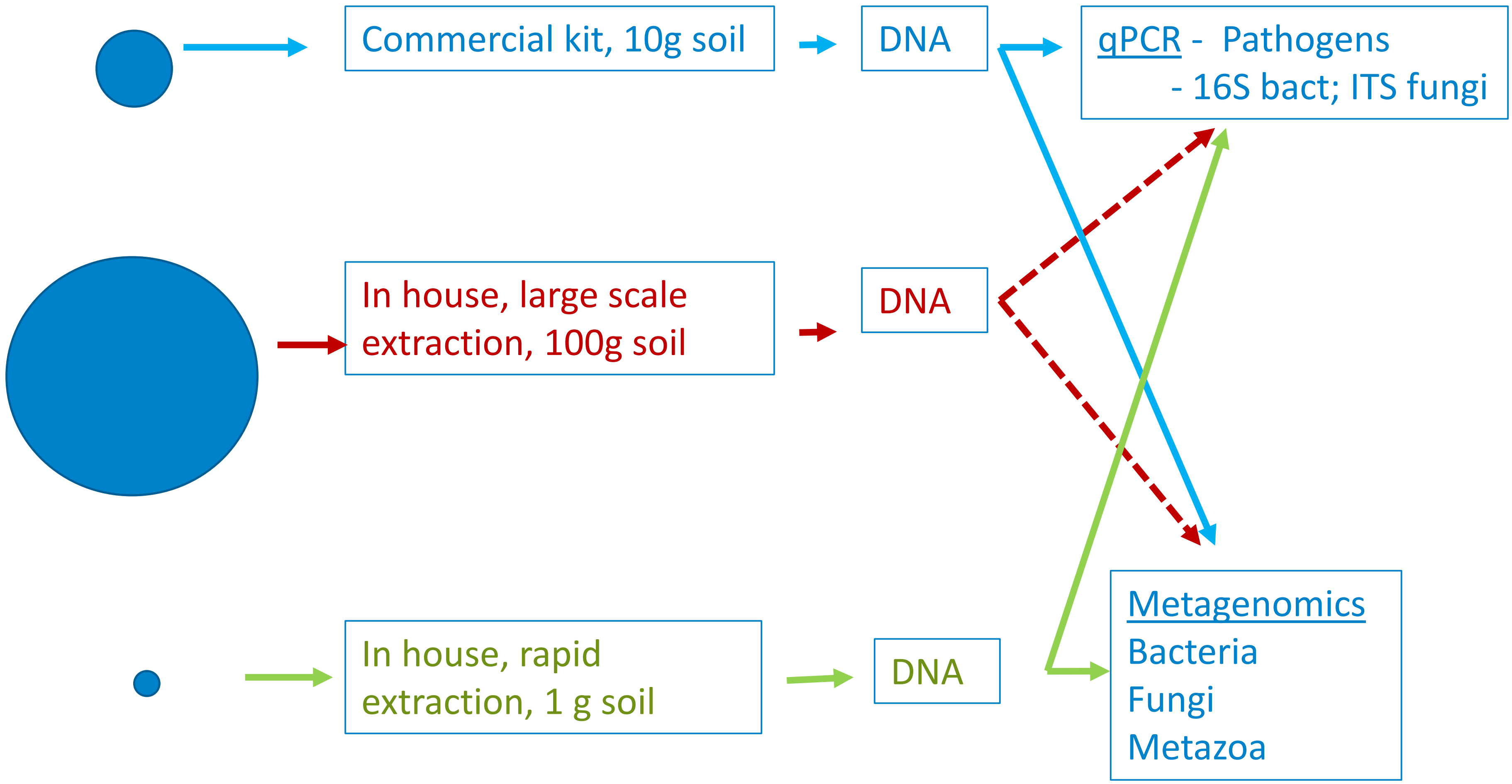
Outline of comparison experiment



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P9 On-farm soil health assessment:

Valuing and working with farmer innovation developing locally adapted practices

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Thank you
Questions?

Long term tillage and amendment experiments and on farm trialling

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The New Farming Systems Experiments
NIAB TAG
THE MORLEY AGRICULTURAL FOUNDATION
JC Mann Trust
Long term (2007-present) set of trials at Morley, Norfolk (medium, sandy loam soil)
Delivered through NIAB TAG supported by the Morley Agricultural Foundation and The JC Mann Trust
Soil amendments experiment
3 rotations
1. Spring breaks
2. Spring breaks + cover crop
3. Cont. Wheat (spring breaks 2018 onwards)
With or without 35t ha of compost (applied annually between 2008 and 2011)
Rotations experiment
3 Rotations:
1. Winter cropping
2. Spring cropping
3. Mixture of the two
4 cover crop treatments
1. standard practice (stubble)
2. legume (clover) bi-crop
3. legume mix cover crop
4. non legume cover crop
N strategies
1. no nitrogen (N)
2. 50% standard N dose
3. 100% of standard N dose (220kg/ha WW)
0%
50%
100%
0%
50%
100%
Cultivations experiment
4 cultivation systems
1. Plough
2. Deep non-inversion (20cm)
3. Shallow non-inversion (10cm)
4. Managed approach
Stubble or autumn cover crops ahead of spring crops (companion crop in WOSR rape)

NFS Cultivation experiment

4 cultivation systems (plough, deep and shallow non-inversion and managed)
± autumn cover crops ahead of spring sown crops

Rotation	Year 1 (2008)	Year 2 (2009)	Year 3 (2010)	Year 4 (2011)	Year 5 (2012)	Year 6 (2013)	Year 7 (2014)	Year 8 (2015)	Year 9 (2016)	Year 10 (2017)	Year 11 (2018)
Winter rotation	ww	wosr	ww	wbn	ww	wbrly	wosr	ww	woats	ww	wbrly

Long term yield and margins (all crops)

	Relative yield (to ploughed approach)	Cumulative gross margin minus machinery cost (£/ha)	Relative margin (to ploughed approach)
Plough	100	4823	100
Managed	99	5138	107
Deep	97	5150	107
Shallow	92	4929	102

Sustainability Trial in Arable Rotations (STAR)

STAR Project

- **2007-present (14th year of cropping)**
- **Clay loam (heavy soil), Otley in Suffolk**

Cultivations- Plough, shallow non-inversion (10cm), deep non-inversion (20cm), managed approach

Rotation	2006 (Yr 1)	2007 (Yr 2)	2008 (Yr 3)	2009 (Yr 4)	2010 (Yr 5)	2011 (Yr 6)	2012 (Yr 7)	2013 (Yr 8)	2014 (Yr 9)	2015 (Yr 10)	2016 (Yr 11)	2017 (Yr 12)	2018 (Yr 13)
Winter	WOSR	Wheat	Wbeans	Wheat	WOSR	Wheat	WBeans	Wheat	WOSR	Wheat	WBeans	Wheat	2nd Wheat
Spring	Sbeans	Wheat	SOats	Wheat	SBeans	Wheat	SLinseed	Wheat	SOats	Wheat	SBeans	Wheat	2nd Wheat
Cont. wheat	Wheat	Wheat	Wheat	Wheat	Wheat	Wheat	Wheat	Wheat	Wheat	Wheat	Wheat	Wheat	Wheat
Alt fallow	Fallow	Wheat	Fallow	Wheat	Fallow	Wheat	Fallow	Wheat	Fallow	t Wheat	Fallow	Wheat	2nd Wheat

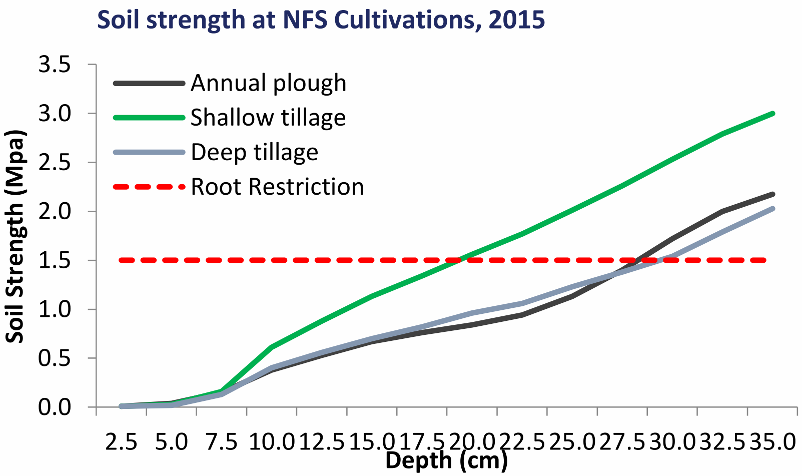
STAR Project yields and margins

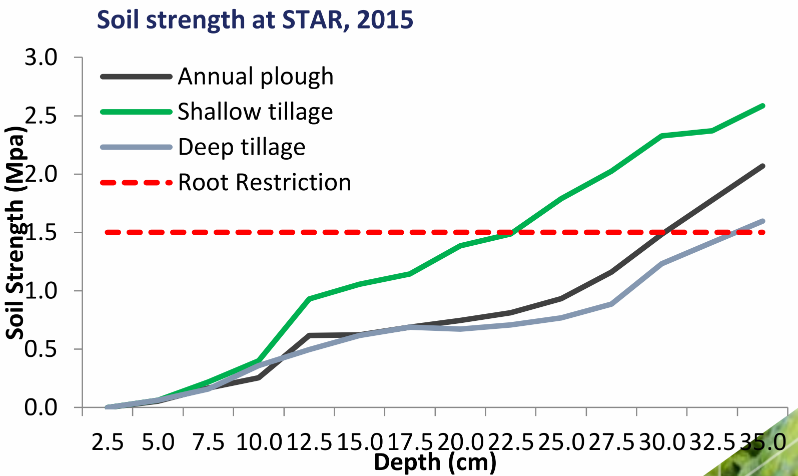
Yield as % plough in each rotation and cumulative margin, £/ha 2006-2017

Relative yield (%) (*cf.* plough)					
	Winter	Spring	Cont. Wheat	Alt Fallow	Average
Plough	100	100	100	100	100
Deep	90 (*99*)	96	98	100	96
Shallow	95	89 (*94*)	101	99	96
Cumulative margin (£/ha)					
Plough	7380	4688	4892	4028	5247
Deep	7319 (*7678*)	4920	4990	4322	5388
Shallow	6772	4865 (*5185*)	5462	4251	5337
Average	7157	4824	5115	4200	-

Soil physical properties- Penetrometer

At STAR and NFS we have seen slightly tighter soils with the shallow non inversion although across seasons this only marginally exceeds 1.5 Mpa





