Delivering Sustainable Production Systems

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2015 International Year of Soils

Roy Neilson

- Alternative nutrients
- Nutrient/soil/water conservation
- Irrigation/water management
- Soil science

System Management

Plant Soil Interactions

- Plant-soil interactions
- Resource capture
- Nutrient uptake

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Sustainable Production Systems

Plant biology

- Crop Genetics
- Novel crops
- System specific breeding
- Plant eco-physiology

Agroecology

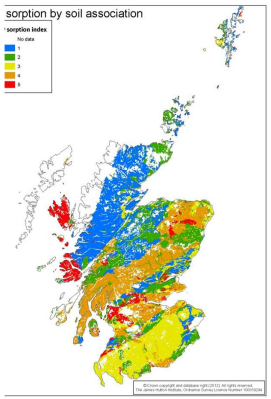
- IPDM
- Biodiversity conservation
- Soil science
- Nutrition/Environment

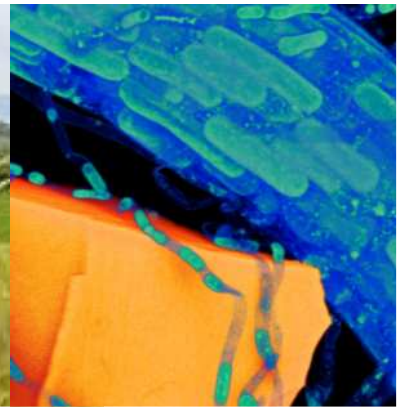
Social Sciences

- Sustainability economics
- Intelligent land use
- Social adoption/acceptance

Modelling

- Process/systems modelling
- Environmental bioinformatics
- Decision support tools
- Root models





The Centre for Sustainable Cropping

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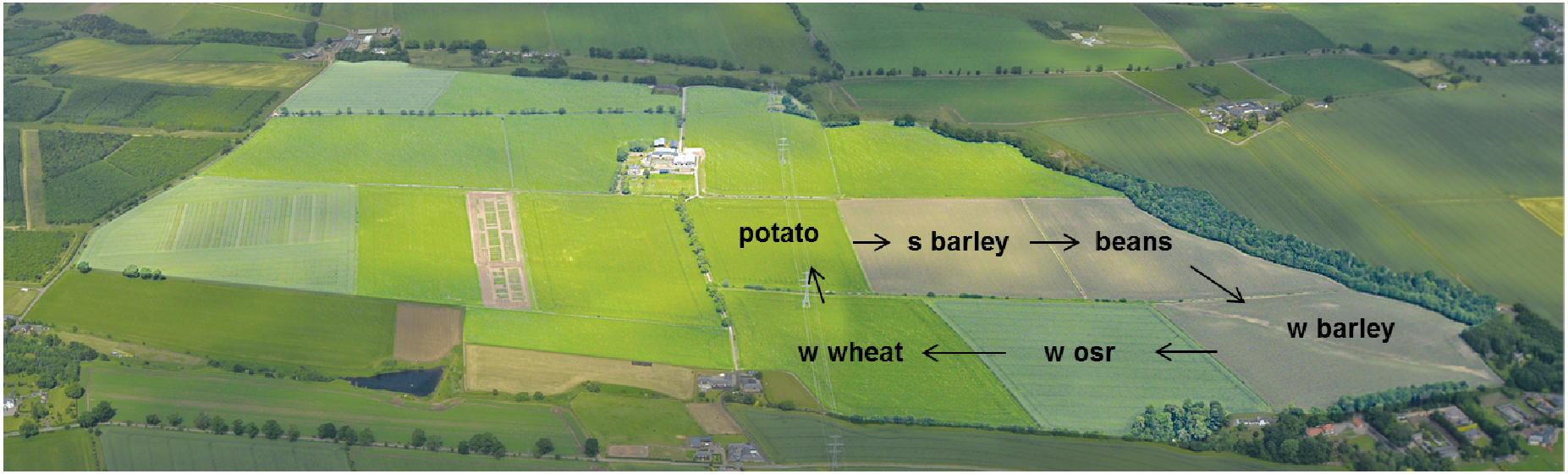


