Soil Research Centre

University of Reading

Soil & Food Security

Martin Lukac

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"We are at a unique moment in history … the needs of a growing world population will need to be satisfied as critical resources … become increasingly scarce.

The food system must become sustainable, whilst adapting to climate change and substantially contributing to climate change mitigation"

Sir John Beddington

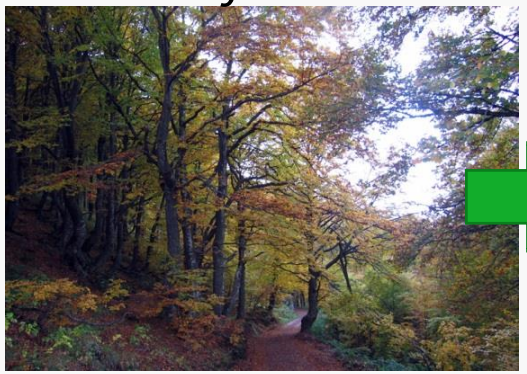
Chief Scientific Advisor, UK Government, 2008-2013

Overview

- Selection of projects summarised today on:
  - Soil ecosystem services and biodiversity
  - Soil organic matter and carbon
  - Soil loss/erosion
  - Microbes
  - Plant health
  - Phosphorus
  - Ecological intensification

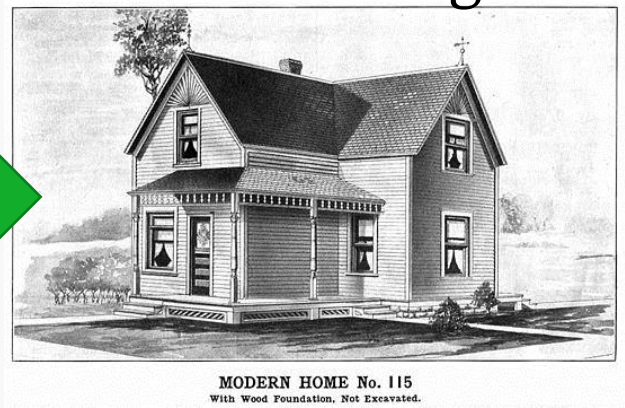
What are ecosystem services?

Ecosystems



Goods/Services

Wellbeing



Our health and well being depends on goods and services provided by ecosystems

Soil ecosystem services

Contact: Simon Mortimer

University of Reading

Soil biodiversity

Actions of, and interactions among, soil organisms

Processes and intermediate services

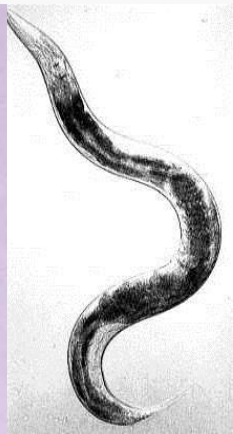
Decomposition
Weathering
Soil formation
Nutrient cycling
Water cycling
Primary production

Final ecosystem services

Provisioning:
Food, fibre, fuel
Clean water
Regulating:
Climate regulation
Flood regulation
Disease regulation







SOILSERVICE: Impact of land management on soil food webs

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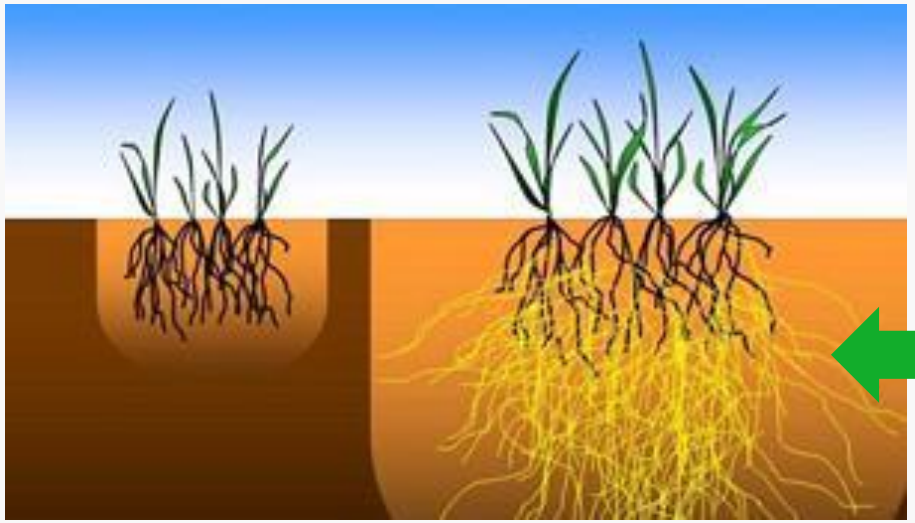
Key finding: Energy flow through fungi most vulnerable to agricultural management



