Healthy soils for crop production

SEFARI
LEADING IDEAS FOR BETTER LIVES

The James Hutton Institute

Kenneth Loades

Soil delivers multiple benefits

The James Hutton Institute

Creating and maintaining optimum soil condition for multi-functional balance of the ecosystem

Food production | Climate regulation | Water regulation

By monitoring and management of soil-plant interactions

- Water supply
- Nutrient supply
- Rooting conditions
- Plant pathogen risk
- Drainage
- Microbial activity
- Nitrate availability
- C stabilisation
- Structural stability
- N & P availability
- Soil cover

Scottish Government
Riaghaltas na h-Alba
gov.scot

Soils are complex

Climate

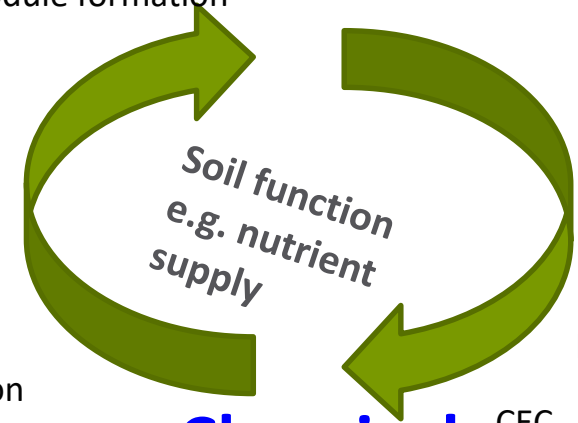
Temperature, rainfall, evaporation

Where impact is mediated by both amount and seasonality

Nutrient inputs

e.g. Fertiliser, manure, deposition

Where availability is mediated by many of the same factors



Plant

Root infection with mycorrhizal fungi

Nodule formation

Nitrogen fixation

Soil enzymes

Action and activity of soil fauna

Biological

Activity of decomposing micro-organisms

Mineralisation immobilisation

Organic ligands

Presence of potentially toxic elements

Physical

Compaction

Bulk density

Aeration

Soil water balance

Buffer capacity

pH

Pore size distribution

Temperature

Texture

Chemical

CEC

Balance of micronutrient availability

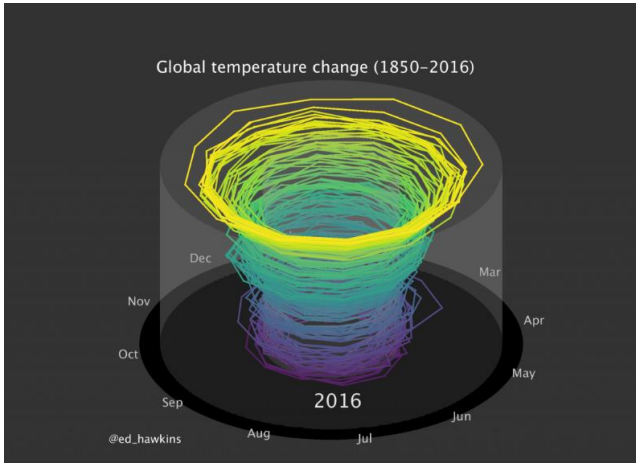
Redox potential

Salinity

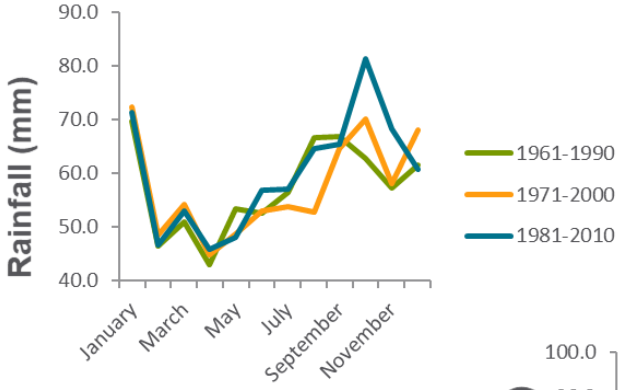
Mineralogy

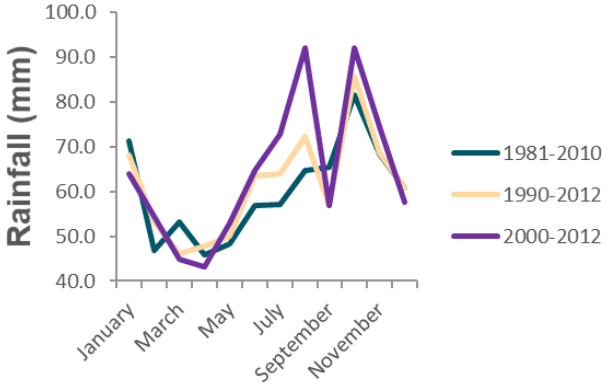
Threats to soil – a changing climate

1.6 ° C
(since 1954)



Source: Climate Lab Book – Open Climate Science





What is a healthy soil?

- It’s complicated……
- Function and service, capability, resilience?