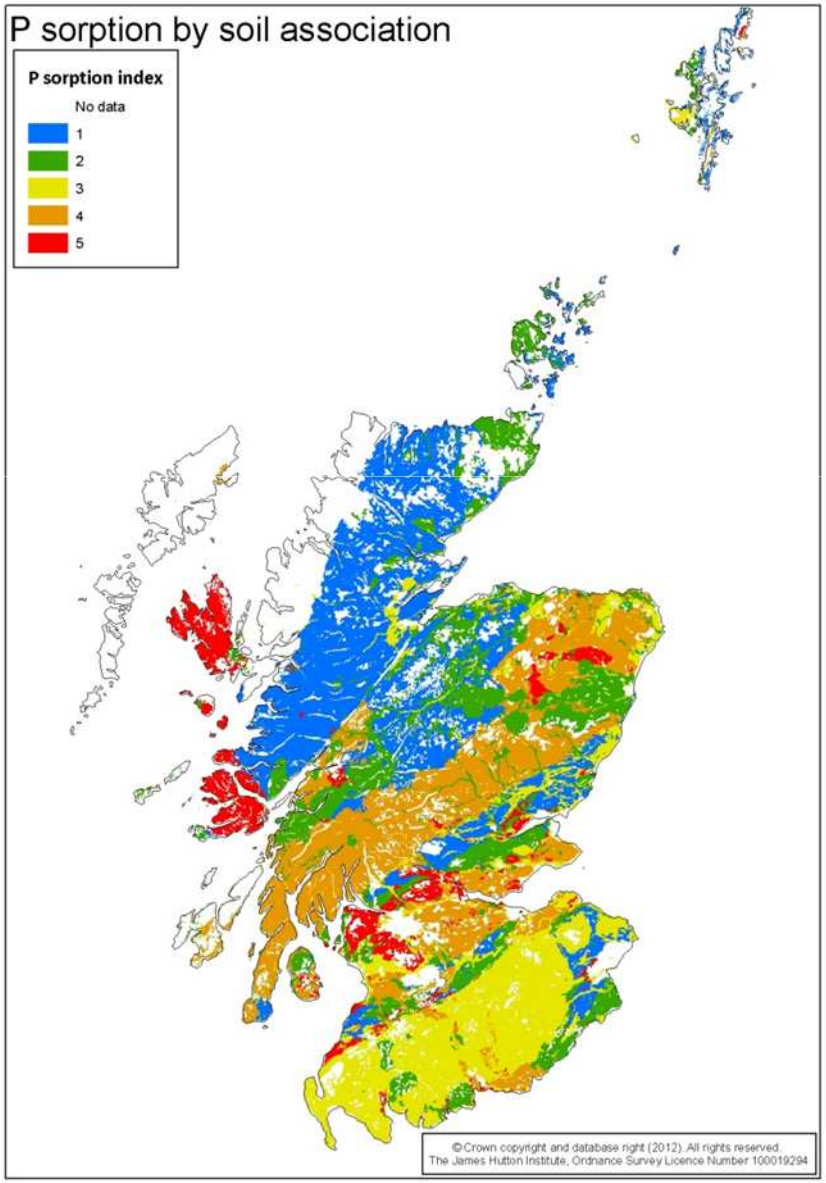
- Aim to design a sustainable system (both crop varieties and management) to:
  - Maintain the quality and stability of crop yields using lower levels of agrochemical inputs
  - Reduce greenhouse gas emissions and nutrient leaching
  - Enhance soil quality and arable biodiversity
- Provide a field scale test bed for new 'sustainable' crop cultivars to:
  - Enhanced resource use efficiency
  - Weed suppression
  - Pest/disease resistance

IPM toolboxes for crops

Raspberry beetle trap developed with Agrisense

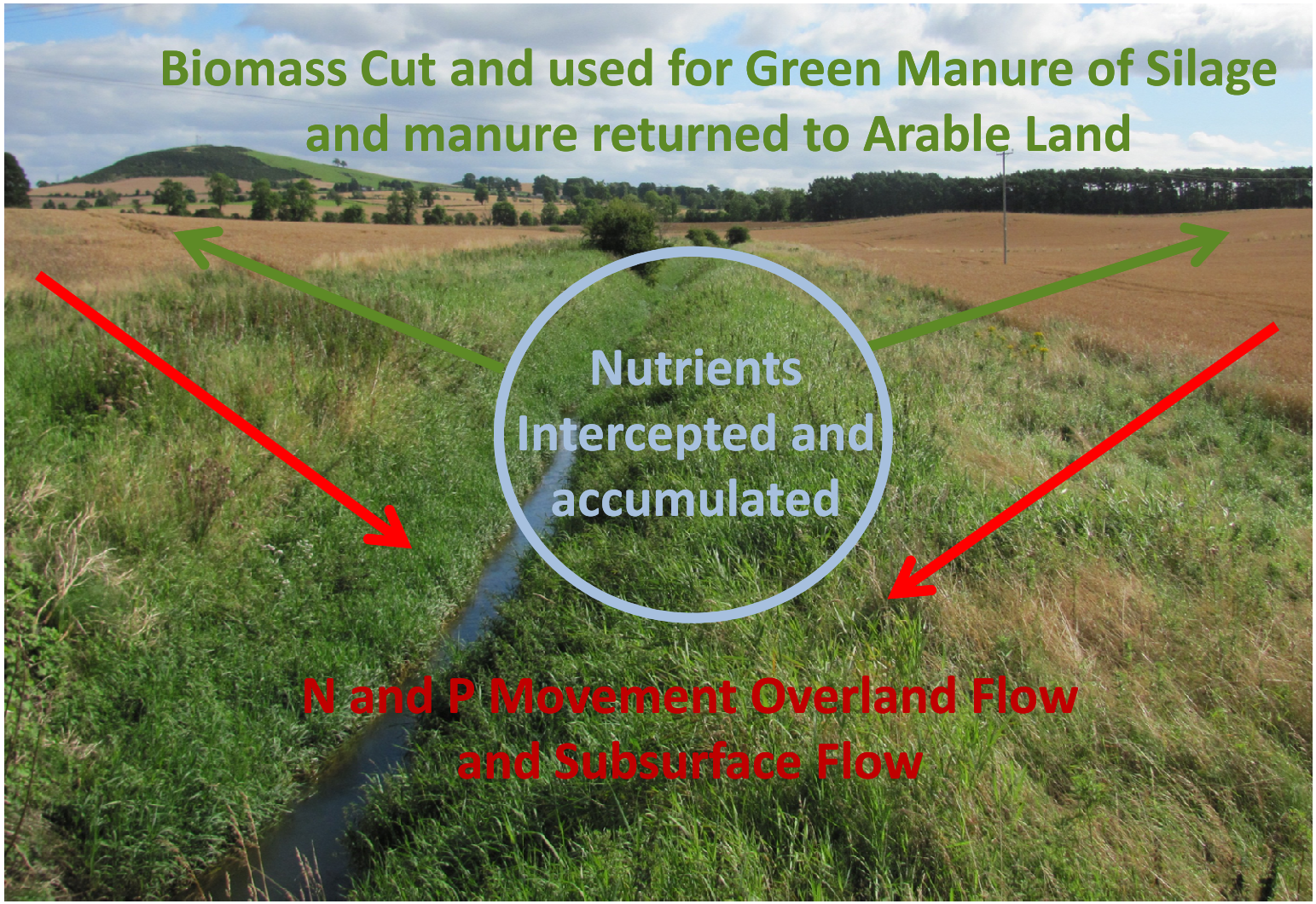
- Including soft fruit, brassicas and cereals
- Inter-disciplinary research:
  - Plant genetics and breeding
  - Pest ecology
  - Chemical ecology
  - Plant pathology
  - Agronomy
  - Modelling population dynamics across multiple scales.