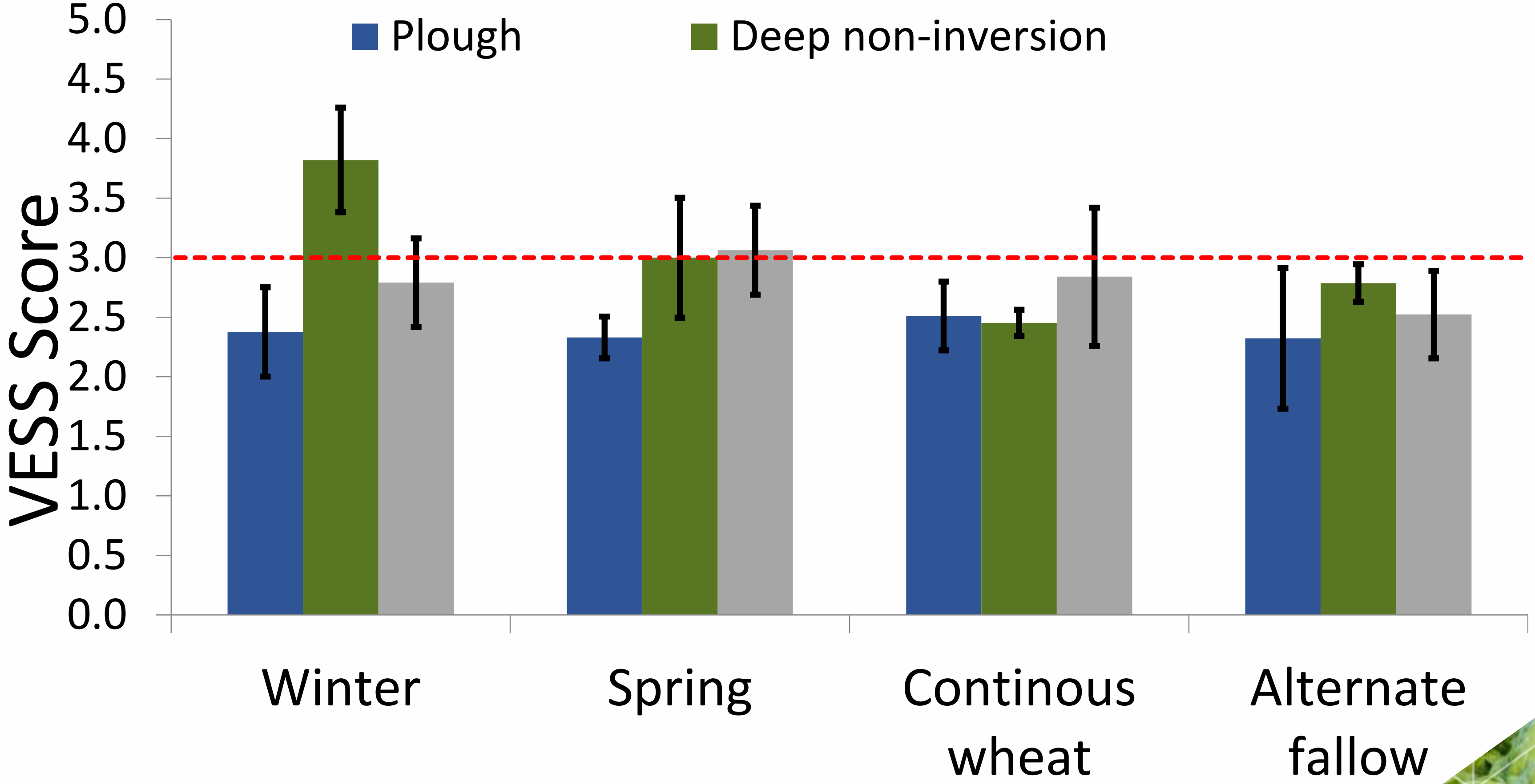
Soil physical properties- VESS (STAR)

Plough

Deep non-inversion

Shallow non-inversion

Soil physical properties- VESS (STAR)



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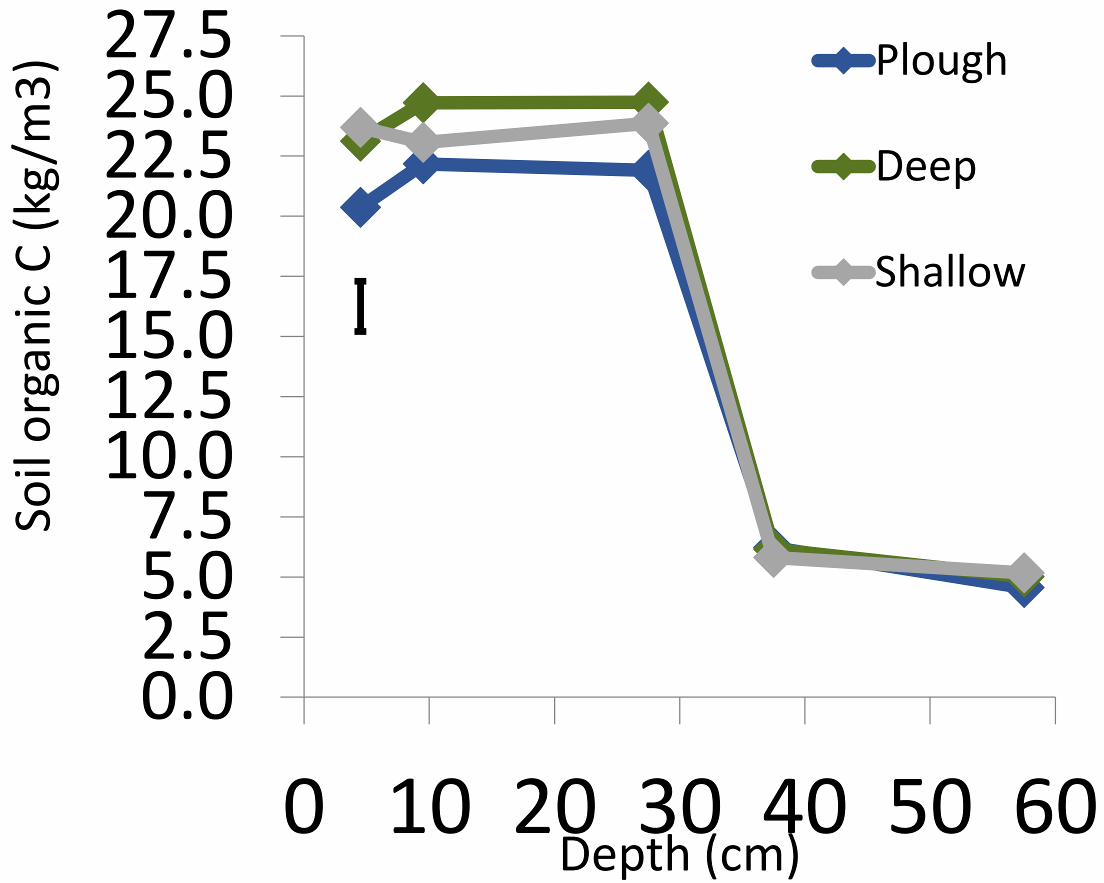
Soil chemical properties- Soil organic C (STAR)



Soil Organic Matter (April 2018)	
Plough	3.7
Deep	3.9
Shallow	4.0

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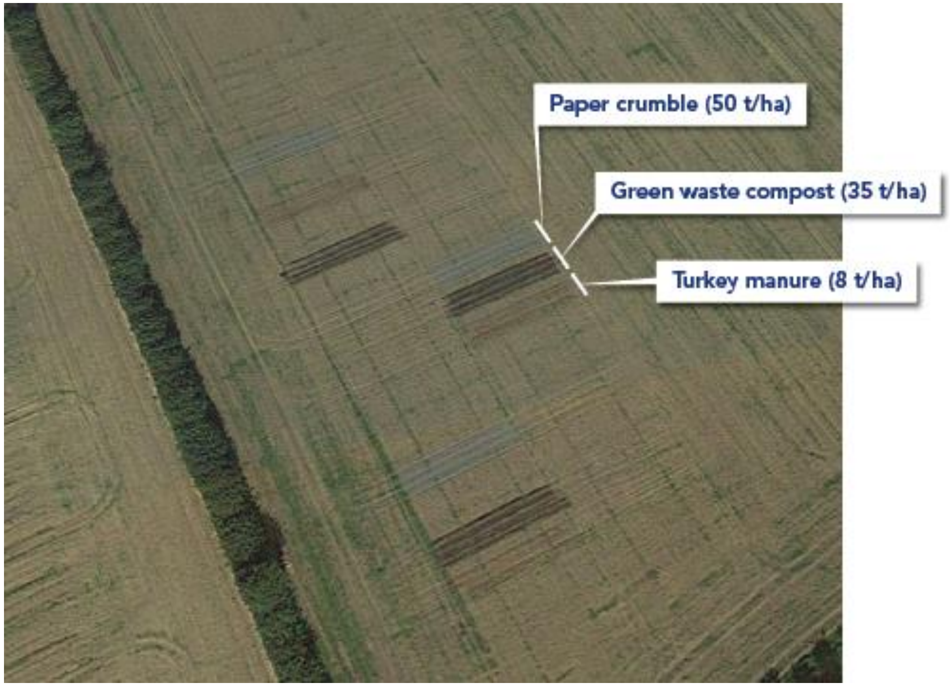
Manure and Organic Replacement Experiment (MORE)

- Measure the development and diminution of soil and crop benefits from the application of selected soil amendments within a farm rotation

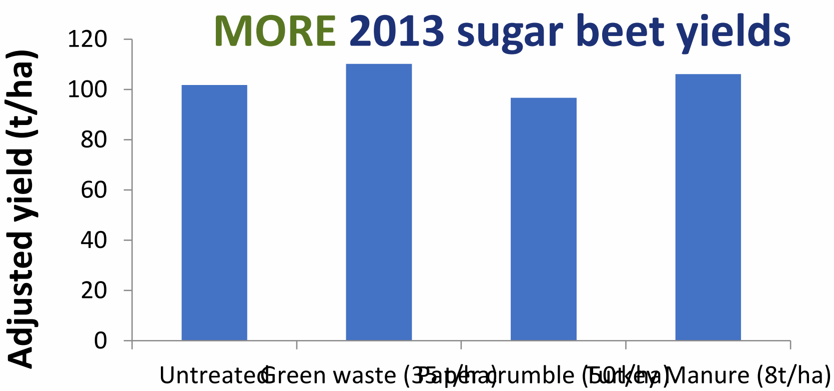
(Year 1)	(Year 2)	(Year 3)	(Year 4)	(Year 5)	(Year 6)	(Year 7)
2012	2013	2014	2015	2016	2017	2018
WW	S beet	Peas	WW	OSR	WW	S beet

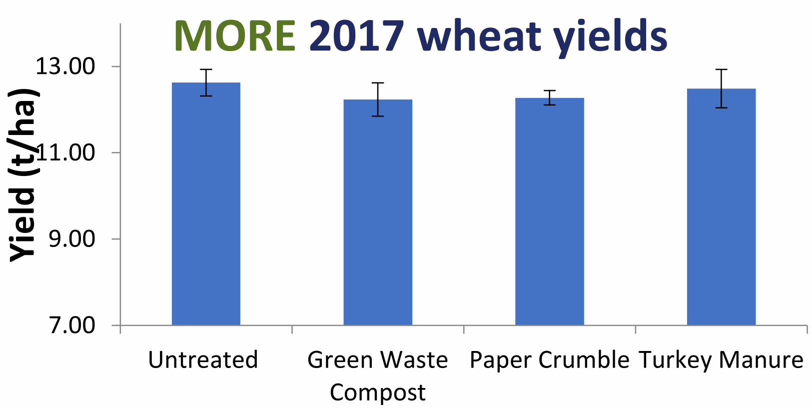


2018 through tramlines

2018 Agricultural drought

Manure and Organic Replacement Trial (MORE)



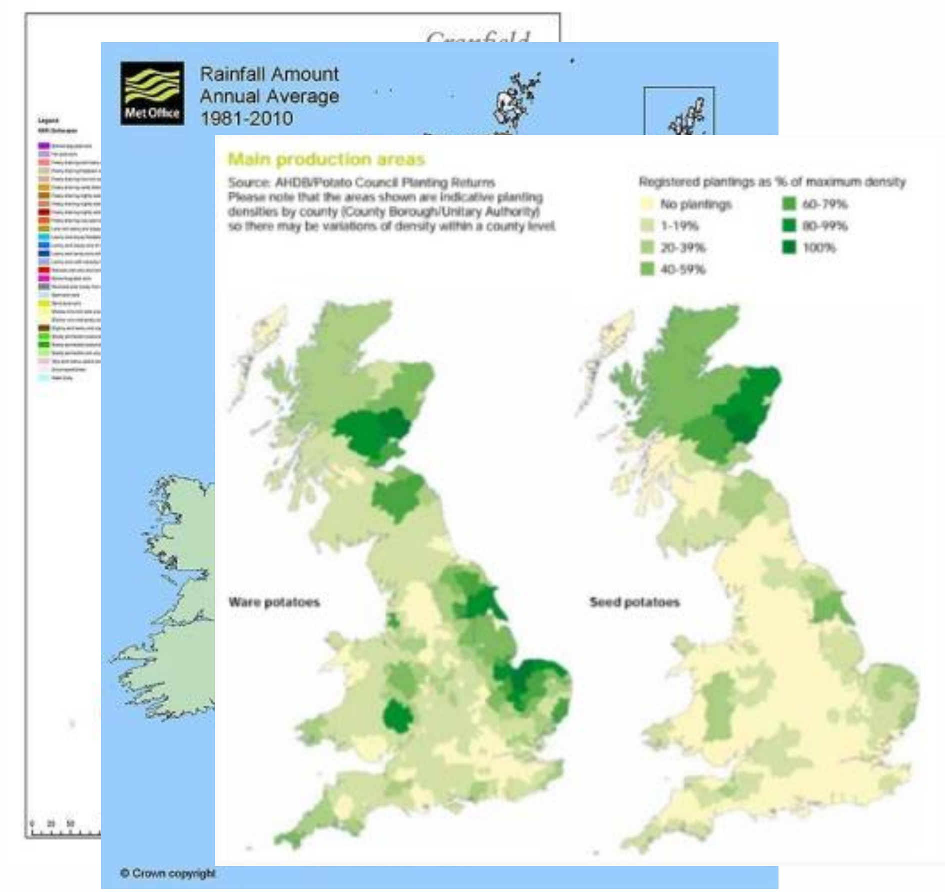


Differences in 2018 vigour

On Farm Trialling

When performed correctly split field trials can be a useful farm specific decision making tool

Why?....UK Farming is diverse!