- Healthy soil a balance of:
  - Biology
  - Chemistry
  - Physical attributes
- IF you were to be paid for having a healthy soil what would be the best measure?

The James Hutton Institute

Scottish Government
Riaghaltas na h-Alba
gov.scot

Key is in understanding what baseline we are working from?

- Recent Scottish Climate Change and Adaptation Programme highlighted a lack of metrics
- Different attributes dependent on soil type
- Measuring resilience must include recovery
- Scale of measurement (satellite imagery, drone technology etc.)
- Soil tests are available and more being developed to include measures for chemistry, physics and biology
- No single tool available to measure soil health, quality and resilience

The James Hutton Institute

Scottish Government
Riaghaltas na h-Alba
gov.scot

What measurements are available for soil health?

The James Hutton Institute

Scottish Government
Riaghaltas na h-Alba
gov.scot

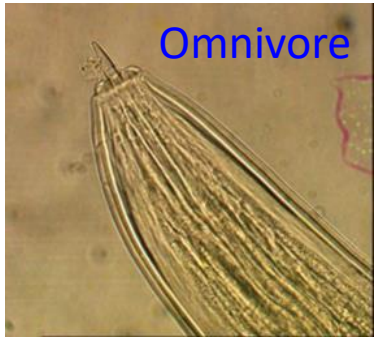
Benefits of using nematodes as bioindicators

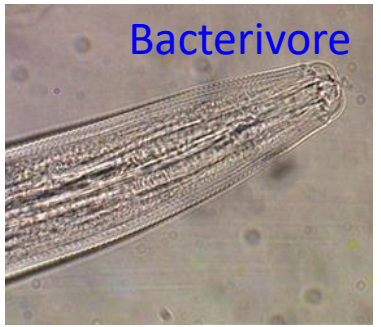
- Abundant in all habitats
- High species richness
- Tolerance sensitivity range
- Low mobility
- Conservative reproduction strategies
- Interstitial mode of life
- European (global) scale monitoring
- Accepted functional classification

The James Hutton Institute

Scottish Government
Riaghaltas na h-Alba
gov.scot

T-RFLP peaks aligned with identified nematodes



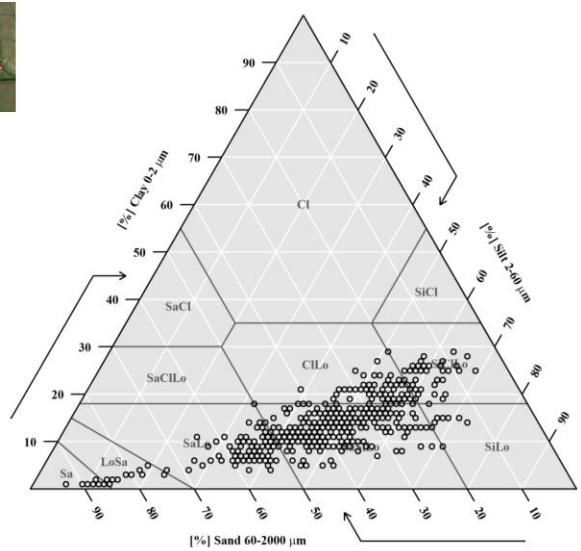


The James Hutton Institute

Scottish Government
Riaghaltas na h-Alba
gov.scot

Soil sampling for SoilBio

- c. 5200 soil samples including:
  - nematode community
  - soil chemistry
  - management data
- c. 1100 samples with additional soil physics data