P sorption modelling



- Soil sorption model provides understanding of interactions at a nano scale
- Application to NSIS soil database
  - Soil association data
  - Metal contents
  - Organic matter
  - Clay
  - pH
- Allows mapping at large scale
- SEPA using index to prioritise areas for remedial action

Potential landscape management of nutrients



Analysis of complex populations

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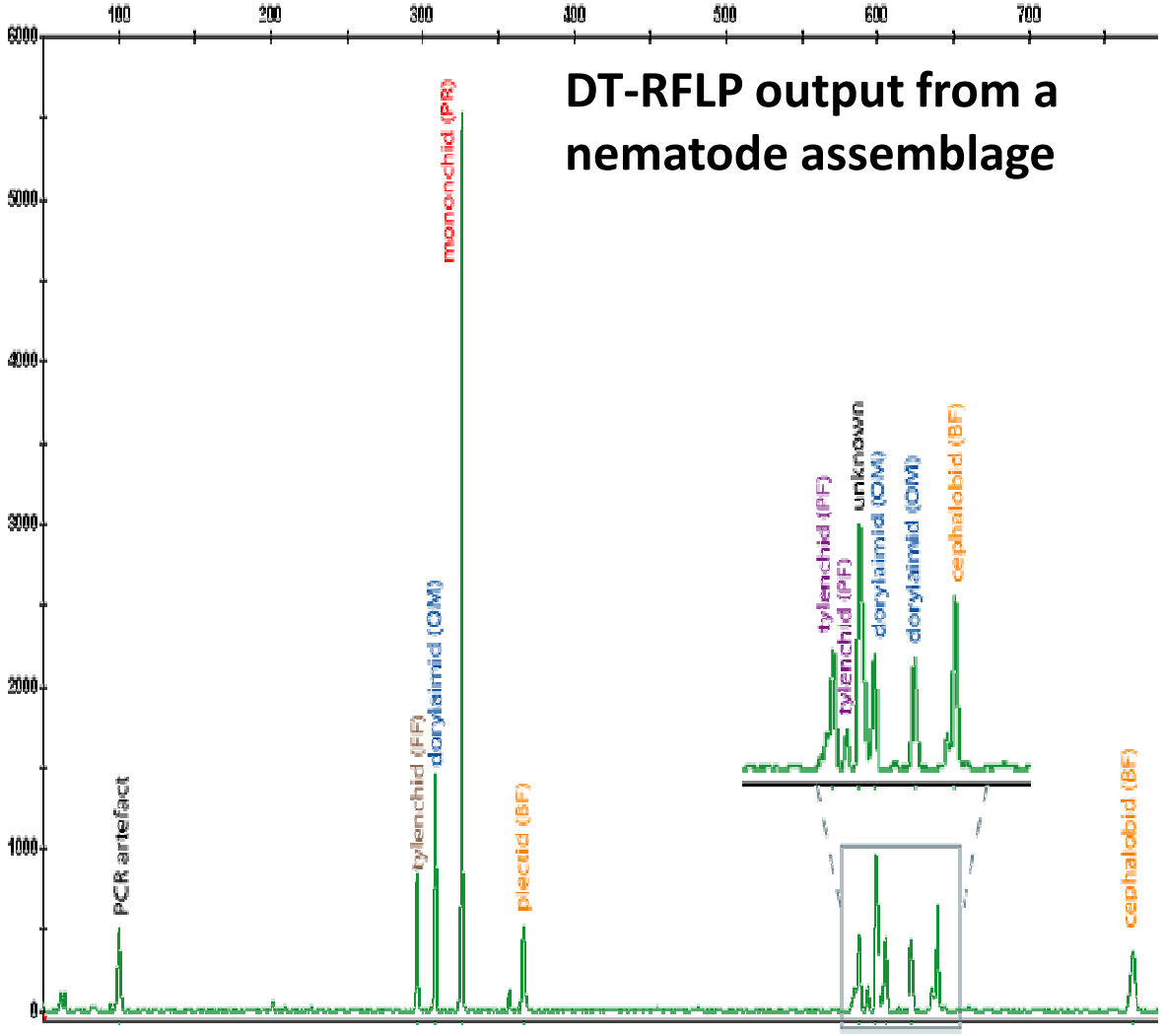
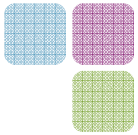
- Nematodes - a potential biological indicator?
- Ubiquitous
- Easily extracted
- Short generation times
- Range of trophic (functional) groups
- Aligns well with classical taxonomy
- Operates across a range of habitats
- Quantitative when combined with real time PCR