Mycorrhizal fungi extend root network

(de Vries et al., SOILSERVICE project)

SOILSERVICE

SEVENTH FRAMEWORK PROGRAMME

Modelling impact of soil organic matter change on farm income

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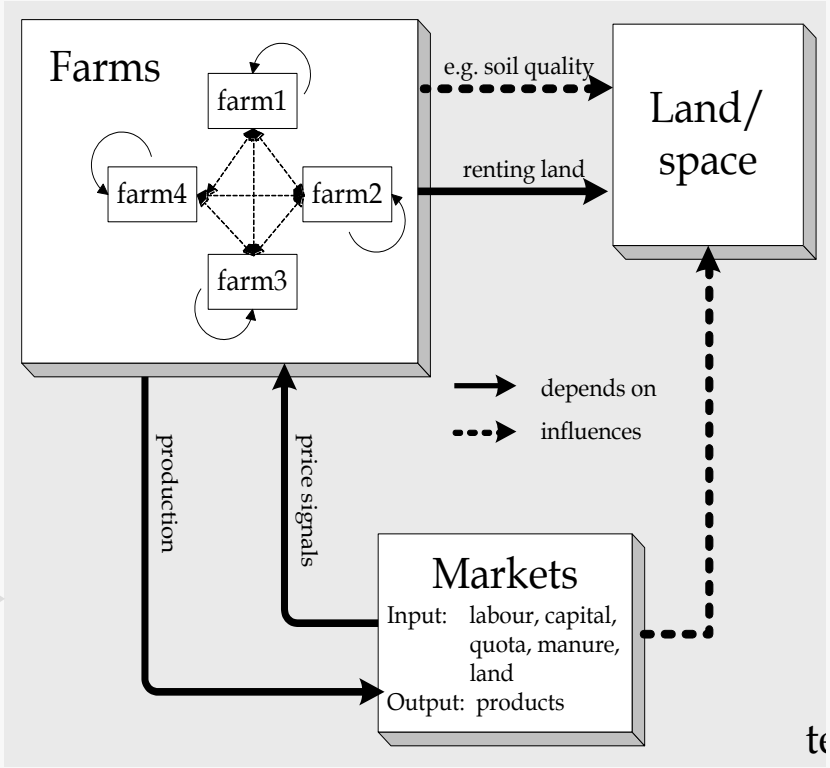
Key finding: ↑SOM = ↑farm profit, ↓SOM = ↓farm profit

AGRIPOLIS model, an agent-based model to explore scenarios of future land use

(Brady et al., SOILSERVICE project)



How to maximise carbon sequestration on a soft fruit farm

Contact: Martin Lukac

- Expand **grass strips** between crops
- Plant **deeper rooting** grass species with nitrogen fixers (clovers)
- Maintain soil rooted berry **shrubs in situ as the deep rooting** leads to C accumulation at depth.
- **Utilise the biomass waste** for a biomass boiler

Mitigation options to reduce soil loss: potential uptake by farmers

University of Reading

Contact: Alison Bailey

	Treatment	Cost to Farm (£ ha^{-1})	Effectiveness (%)
	Tramline disruption	- 2-4	69-99
	Minimum tillage	+ 68-78	4-98
	Crop residues	- 17-19	24-50
	Contour cultivation	- 0-5	45-79
	Vegetative barrier	- 2-7	9-97