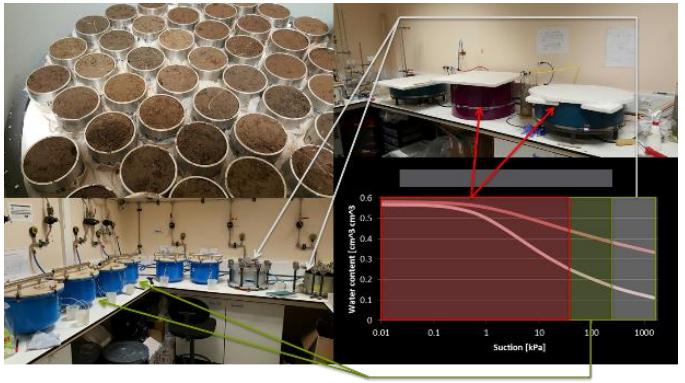


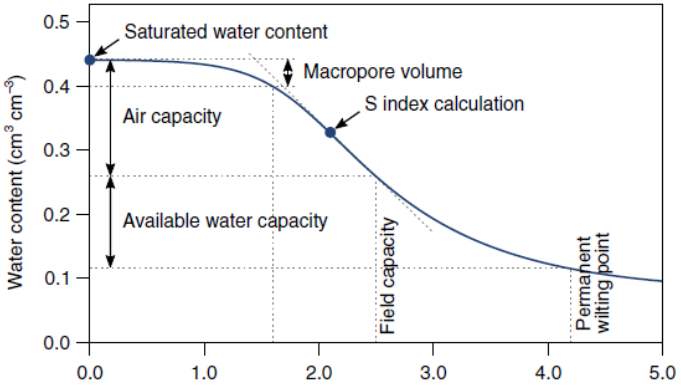
The James Hutton Institute

Scottish Government
Riaghaltas na h-Alba
gov.scot

Soil physics data

- Critical information on soil functions
- Long time to gather data (3-6 months for a core)
- Soil texture significantly alters physics
- Fundamental information for assessing different soil functions
- Provides information