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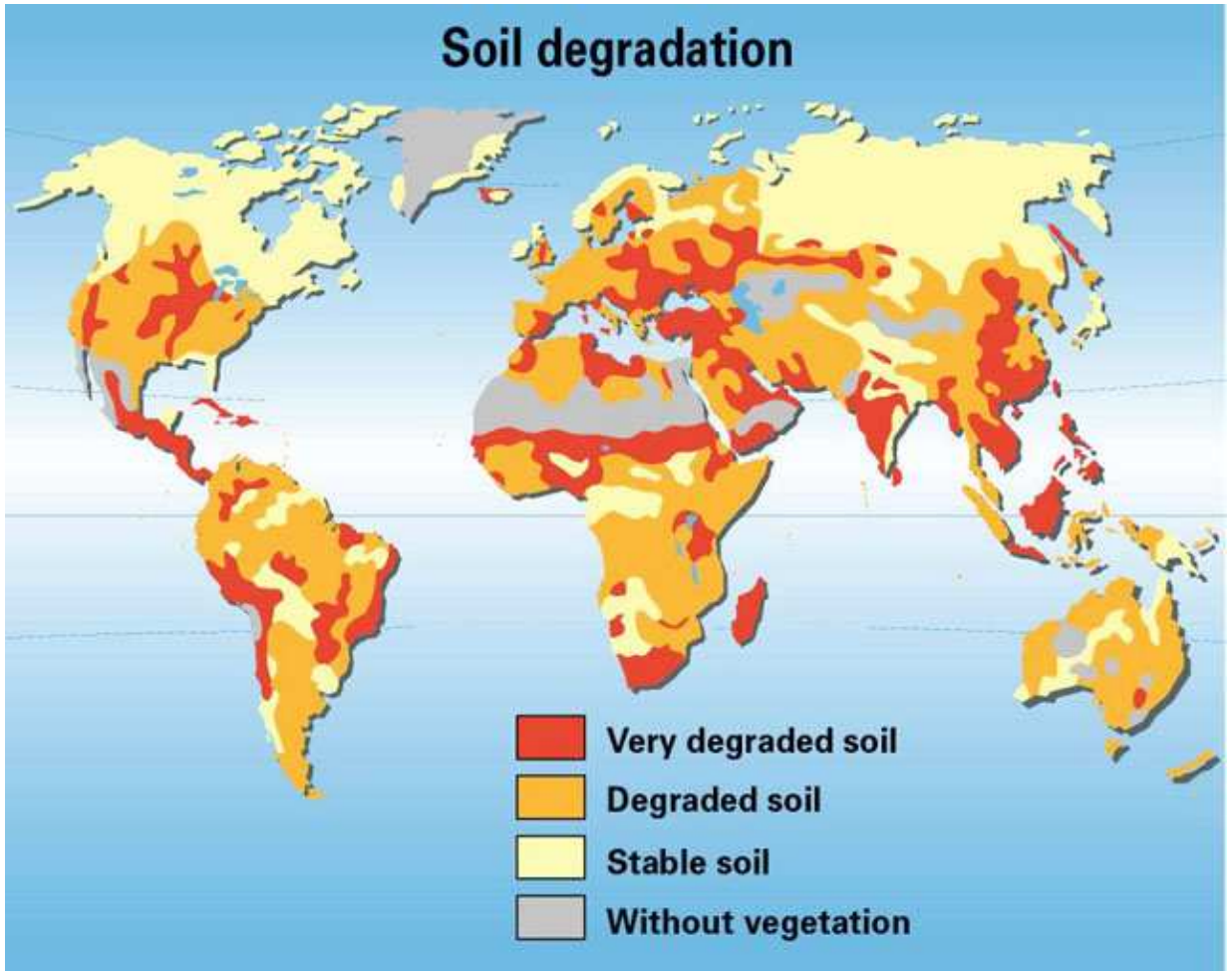
A nation that destroys its soils destroys itself.