Key finding:
Minimum tillage saves money.
Effective on sand
Poor on clay

Stone row cultivation
£30-£60 ha^{-1}

Wetland construction
0.01t-6t ha^{-1} yr^{-1}
£280-£3100

Rhizosphere carbon flow

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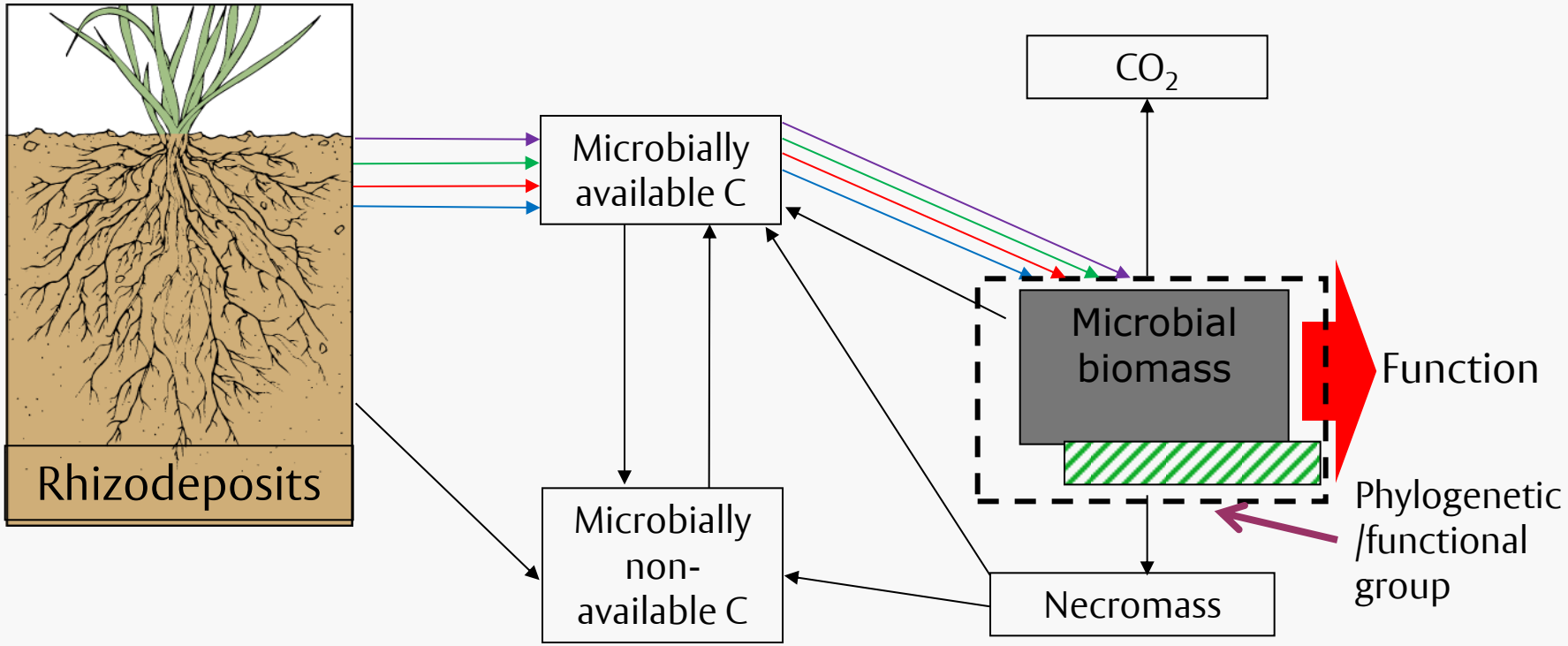
Contact: Liz Shaw

Key finding: ^{14}C FISH-FACS able to track microbial carbon flow



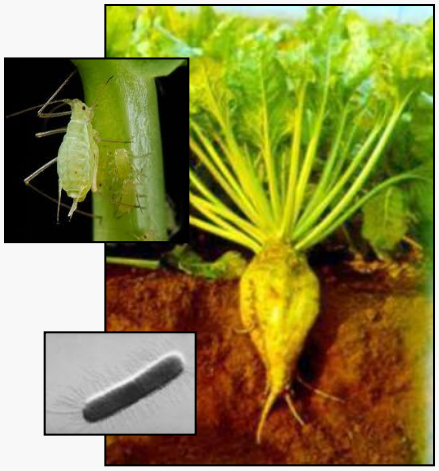
Aim: develop methods to quantify rhizodeposit carbon use by specific microbial groups

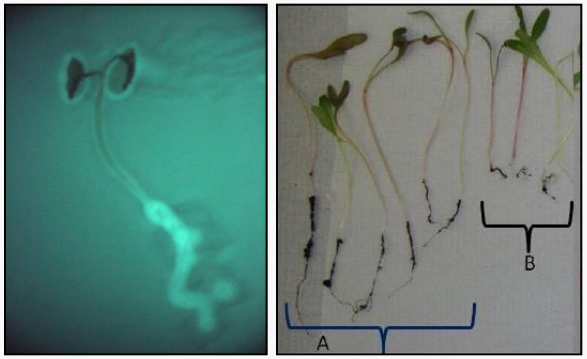
NERC SCIENCE OF THE ENVIRONMENT
BBSRC 20 Years of Pioneering Great British Bioscience
syngenta

Controlling plant pests and diseases

Contact: Rob Jackson

University of Reading





Using soil bacteria to protect the root against pathogens

Developing soil bacteria as biopesticides to kill pests

Key finding:
Pseudomonas kill aphids

Applying soil phage (virus) to treat tree infections

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BBSRC 20 Years of Pioneering Great British Bioscience
BARTLETT TREE EXPERTS SCIENTIFIC TREE CARE SINCE 1907
BAYER
HDC
The Leverhulme Trust