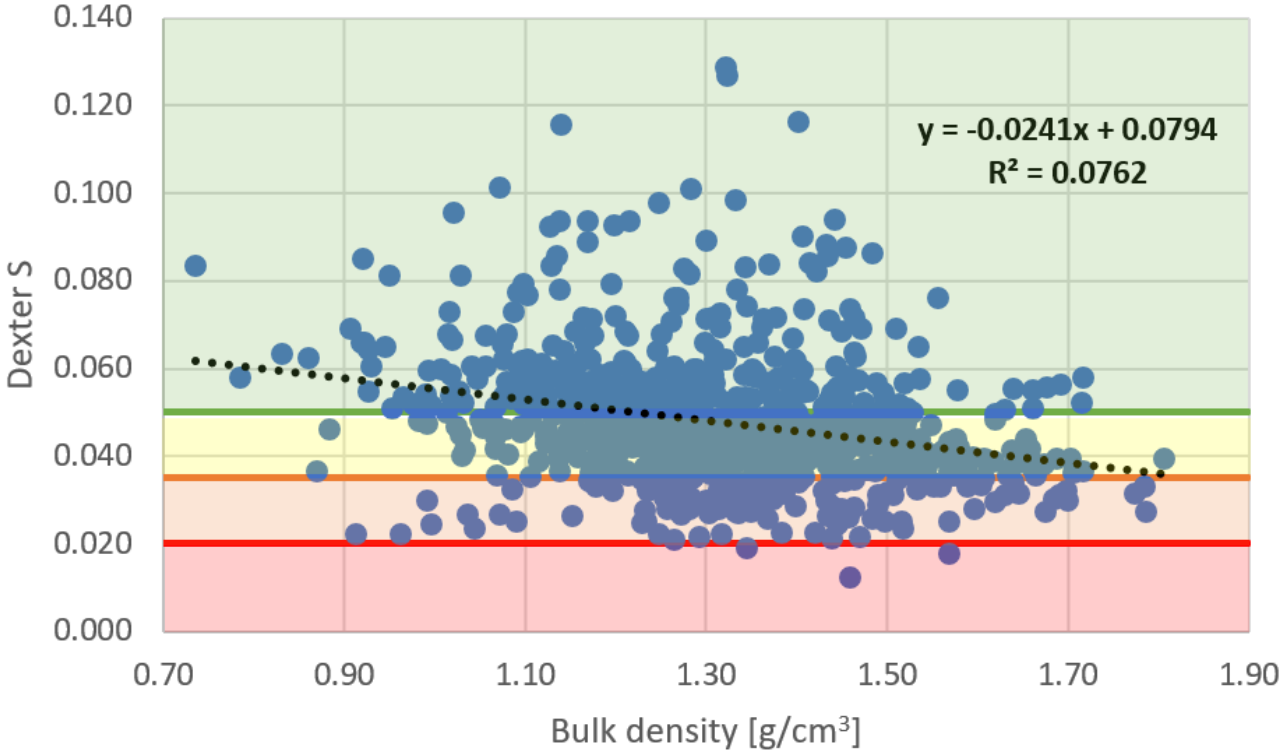




The James Hutton Institute

Scottish Government
Riaghaltas na h-Alba