We all have different

- Soils
- Weather
- Weed and pest pressures
- Rotation
- Machinery
- History

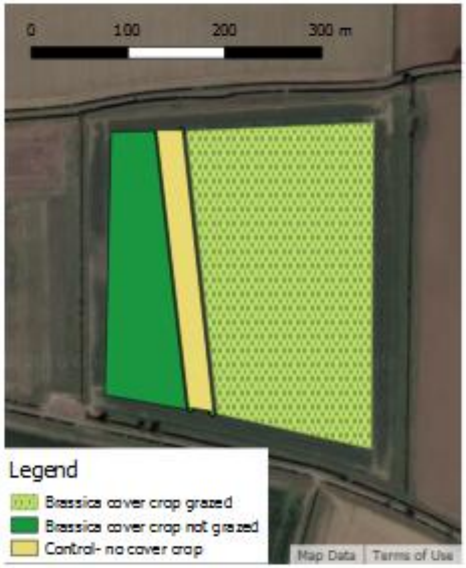
If you are considering implementing a change in your farming system all these aspects should be considered!

Split field trials influencing farm practice

Trial: The use of a grazed brassica cover crop in front of sugar beet

Location: Holkham Estate (light soil)

Conclusion: No recordable negative impact on plant populations and yield + potential benefits in reducing over winter leaching and N capture



N retention: winter 2017		
	Grazed Cover crop	No cover crop
Soil N (kg N/ha)	10	22
Crop (kg N/ha)	55	-
Total N (kg N/ha)	65	22

Crop establishment: spring 2017		
	Grazed Cover crop	No cover crop
Plant population ('000/ha)	91.6	86.2
Crop GAI	0.65	0.60
Yield (t/ha)	57	55

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Setting up a trial - Field

- Big enough and of reasonably uniform shape

- A good history of cropping and management
  - -Yield maps **(Most important tool!)**
  - -Soil scans
  - -Satellite images

- Doesn’t mean you need your best field - Some of your worst fields may;
  - Have less risk/bigger gains
  - Require a change in management practice

- Make sure treatments are simple, relevant and comparable - **Must have a control (farm standard)**

Assesse the impacts of what you are testing

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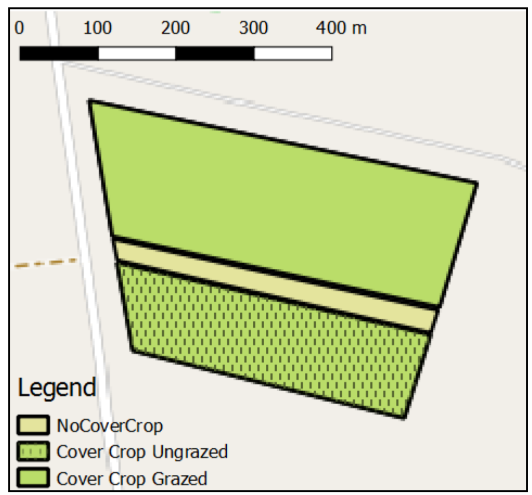
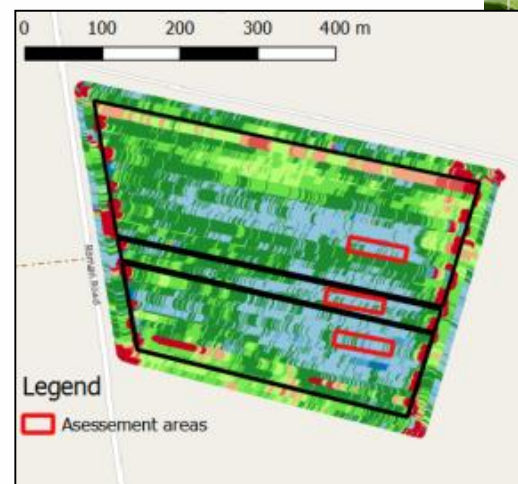
Assessments

- Use previous yield maps to identify similar performing areas within each treatment
- Compare good areas with good and bad with bad
- The more assessments you perform the stronger your conclusions

Assessment area yields (t/ha) 2017 (before intervention)	
No Cover Crop	11.96
Cover Crop Grazed	11.99
Cover Crop not Grazed	12.11





Yield and Margins

Yield

- Ensure combine yield mapping software is accurately calibrated

- Carefully plan your harvest
  - Pre determined full header width cuts, avoiding tramlines
  - individual yield maps for the trial and rest of the field can be useful

- If yield mapping software and/or the capability to analyse this data is not available then weigh a known area (e.g. 3 x 70m cuts) from each treatment over a weigh bridge

- Split field trials can 'prove' grain yield difference of 0.3-0.5 t/ha (ADAS, 2018)

NO difference can be a important finding!!!

Margins (yield is not everything)

- Keep a record of the costs associated with the different systems – Seed, inputs, work rates etc

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Thank you!

Acknowledgements

THE MORLEY AGRICULTURAL FOUNDATION

JC Mann Trust

FELIX COBBOLD TRUST

AHDB CEREALS & OILSEEDS

NIAB

Jamie Stotzka
PlantWorks Ltd.

Use of selected Microorganisms in Agriculture

A Tailored Method for Improved Plant Productivity

Overview

- **Healthy soils and farming**
- **Beneficial microbes** in agriculture – Arbuscular Mycorrhizal Fungi (AMF) and Plant Growth Promoting Rhizobacteria (PGPR)
- PlantWorks **trials**

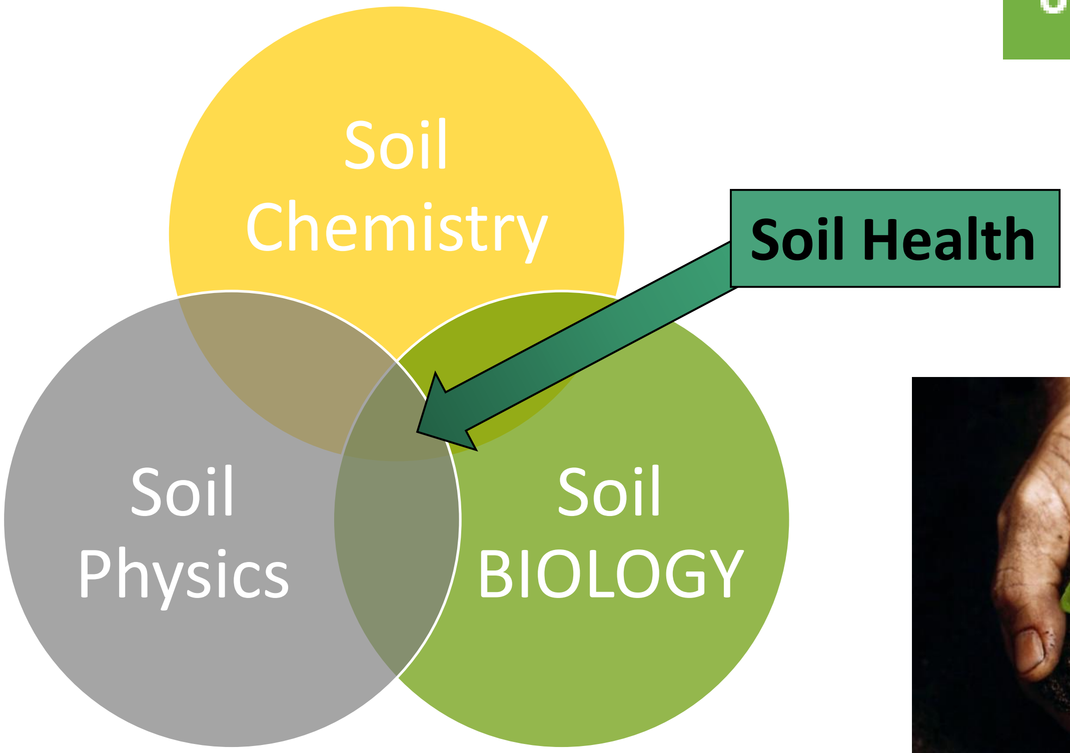
SMART ROTATIONS

PlantWorks

Soil Health and Faming Systems

Soil Health

"Healthy soils are the foundation and future of sustainable farming."



SMART ROTATIONS

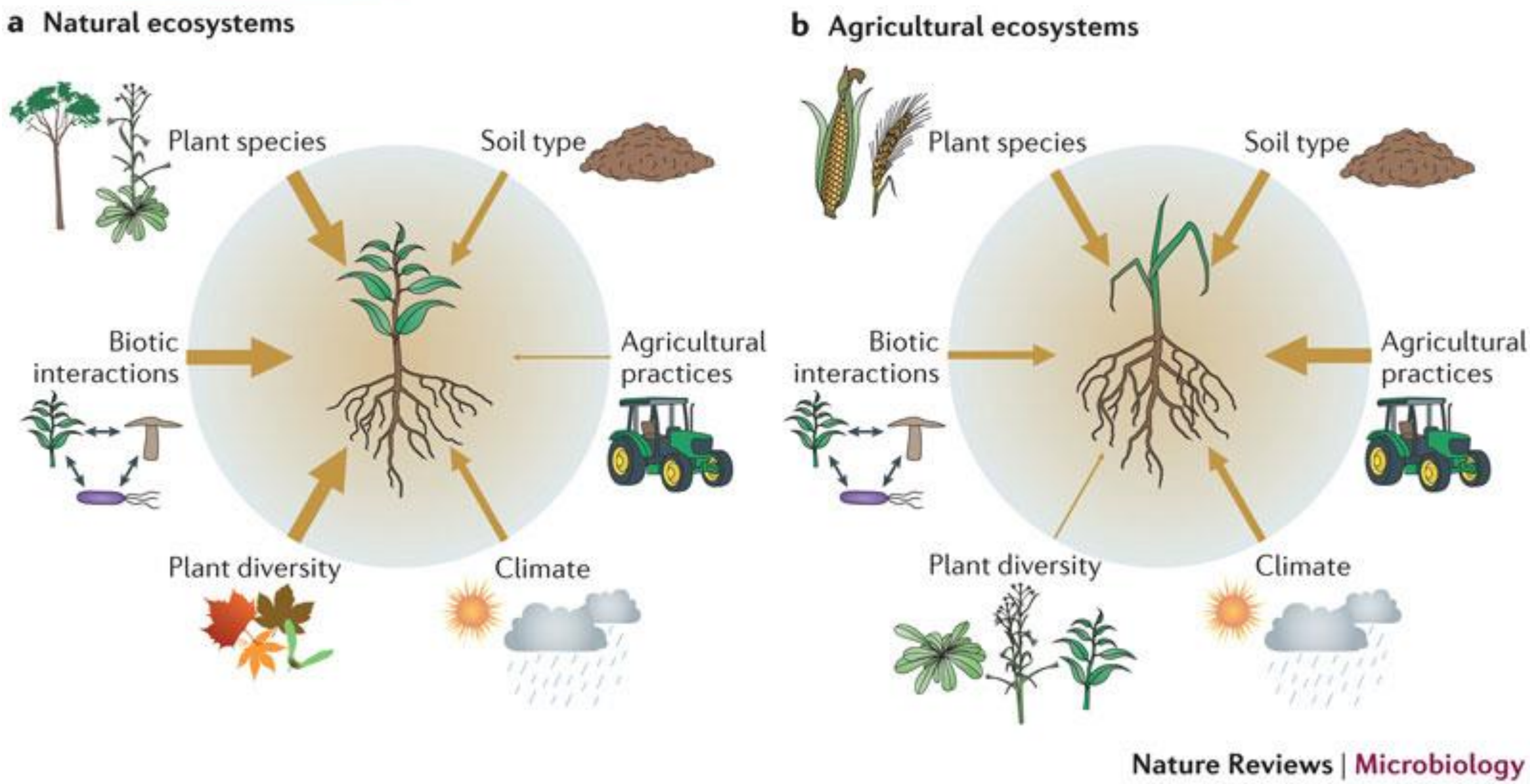
Plant Works

Agriculture and Soil Health

AHDB Nutrient Management Guide (RB209), Section 1, page 6:

"Sources of **inorganic nutrients are limited** and manufacture of fertilisers **requires energy**, so **recycling** of nutrients through organic materials and **improving nutrient availability** from well-structured **biologically active soils** makes better **use of resources** and **economic sense**."