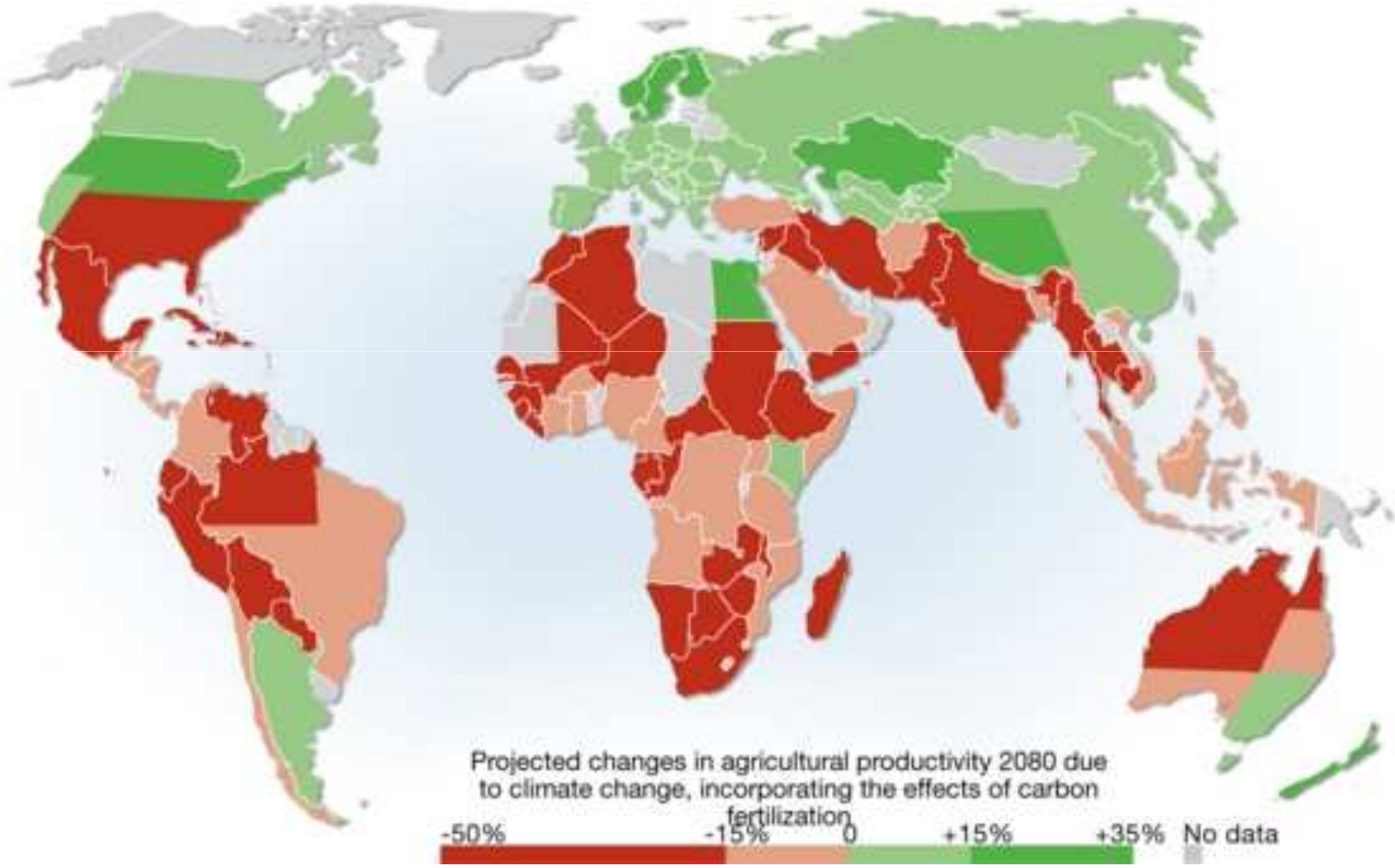
Franklin D. Roosevelt

Global Soil Degradation



http://maps.grida.no/go/graphic/degraded-soils

Changes in agricultural productivity due to climate change by 2080



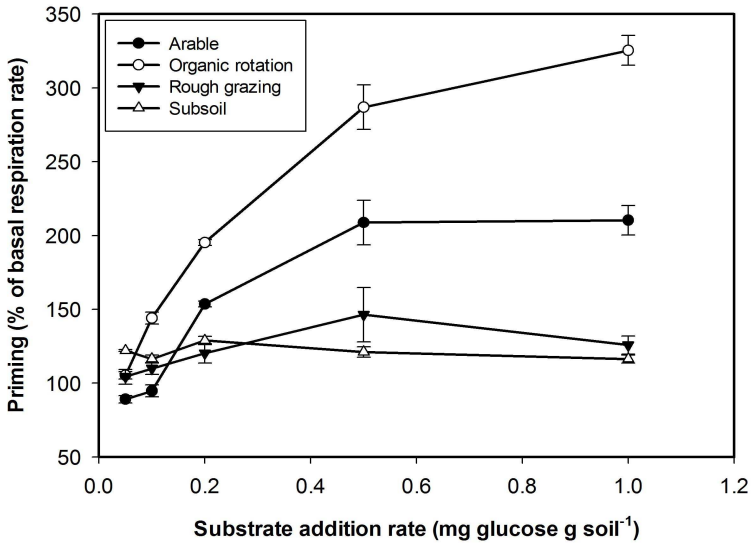
http://maps.grida.no/go/graphic/projected-agriculture-in-2080-due-to-climate-change

Soil – a multifunctional complex system

Constraints for successful growing include:

- Changing Climate
- Resource limitation
- New pests & diseases

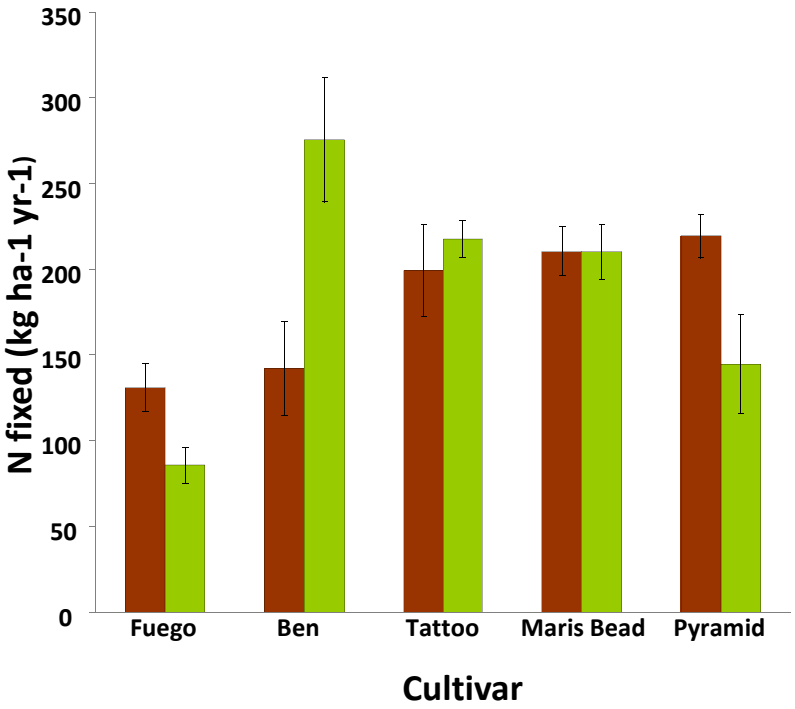
Can we identify soil types and plant traits for improved production?



- Potential for soil-specific fertiliser recommendations (reduced costs, reduced pollution)
- Manipulate microbial communities to manage nitrification
- Roots for optimal nutrient acquisition
- Develop soil amendments that provide the required elements
- Improve P access

Screening for improved N-fixation

Legume Futures



- Nitrogen fixation by 5 faba bean cultivars grown under two fertiliser regimes at the Centre for Sustainable Cropping (CSC) was assessed.
- Beans under both treatments were capable of fixing >200 kg N ha^{-1}
- Varietal differences were apparent, and these are being investigated further.