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Phosphorus Cycling in the Soil-Microbe-Plant Continuum

New 4 year BBSRC-NERC Global Food Security - Soil and Rhizosphere Interactions for Sustainable Agri-ecosystems project,

Contact: John Hammond

THE UNIVERSITY OF WARWICK

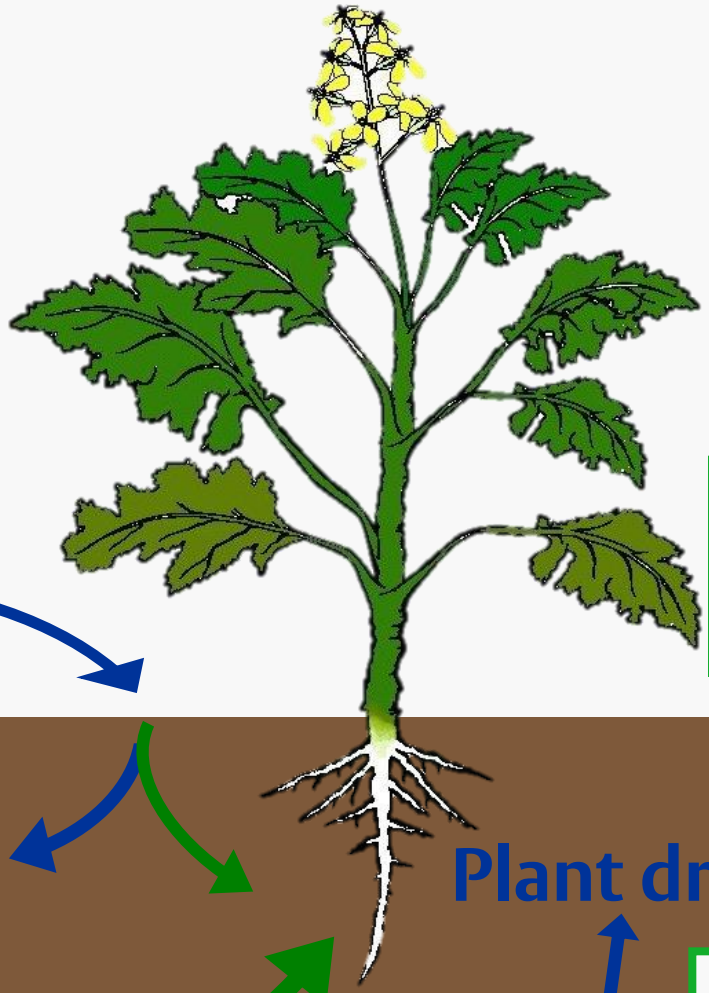
University of Reading

Cranfield UNIVERSITY

BBSRC bioscience for the future

NERC SCIENCE OF THE ENVIRONMENT

Investigating phosphate cycling in agricultural soils



Can we reduce inputs, by improving below ground processes?

Fertiliser P

How do these processes change during the season?

Soil P

Organic/ microbial P

Labile P

Non labile Soil P

Plant driven processes

How do these processes interact?

Microbial driven

Which microbes are driving this process?

Liberation Project

Linking farmland biodiversity to ecosystem services for effective ecological intensification

Contact: Simon Potts

Liberation Project

1) Quantifying the relationship between **soil management**, **semi-natural habitats** and multiple **ecosystem services** delivered by **biodiversity**: *A pan European field study*

2) Assessing the impacts of field boundary management for promoting **above-** and **below-ground** ecosystem services including **pollination**, **pest regulation** and **soil services**: *A UK field trial*

3) Identifying relationships between **semi-natural habitats**, **on-farm management** and **below-ground biodiversity**: *A review of current research*

Soil & Food Security

Soil & Food Security: Research Highlights

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- Effective and sustainable use of soils is essential for food security
- **Soil biodiversity**: fungi are most affected by land management
- **Soil organic matter**: ↑SOM = ↑Farm profit
- **Carbon**: low- or no-cost solutions for ↑SOM
- **Soil loss**: minimum tillage reduces soil loss and saves money
- **Microbes**: technology developed to understand how plants could be used to reduce GHG emissions and plant pathogens
- **Plant health**: soil bacteria can control pests
- **New projects**:
  - Managing soils to use **phosphorus** more efficiently
  - How biodiversity can deliver **ecological intensification**

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For more information, contact…

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Ecological Intensification

Simon Mortimer
Biodiversity

Martin Lukac
Carbon

John Hammond
Plant-soil

Mike Garratt
Ecosystem Services

Liz Shaw
Microbiology

Alison Bailey
Farmers

Rob Jackson
Pathogens