Agriculture and Soil Health



Philippot *et al.*, 2013

SMART ROTATIONS

PlantWorks

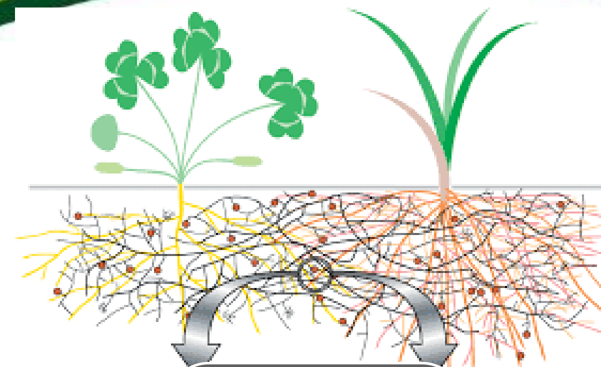
Agriculture and Soil Health

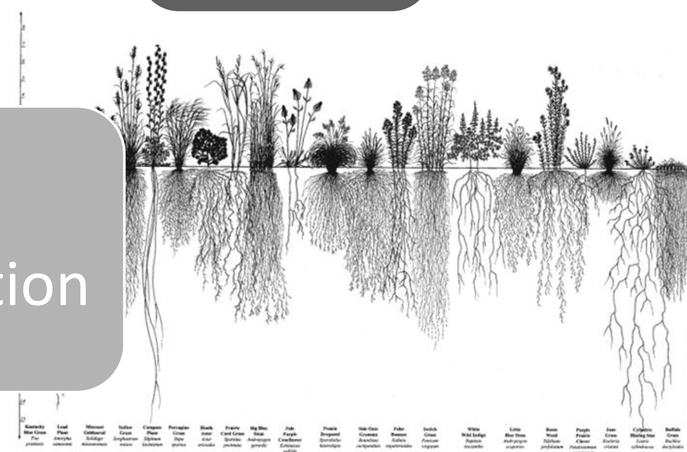
Mitigation by Method

Continuous Crop Cover

No-till Practices

Crop Diversification





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Agriculture and Soil Health

SR1 – High value vegetables and field crops

Mitigation by Intervention

SR3 – tailored bacterial treatments for specific crops

Build AMF reserves for long term soil health, yield effects and plant health

SR2 – cover crops, leys and forage crops

Reap yield and plant health benefits from crop tailored bacteria mixes

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Beneficial Soil Microbes

Arbuscular Mycorrhizal Fungi (AMF)
and
Plant Growth Promoting Rhizobacteria (PGPR)

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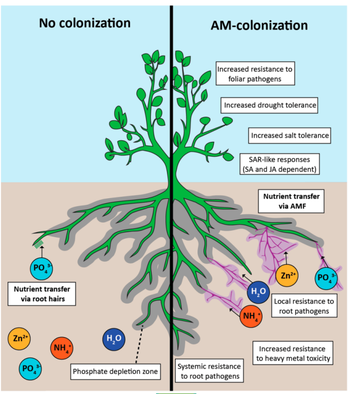
Two Types of Beneficial Microbes – A Wealth of Benefits

Arbuscular Mycorrhizal Fungi – AMF

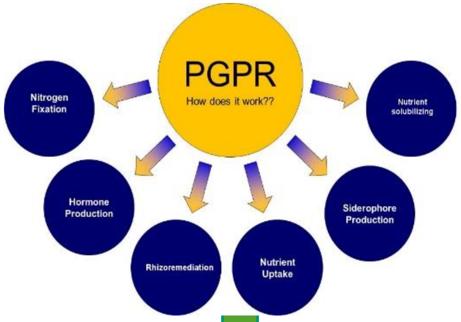


Treat soils with AMF to build up a healthy fungal network for all host-plants and years of benefits

Agricultural practices can lead to depletion of soil biology

Treatment of soils and crops with high quality inocula can help mitigate these negative effects

Plant Growth Promoting Rhizobacteria - PGPR



Treat crops annually with plant specific tailored PGPR for yield and health benefits

Benefits for Host Plants

Improved nutrient availability and uptake
Increased crop quality and yield
Improved systemic resistance for healthier plants
Increased drought tolerance and water use efficiency

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Plant Works

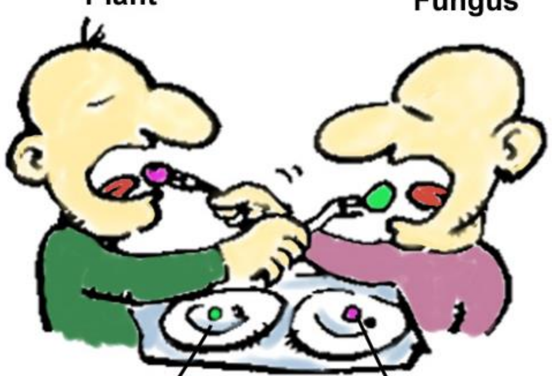
Arbuscular
Mycorrhizal
Fungi

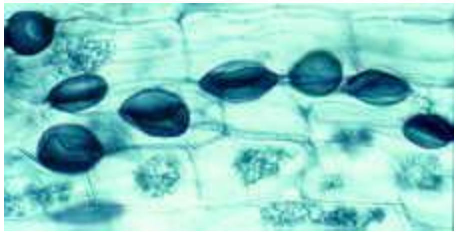
AMF

SMART ROTATIONS

Plant Works

AMF

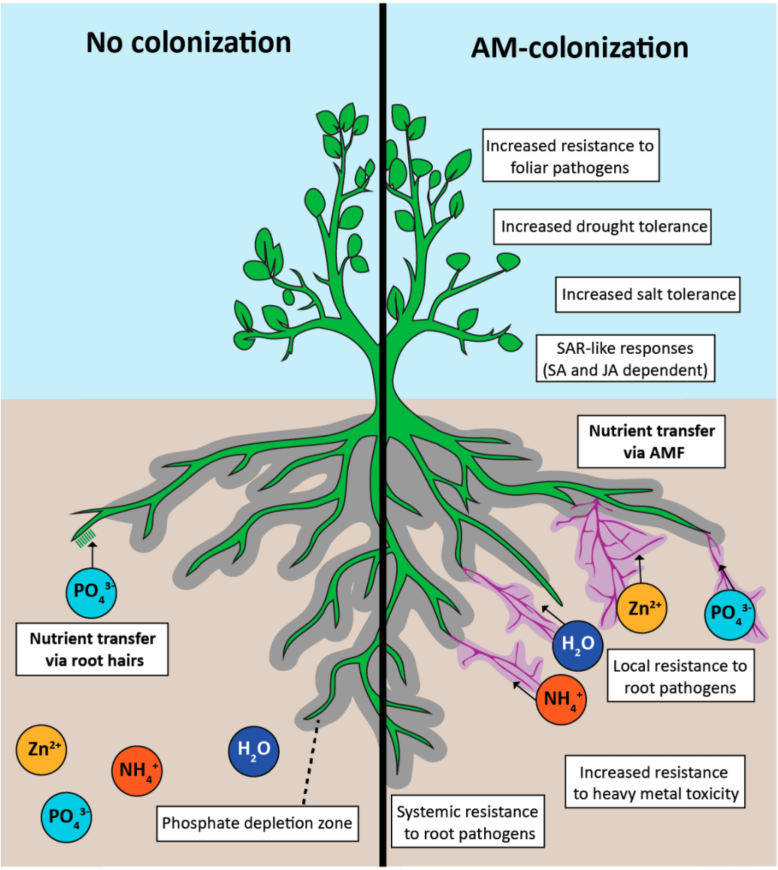




Mineral nutrients and **water** extracted from the soil

Organic carbon compounds transferred to fungus

Arbuscular Mycorrhizal Fungi - AMF



Benefits for Host Plants

- Improved nutrient availability and uptake
- Increased crop quality and yield
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- Increased drought tolerance and water use efficiency

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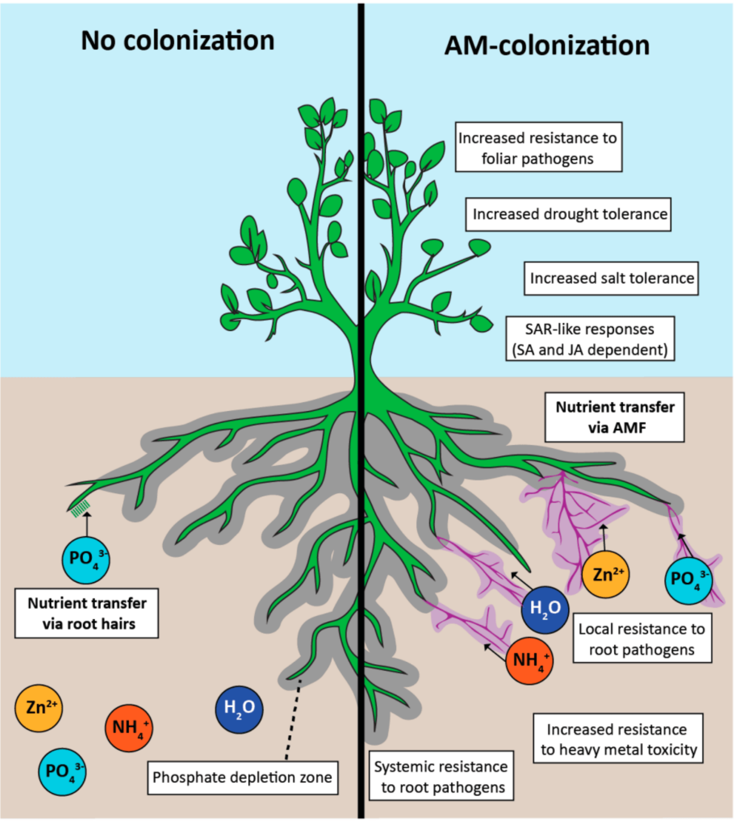
Arbuscular Mycorrhizal Fungi - AMF



Agricultural practices can lead to depletion of AMF

- **Soil disturbance**
- **Fallow periods**
- **Non-mycorrhizal crops –**Brassicaceae, Ameranthaceae
- **Pesticides**