Arbuscular mycorrhizal (AM) fungi

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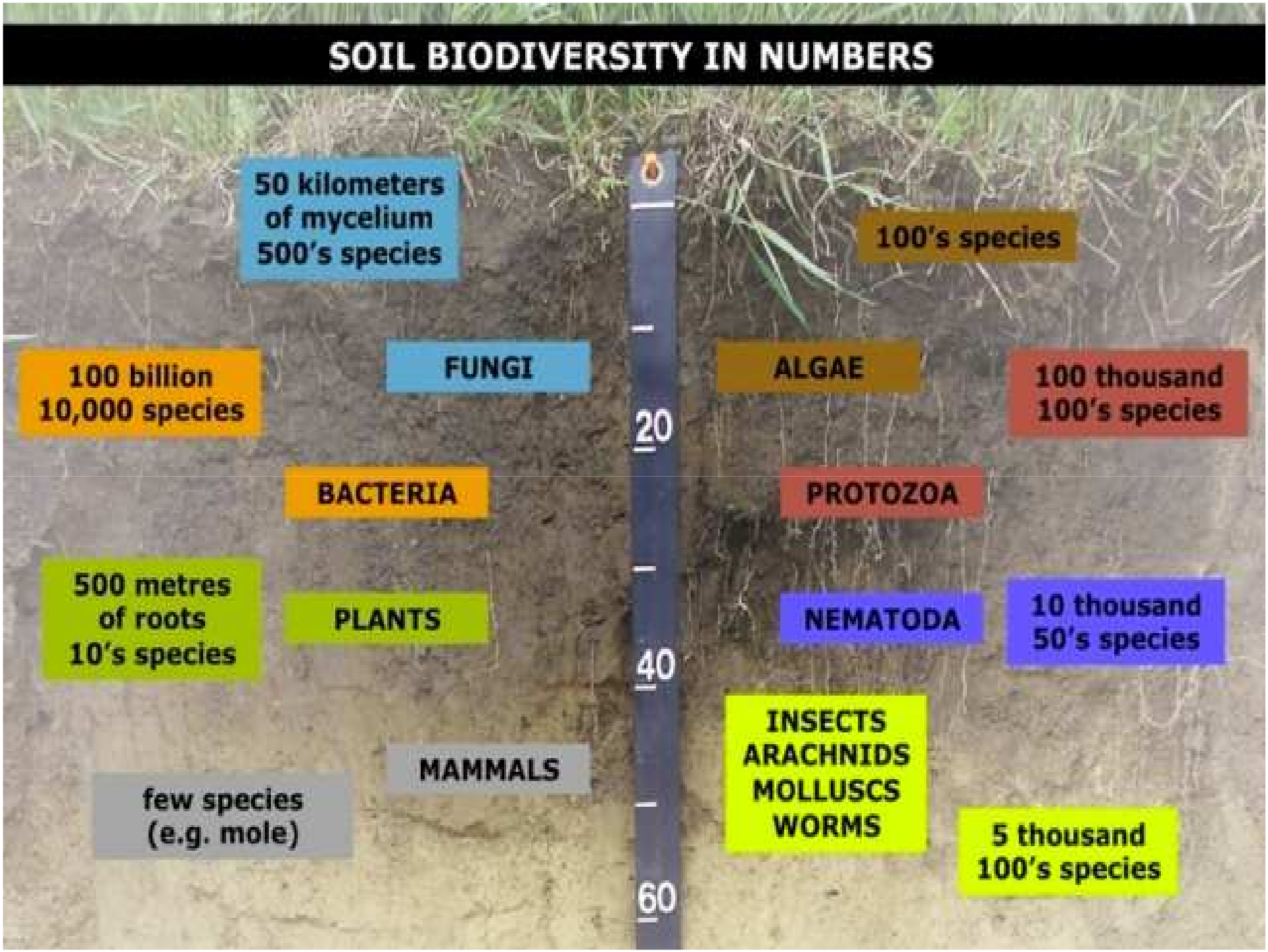
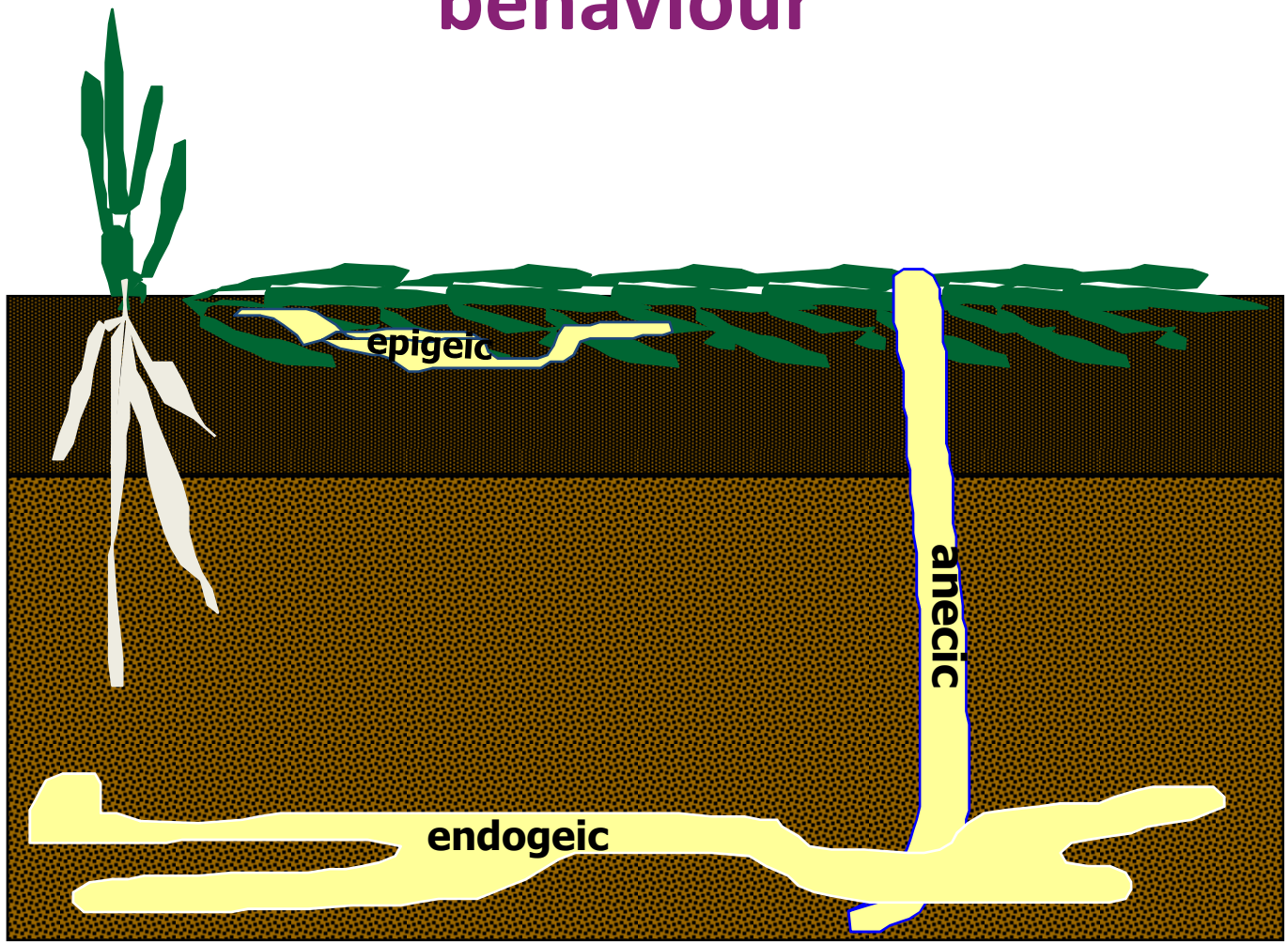
- AM fungi are unculturable
- Most agricultural plants are mycorrhizal
- Highly multifunctional for example roles in nutrient uptake, resistance to pest, pathogen and drought.
- Can we use AM to aid sustainable agriculture?