gov.scot

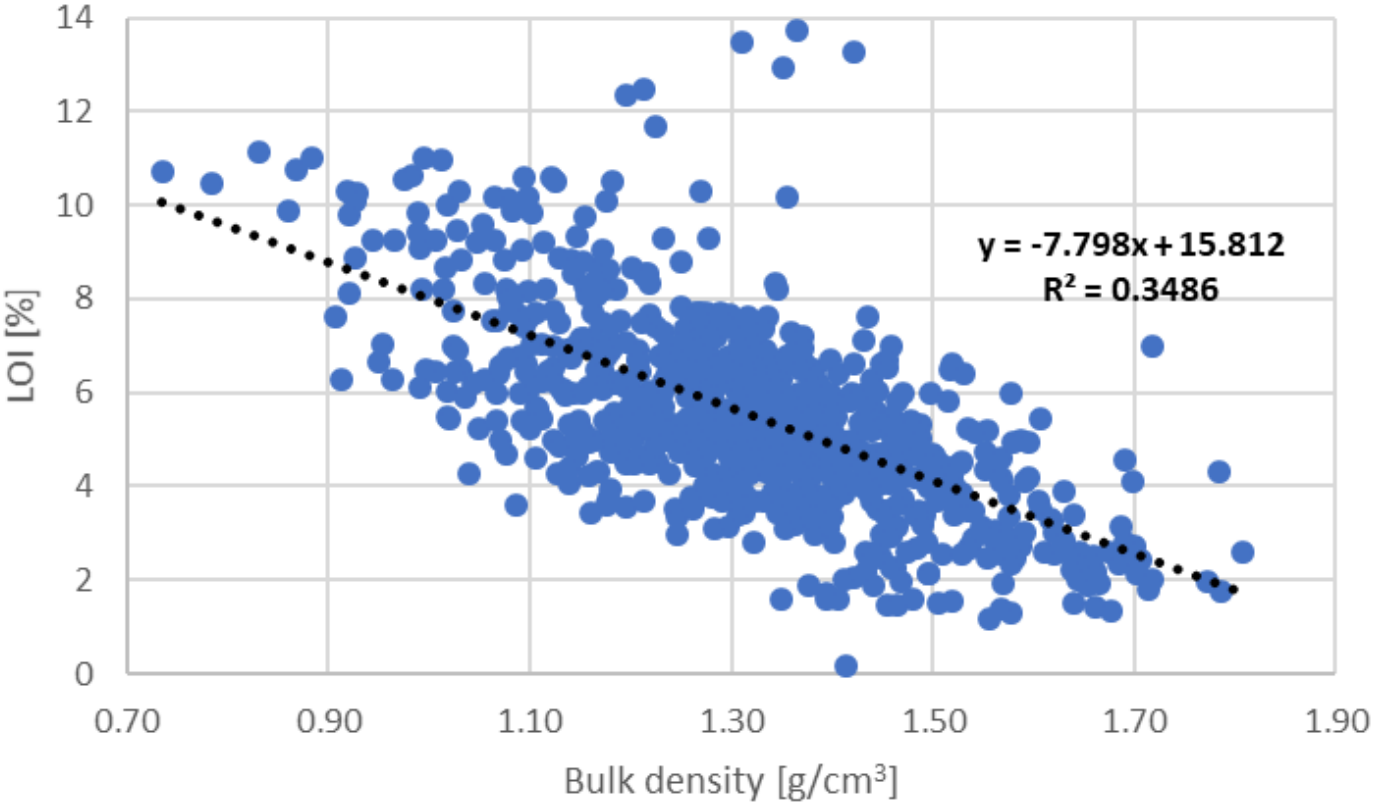
Soil pore sizes – Dexter S indicates size distribution