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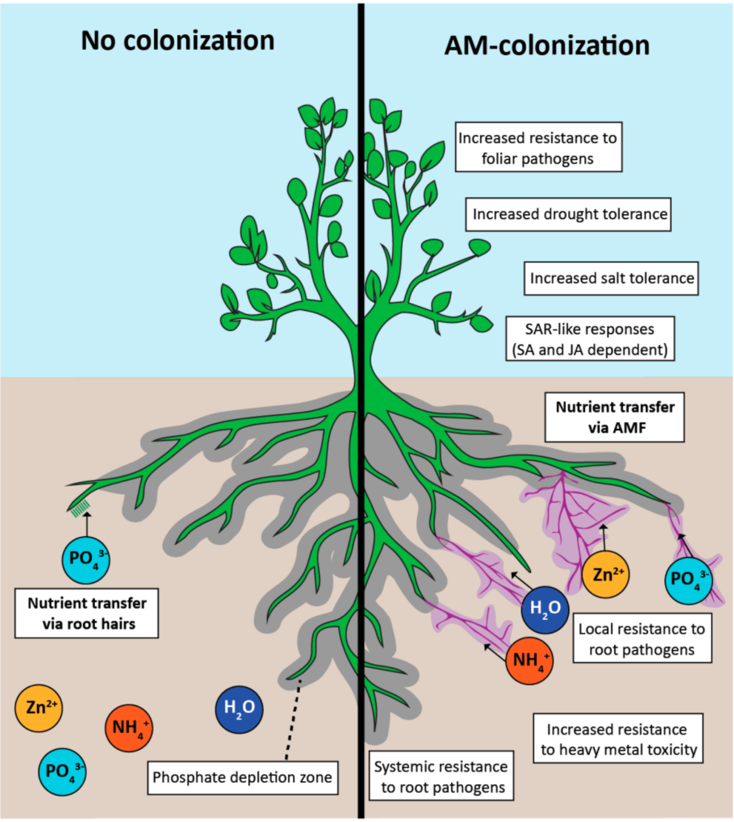
Arbuscular Mycorrhizal Fungi - AMF



Treat soils within arable rotation with AMF to build up a healthy fungal network for all host-plants and years of benefits

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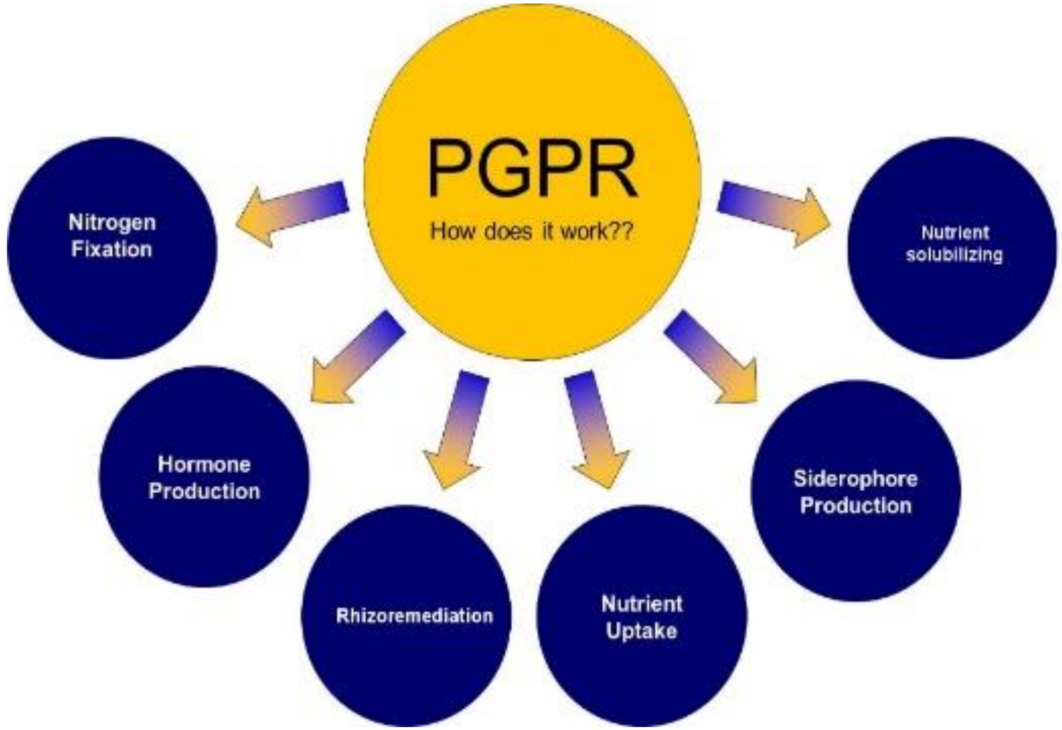
Plant Growth Promoting Rhizobacteria

PGPR

Plant Growth Promoting Rhizobacteria - PGPR



Plant Growth Promoting Rhizobacteria - PGPR

Treat crops annually with plant specific tailored PGPR for yield and health benefits

SMART ROTATIONS

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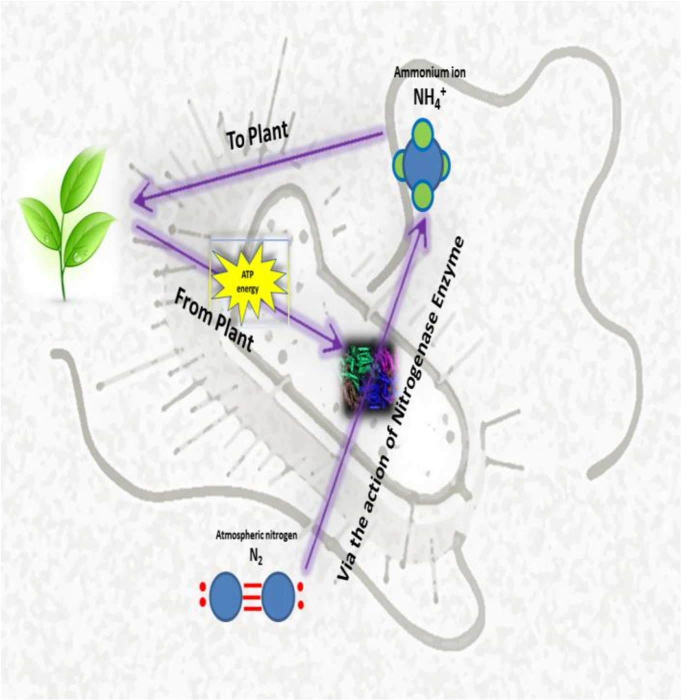
Plant Growth Promoting Rhizobacteria - PGPR

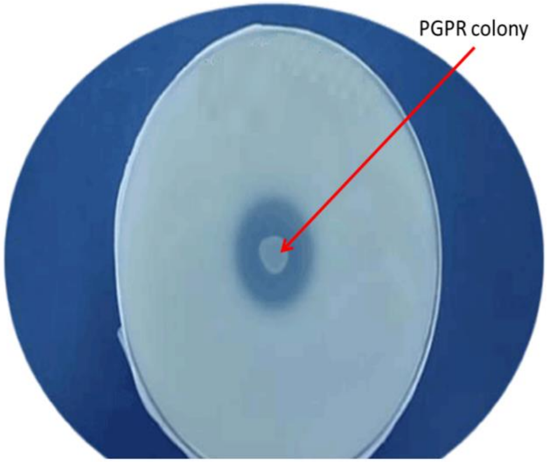
Increasing plant available nutrients

Biological nitrogen fixation

- Over 78% of the atmosphere is gaseous N2.
- Not usable by plants.
- PGPR enzymes to **convert** the atmospheric N_2 into **plant available NH_4^+**
- **74,000 tonnes** of **N_2** is available for fixing in the air **above each hectare** of land
- Fixed nitrogen from the bacteria is **exchanged for** phostosynthesised **carbon** and other **organic nutrients** from plants



Plant Growth Promoting Rhizobacteria - PGPR



Phosphate solubilising halo produced by a PGPR on a medium agar containing insoluble phosphate

Phosphate solubilisation

- **P** is very **immobile**
- Soil microbes release **organic acids**
- Organic P is locked up in biological macromolecules (DNA and cell membranes etc.)
- Some PGP Rhizobacteria can release this organic P enzymatically
- Soil microbes can **increase soil available P by 62%**
- These organic molecules also chelate **other micronutrients**

PGPR Production

- PlantWorks PGPR collection - **14 species**
- Cultivated as **mono-species** in 10L bioreactor and shakers
- PGPR identity **confirmed by** 16S rRNA **sequencing**
- Viable **cells enumerated** before and after turned into final product
- **5 years research** on
    - Generating growth curves – now know when to harvest cells to improve survival rate
    - Product formulation and application methods
    - Tailor consortia to specific target crops

Plant Works

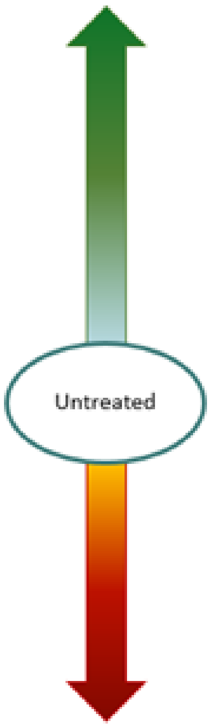
PlantWorks

Tailoring of PGPR consortia for specific crops

Q Lin/Jamie Stotzka/Natallia Gulbis

PGPR single strains

Oats	Wheat	Barley	Linseed
F *35%	F *14%	E *3%	E *50%
E *20%	D *12%	D *1%	K *35%
A *20%	B *7%	A *4%	D *6%
	E *4%		B *5%
			A *2%
K	O	O	O
O	A	K	F
B	K	F	
D		B	



Grain yield per plant when treated with single PGPR (PlantWorks codes).

*Shows the difference in yield compared to untreated control plants.

SMART ROTATIONS

Plant Works

PGPR crop targeted products

Less is more…

- Trial work showed that **different PGPR** consortia need to be formulated **for each target crop**.
- **SR3** liquid range developed for specific crops including Beets/Spinach, Onions/Leeks and Potatoes/Carrots **available now**
- Specific **SR3 cereal and oilseed products** to follow – wheat and OSR trials underway.

SMART ROTATIONS

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Sugar Beet

Allpress Farms Ltd. Cambridgeshire

Q Lin/Jamie Stotzka

Sugar Beet

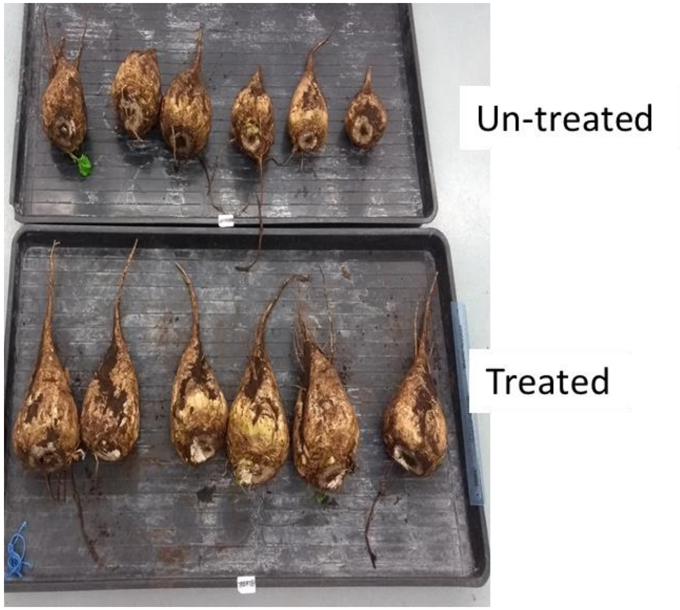
Materials and Method

- 1 hectare of sugar beet inoculated twice with SR3 Beet formulation
- Standard crop sprayer, dilution rate 200L water/ha, medium – coarse droplet, low pressure settings

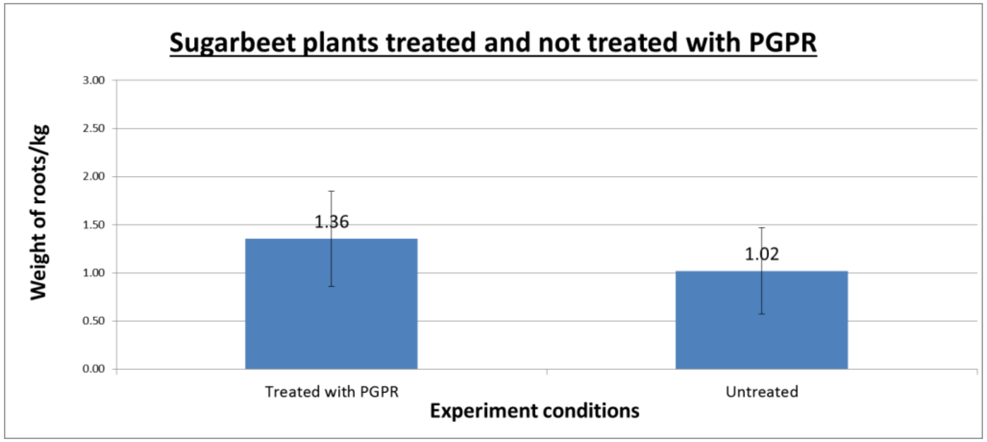
Assessments

- 100 beets picked at random from each inoculated and untreated areas. Beet weights taken and recorded in kg.
- Quality assessment (British sugar) to determine sugar content, Amino N, Sodium and Potassium contents.