SOIL BIODIVERSITY IN NUMBERS
50 kilometers of mycelium 500's species
FUNGI
100 billion 10,000 species
BACTERIA
500 metres of roots 10's species
PLANTS
few species (e.g. mole)
MAMMALS
100's species
ALGAE
100 thousand 100's species
PROTOZOA
10 thousand 50's species
NEMATODA
INSECTS ARACHNIDS MOLLUSCS WORMS
5 thousand 100's species
0
20
40
60

Megascolecidae

Earthworm feeding strategy and behaviour



Influence of environmental factors on earthworms

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- **Moisture:** Earthworms are vulnerable to desiccation, so will not survive prolonged dry soil (below 20% water content) - earthworms are aerobic organisms, so they need an oxygen supply and will not survive prolonged water-logging
- **Temperature:** Temperature optima are typically 12-20^{o}C
- **pH (acidity):** Earthworms differ in sensitivity to acidity depending on species, e.g. epigeic species (litter-dwelling) tend to be more acid tolerant
- **Organic matter:** OM is the primary food source – earthworm numbers related to OM content, quality of plant residues, dung, compost etc
- **Soil type:** Direct influences difficult to find – soil type integrates other factors

New Zealand flatworm

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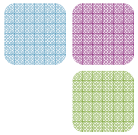