Sugar Beet



Visual difference between treated and untreated sugar beet



Weight measurements of beets treated and untreated with PGPR.
Unpaired *t* test on beet weight between PGPR treated and untreated: $P < 0.001$.

SMART ROTATIONS

Plant Works

Sugar Beet

Quality assessment of PGPR treated and untreated sugar beet

	Plot Sample Dirty Wt	Plot Sample Clean Wt	Sugar %	Amino Nitrogen (mg/100g beet)	Sodium (mg/100g beet)	Potassium (mg/100g beet)	Trial Operator	Trial Description
Sample A (PGPR)	10.7	10.3	17.52	15	25	161	British Sugar	Frontier Ag Ltd.
Sample B (Untreated)	8.2	8	16.98	15	26.2	155	British Sugar	Frontier Ag Ltd.
			3.2% increase with treatment					

SMART ROTATIONS

Plant Works

Smart Rotations – Benefits of re-establishing AMF after non-mycorrhizal crops
SR3 Trials 2017-18

PW Trial Personnel:
Natallia Gulbis, Q Lin, Jo O'Regan, Marios Stamatiou, Jamie Stotzka

Wheat

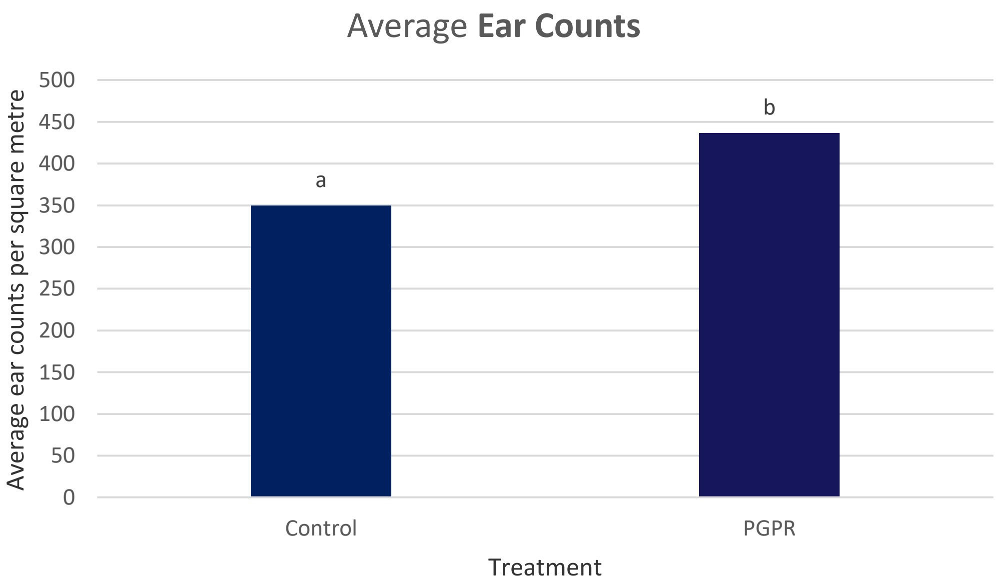
SMART ROTATIONS

Plant Works

Simon Cowell - Essex

Average **ear counts** per square metre

Control	PGPR	Difference
350	437	Up 20%



NB: Data shows **statistical significance** between control and bacteria treatment –

P< .001

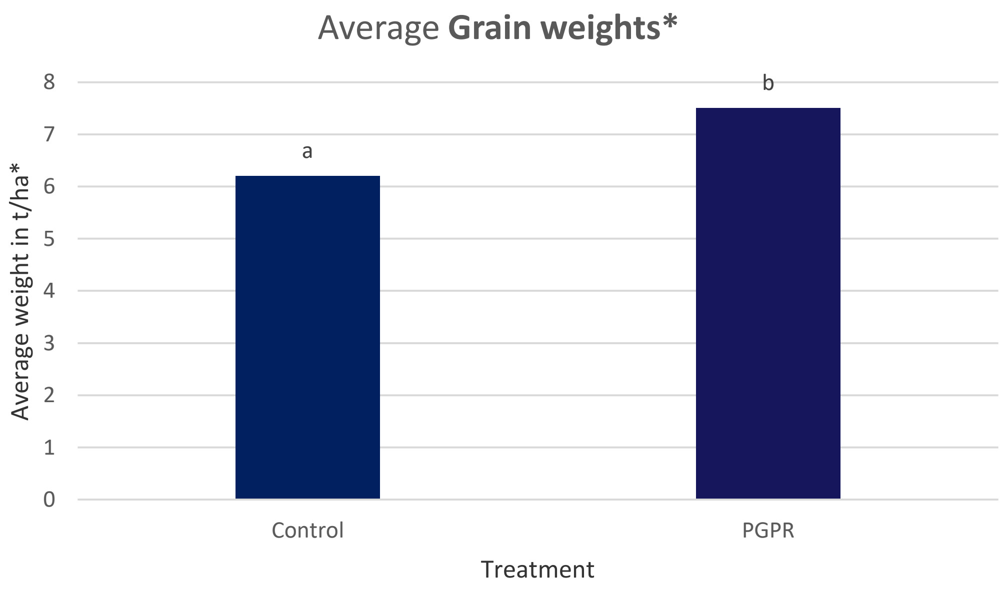
SMART ROTATIONS

Plant Works

Simon Cowell - Essex

Average grain weights in t/ha*

Control	PGPR	Difference
6.2	7.5	Up 17%



*Grain weights in hand harvested trials 20-30% higher than combine readings

NB: Data shows **statistical significance** between control and bacteria treatment –

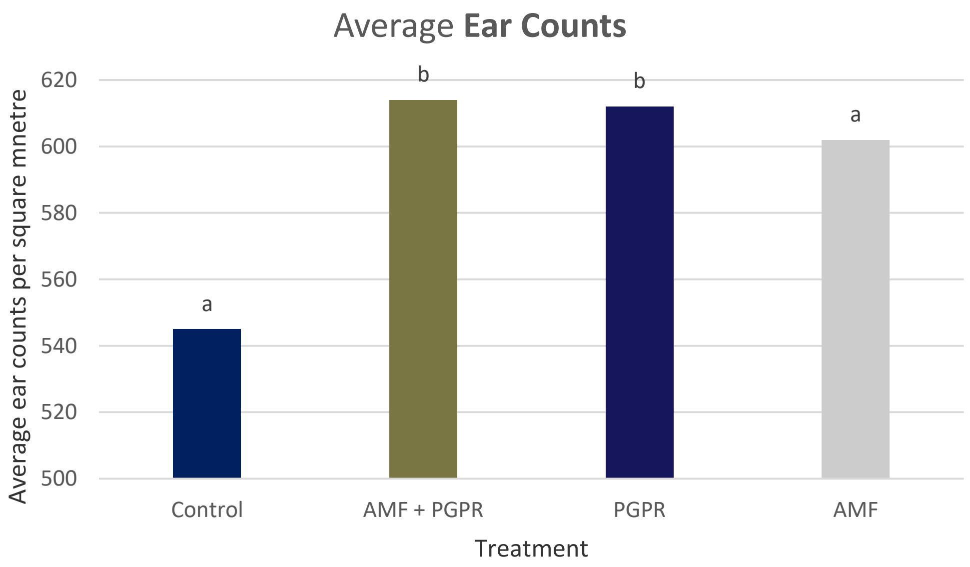
P< .01

GH Dean - Kent

Average **ear counts** per square metre

Control	AMF + PGPR	PGPR	AMF
545	614	612	602

Yield difference	
Control vs AMF + PGPR	up 11%
Control vs PGPR	up 11%
Control vs AMF	up 9%



NB: Data shows **statistical significance** between control vs AMF + PGPR and control vs PGPR treatments

P <.05

SMART ROTATIONS

Plant Works

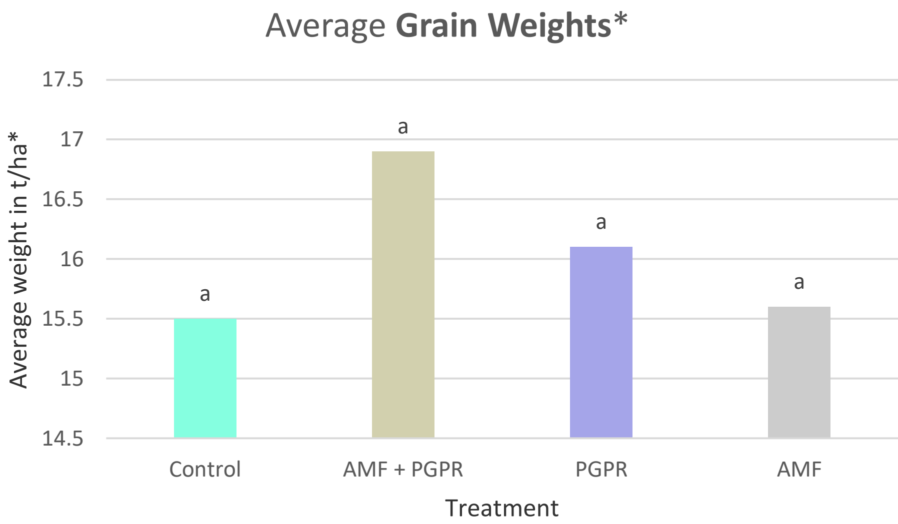
GH Dean - Kent

Average grain weights in t/ha*

Control	AMF + PGPR	PGPR	AMF
15.5	16.9	16.1	15.6

*Grain weights in hand harvested trials 20-30% higher than combine readings

Yield difference	
Control vs AMF + PGPR	up 8%
Control vs PGPR	up 4%
Control vs AMF	up 1%



NB: Data shows no **statistical significance** between control and microbial treatments

SMART ROTATIONS

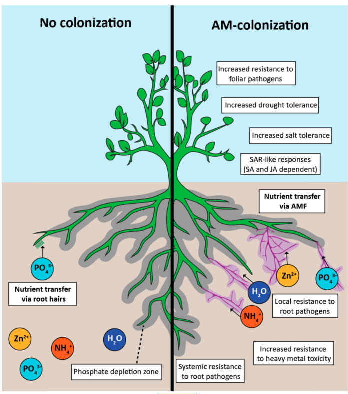
Plant Works

Smart Rotations

Product Range and Applications

Two Types of Beneficial Microbes – A Wealth of Benefits

Arbuscular Mycorrhizal Fungi – AMF

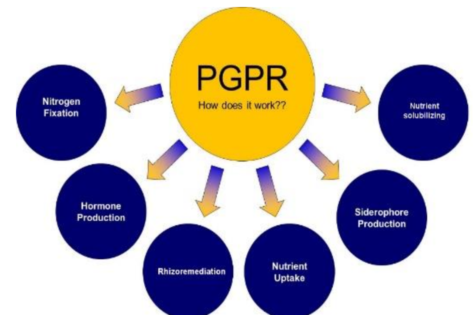


Treat soils with AMF to build up a healthy fungal network for all host-plants and years of benefits

Agricultural practices can lead to depletion of soil biology

Treatment of soils and crops with high quality inocula can help mitigate these negative effects

Plant Growth Promoting Rhizobacteria - PGPR



Treat crops annually with plant specific tailored PGPR for yield and health benefits

Benefits for Host Plants

Improved nutrient availability and uptake
Increased crop quality and yield
Improved systemic resistance for healthier plants
Increased drought tolerance and water use efficiency

SMART ROTATIONS

Plant Works

Smart Rotations Products

SR1 Prime soils with beneficial fungi and reap yield benefits

AMF for cereals and high value field vegetables

SR2 Utilise covers and leys to prime soils with fungi to benefit follow on cash crops

AMF for cover crops, leys and grass

SR3 Specific blends for yield and plant health benefits

Tailored, crop specific bacteria treatments

Improved soil health, plant health and yields

SMART ROTATIONS

Plant Works

Summary

- Biologically active soils **support plant growth and vigour** through symbiotic relationships between microbes and plants
- **Farming activities** can **disrupt** this effect
- Opting for **conservation agriculture strategies** can **support** soil-life
- **Biological additives/inoculants** must be **carefully chosen** and **formulated** – In many cases less is more!
- With the right formulation, **inocula can positively impact yields**

SMART ROTATIONS

Plant Works

Thank You

Companies:

Cotswold Seeds – Paul Totterdell
ProCam – Kevin Pearcy, Richard Harding
Kings Seeds/Frontier AG – Paul Brown
Crop Management Partners – Roger Bryan

Farmers:

Patrick Allpress, Martin Porter and Jim Thompson (Allpress Farms)
Neil Anderson
Mark Bowsher-Gibbs and staff at GH Dean/Hempstead Farm
Simon Chiles
Simon Cowell
Simon Gardner and Charlotte Nicholls (G's Growers)
Tony Wilkins

SMART ROTATIONS

PlantWorks Science Team:

Natallia Gulbis
Q Lin
Jo O'Regan

PROCAM | COTSWOLD Grass Seeds DIRECT | kings | Allpress | G's GROWERS | G.H. DEAN & CO. LTD | CROP MANAGEMENT PARTNERS LLP | Plant Works

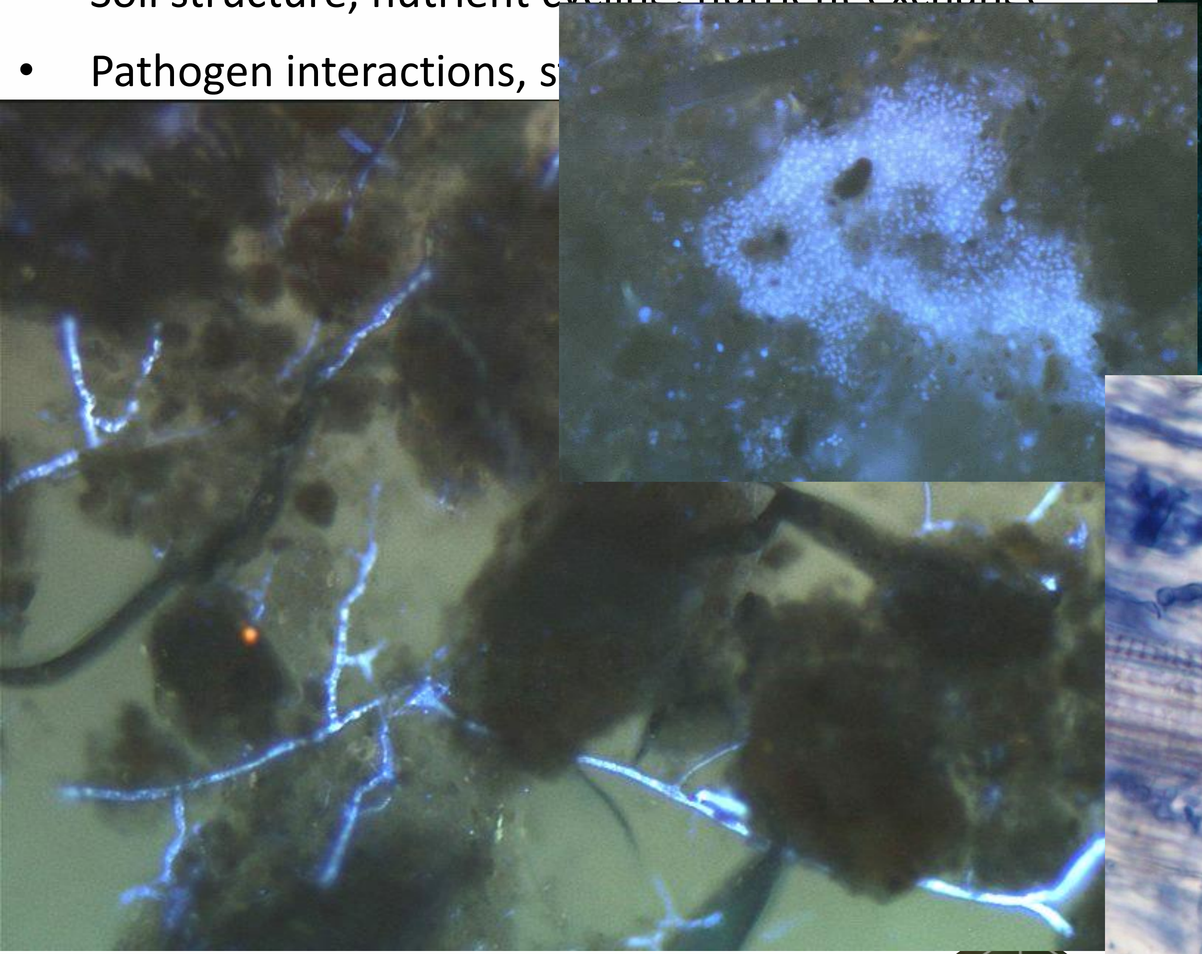
Innovation Farm & Agri-tech Innovation Hub, Dr Lydia Smith

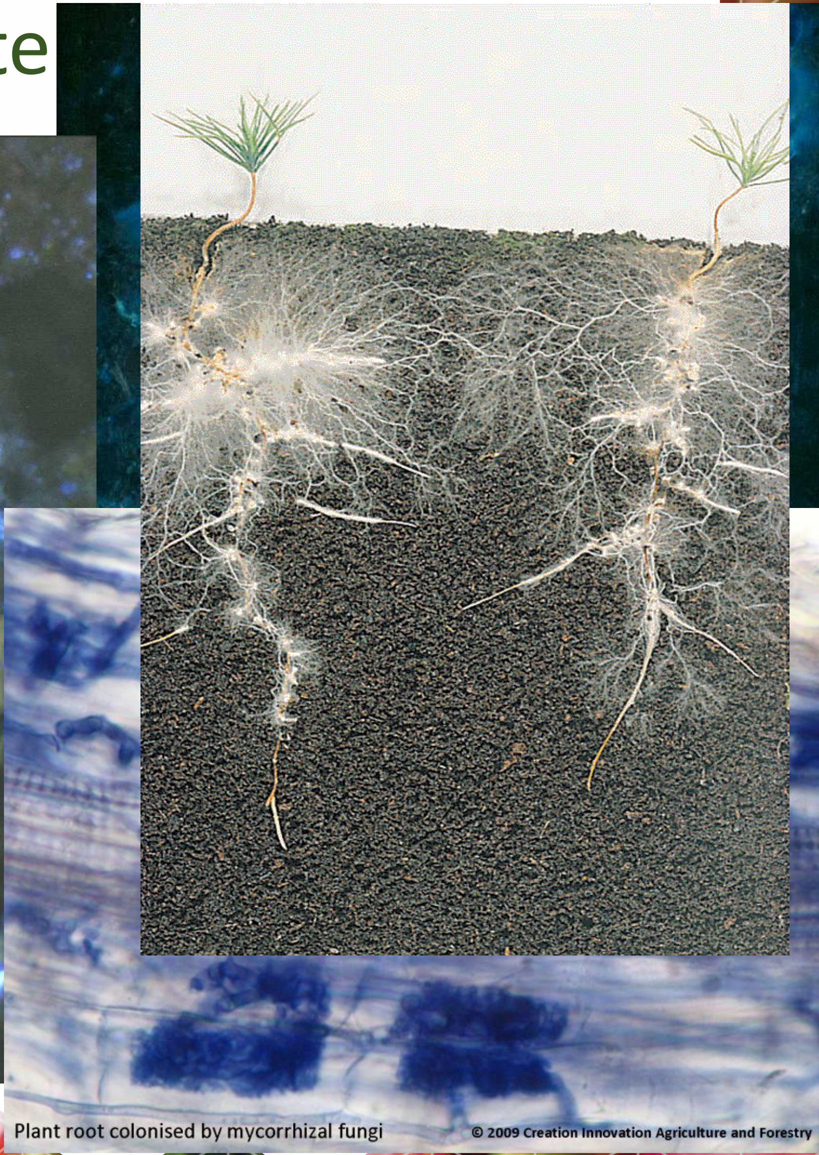
Soil /crop Microbial Interactions

- Symbiotic Associations
- Farmer Participatory research
- International Soil Research Interactions

Soil – Plant - microbial inte

- Soil structure, nutrient cycling, nutrient exchange
- Pathogen interactions, s





East Agri-Tech Innovation Hub - Hasse Fen

NIAB


FIRE
FRASH
Sustainable
bioactive
soil additive
250g


Black vine weevil Larva
Separated spent mushroom compost is a source of chitin = insect cuticle
Ralph Noble NIAB EMR

Heuchera pot plants in
unheated polytunnel

Matthews Plants
Hadley Nursery
Roydon, Essex

Soil (microial) Health projecs

1 Soil CADRE

- **Soil Microbial Interactions (**Soil & **C**over crop **A**ssociations **D**eveloping **R**hizo-biological **E**fficiency)
- AHDB & 'Charities funded
- Examine how farming system, cropping and soil biota interact
- Glasshouse, rhizotron & lab-based
- Quantify if/how the delivery of sustainable, dynamic soil systems can be improved by enriched soil biota
- Collaboration; Dr Ute Paszkowski Cam.U

2 Innovative Farmers field lab

- Improving nutrient use efficiency from **AD digestate allied to Cover Crops** to improve longer term soil function
  - *Using cover crops (4-way mix)*
  - *Stabilising N*
  - *Impact of fibre amendments*
  - *Application time of digestate*
- *Measure; NPK, micronuts, pH CEC, Yield, economics*
- *6 Farmers + AD experts* + Anaero Technologies & Future Biogas

Innovative farm locations

Farmer	Farm	Location
1	Allpress Farms	PE16 6XQ
2	Euston Estate	IP24 2QP
3	Holkham Estate	NR23 1AB
4	Upton Farms	IP28 6SR
5	Boxford Farm	CO6 4PH
6	North Moor Farm	DN17 4BX

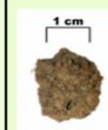
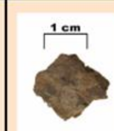
Current progress & assessments