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GROW

OBSERVATORY

GROW Observatory

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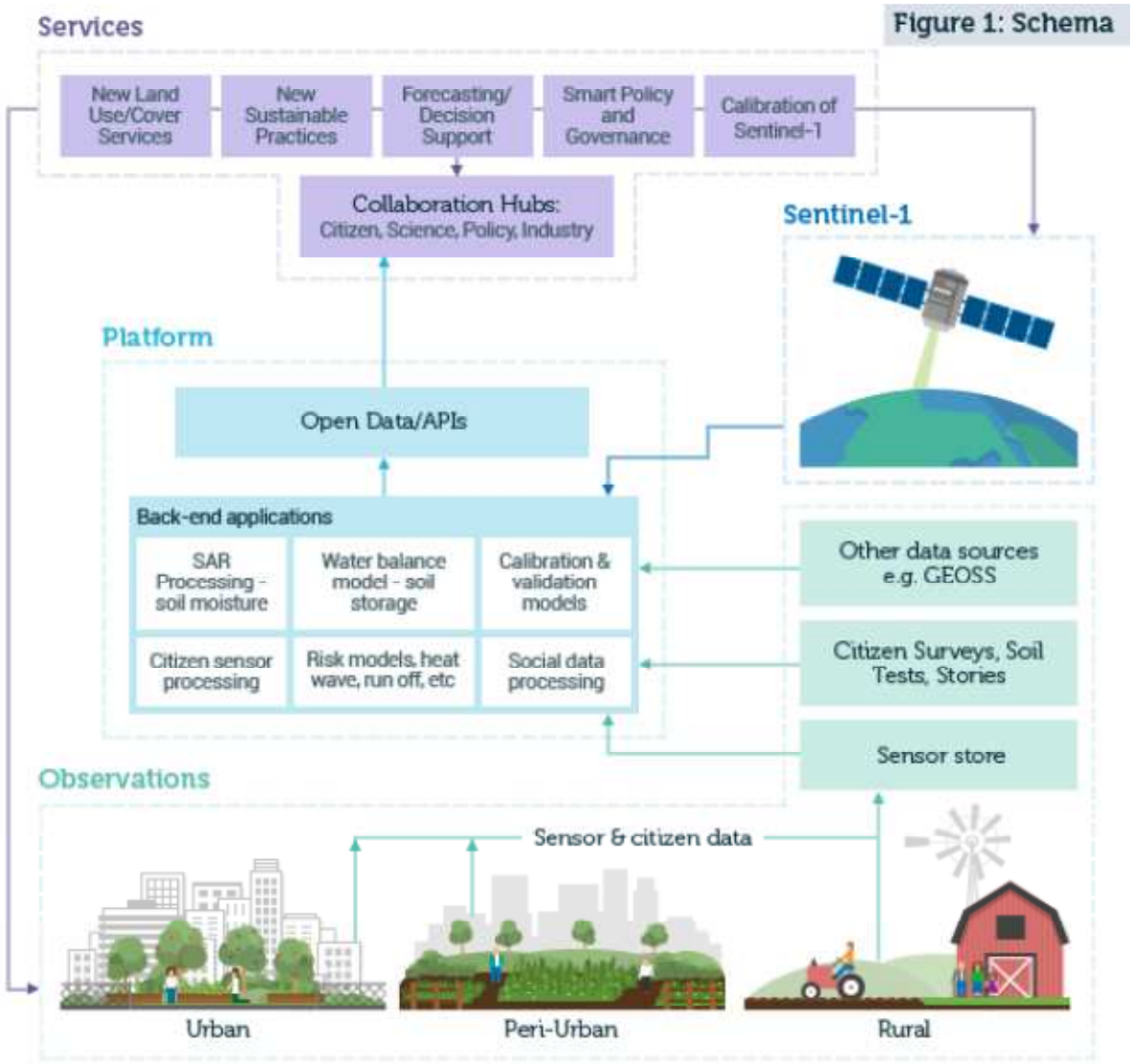
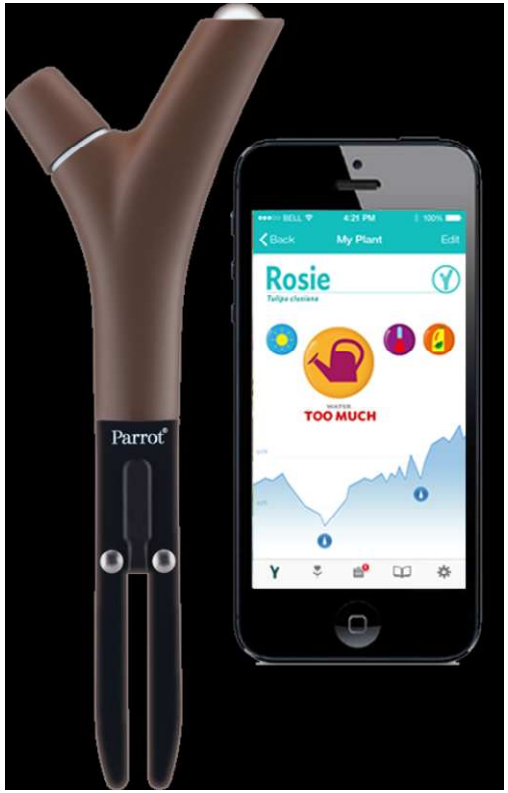
Figure 1: Schema





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- Brian Boag
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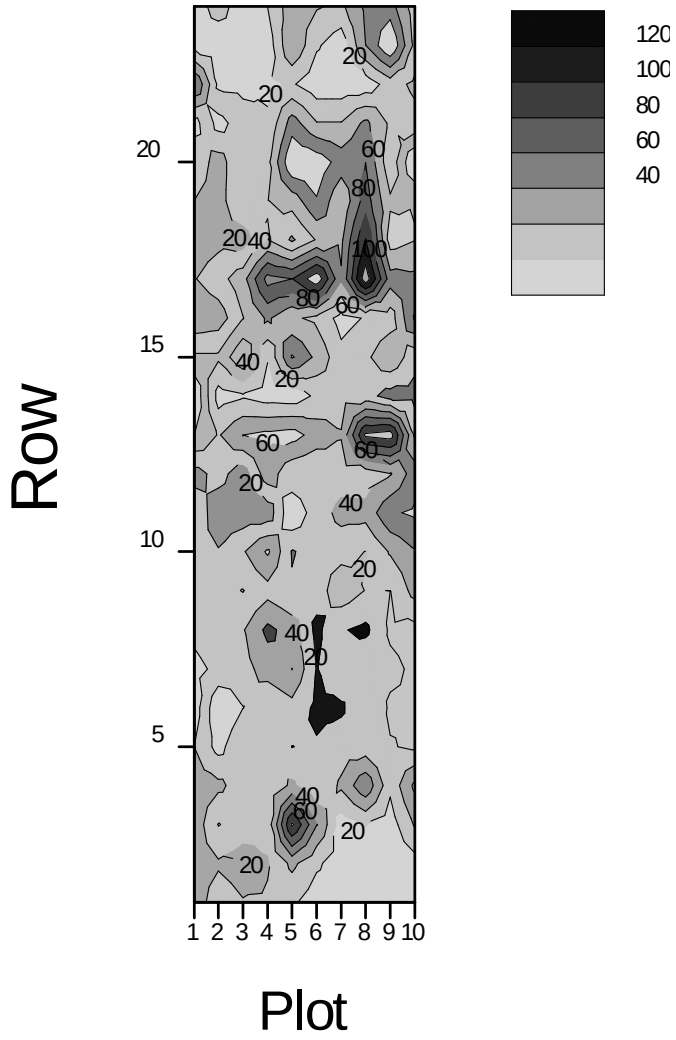
- Parrot Flower Power

(*Para*)*Trichodorus* Field Distribution



Precision nematicide application?

Crop damage due to Free Living Nematodes

TRV symptoms