NIAB training video https://www.youtube.com/watch?v=KKZuPKj7j9Q&feature=youtu.be

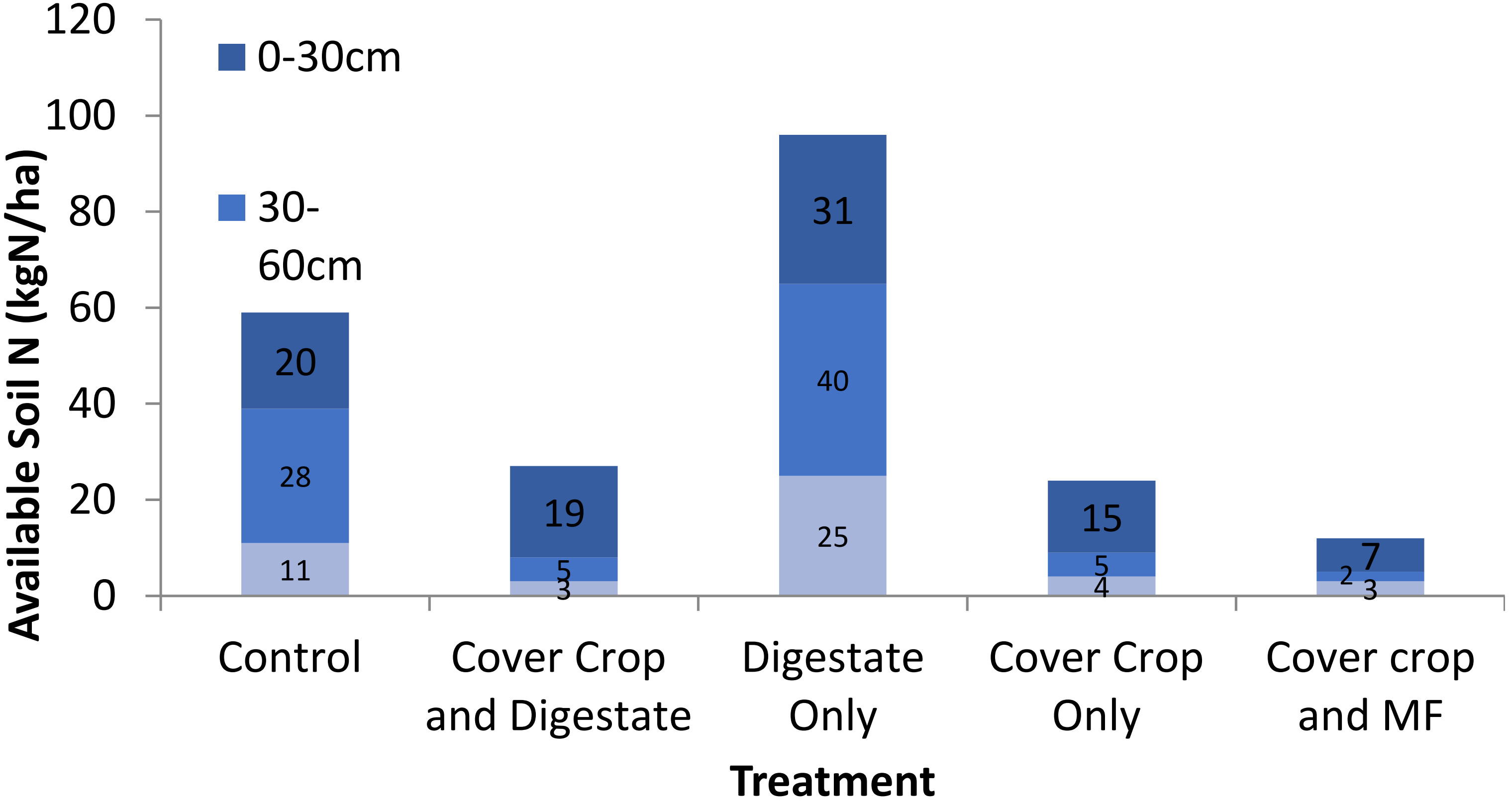
Green Area Index

VESS

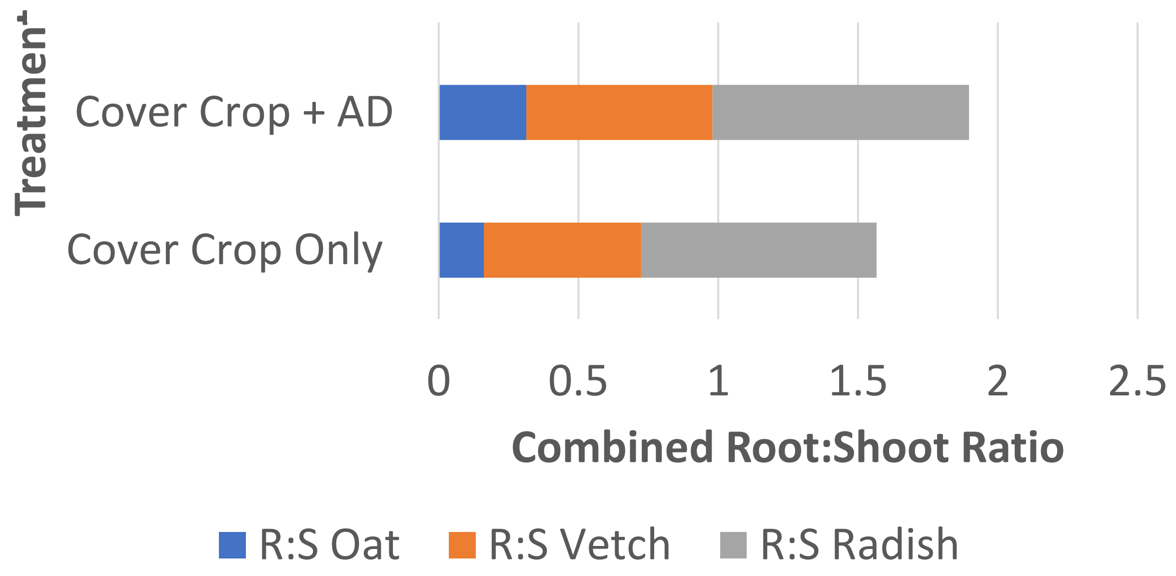
Worm Counts

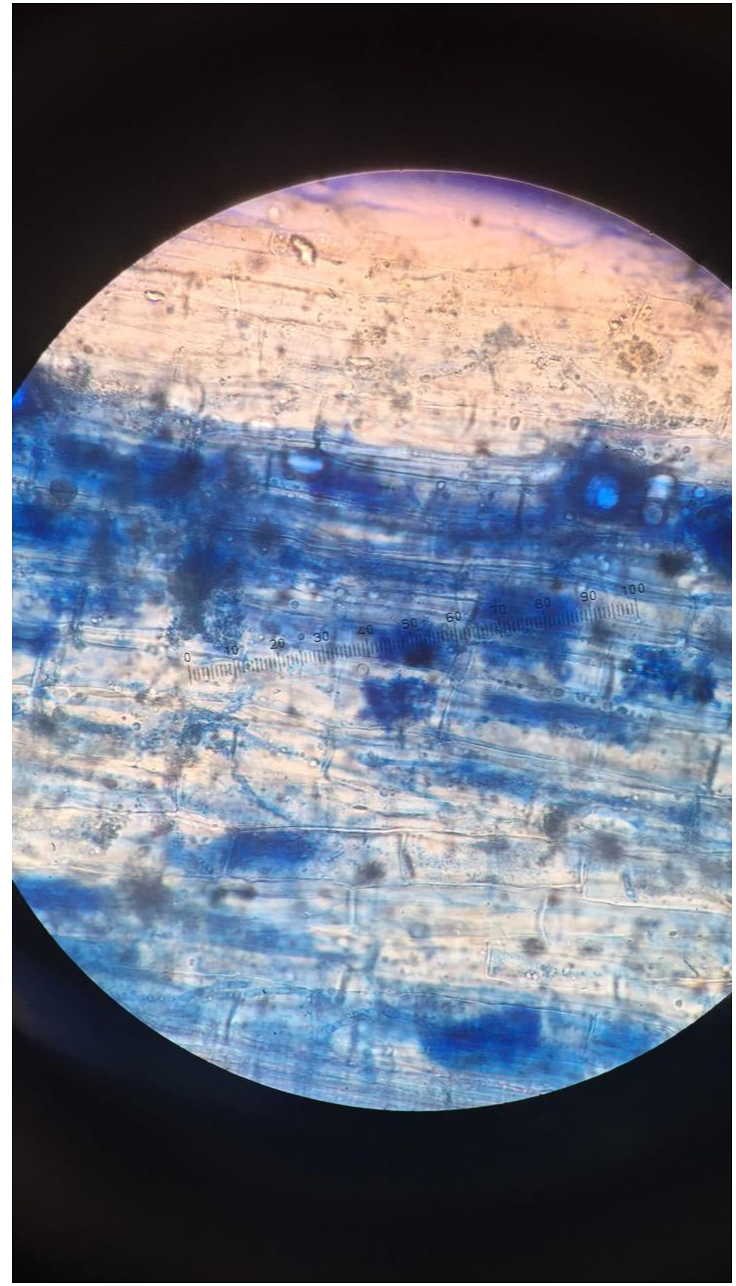
Structure quality	Size and appearance of aggregates	Visible porosity and Roots	Appearance after break-up: various soils	Appearance after break-up: same soil different tillage	Distinguishing feature	Appearance and description of natural or reduced fragment of ~ 1.5 cm diameter
Sq1 **Friable** Aggregates readily crumble with fingers	Mostly < 6 mm after crumbling	Highly porous Roots throughout the soil			 Fine aggregates	 The action of breaking the block is enough to reveal them. Large aggregates are composed of smaller ones, held by roots.
Sq2 **Intact** Aggregates easy to break with one hand	A mixture of porous, rounded aggregates from 2mm - 7 cm. No clods present	Most aggregates are porous Roots throughout the soil			 High aggregate porosity	 Aggregates when obtained are rounded, very fragile, crumble very easily and are highly porous.
Sq3 **Firm** Most aggregates break with one hand	A mixture of porous aggregates from 2mm -10 cm; less than 30% are <1 cm. Some angular, non-porous aggregates (clods) may be present	Macropores and cracks present. Porosity and roots both within aggregates.			 Low aggregate porosity	 Aggregate fragments are fairly easy to obtain. They have few visible pores and are rounded. Roots usually grow through the aggregates.
Sq4 **Compact** Requires considerable effort to break aggregates with one hand	Mostly large > 10 cm and sub-angular non-porous; horizontal/platy also possible; less than 30% are <7 cm	Few macropores and cracks All roots are clustered in macropores and around aggregates			 Distinct macropores	 Aggregate fragments are easy to obtain when soil is wet, in cube shapes which are very sharp-edged and show cracks internally.
Sq5 **Very compact** Difficult to break up	Mostly large > 10 cm, very few < 7 cm, angular and non-porous	Very low porosity. Macropores may be present. May contain anaerobic zones. Few roots, if any, and restricted to cracks			 Grey-blue colour	 Aggregate fragments are easy to obtain when soil is wet, although considerable force may be needed. No pores or cracks are visible usually.

Field x- Available N



Field x – Root:Shoot




0 10 20 30 40 50 60 70 80 90 100

International project; started Aug. 2

Alborada funded

- **Soil Microbial Interactions Using Inoculation and Compost Tea**
- Mycorrhizal fungi tested with crop in Nigeria & natural development
- Production of waste crop compost tea to reduce nutrient turnover(neem, jatropha & castor)
- Use of biochar to reduce nutrient loss
- Collaboration with African arm of Kent SME supplying inoculum
- Capitalise on previous NIAB project on affordable soil testing

Starting 2018

- Testing in UK and Nigeria
- Maize and Pigeon Pea

Starting Now; **SARIC** - Resilient and robust crop and livestock production systems

- Soil quality, structure health & function in Arable/E. England rotations
  - Introducing simple grass ley and complex herbal ley into arable rotation for 2 and 3 years
  - Either grazing or moving each treatment
  - Assessing range of soil crop and animal parameters:
    - Yield and crop quality following leys
    - Animal health and yield
    - Soil health and structure (several meaurements)
    - Economic evaluation
    - Farmer interactive and participatory

J. Leake (Sheffield U.) Lydia Smith (NIAB) D. Jones (Bangor U.) L. Norton (CEH) I Patterson (Loughborough U.) A Collins (Rothamsted) S Ullah (Birmingham U)

Restoring soil heath through re-integration of sheep and leys into arable rotations

- Participat ence-led, industry-i
- Build on c vork (& data

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