The James Hutton Institute

Scottish Government
Riaghaltas na h-Alba
gov.scot

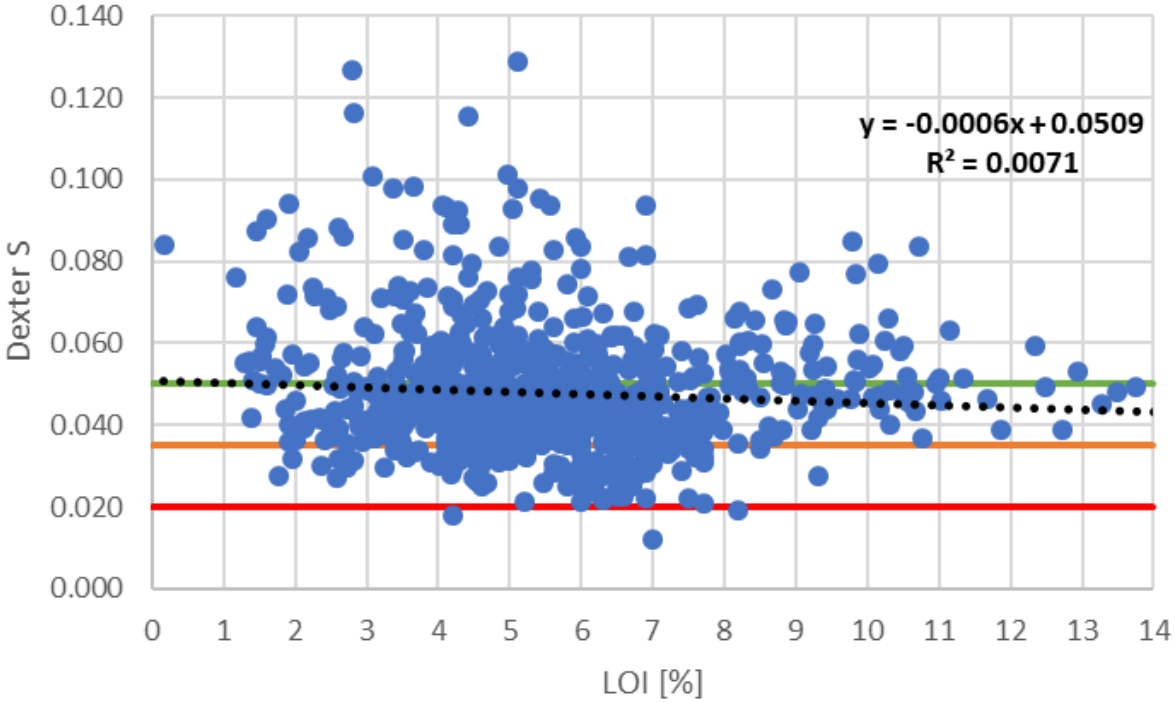
Organic matter and soil bulk density



The James Hutton Institute

Scottish Government
Riaghaltas na h-Alba
gov.scot

Dexter S - Relationship with organic matter (loss on ignition)



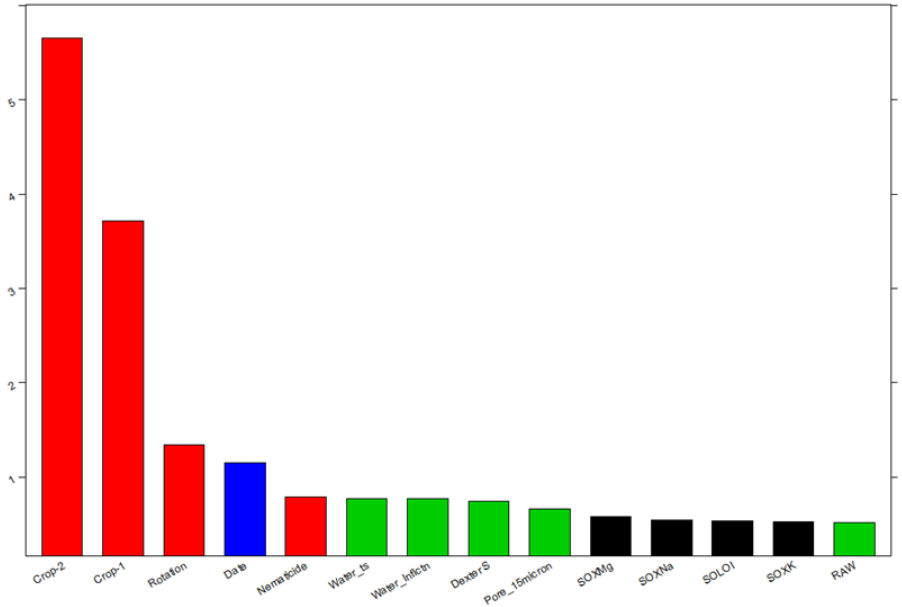
The James Hutton Institute

Scottish Government
Riaghaltas na h-Alba
gov.scot

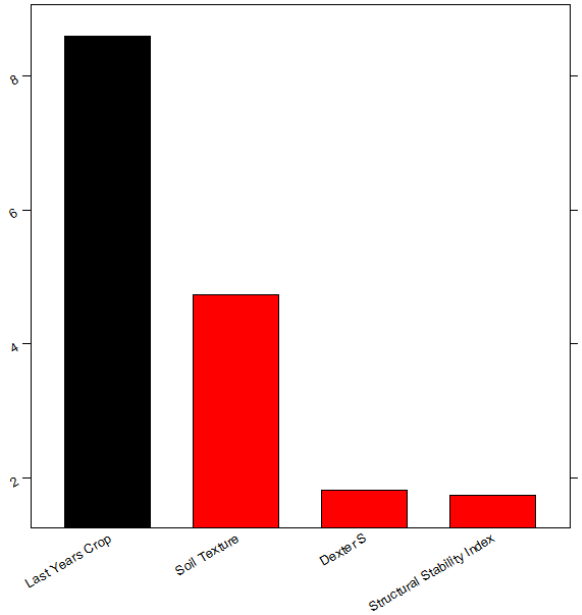
Initial analysis – Drivers of SoilBio data (3 years UK)

The James Hutton Institute

Scotland only data – Year 1



UK data – All years

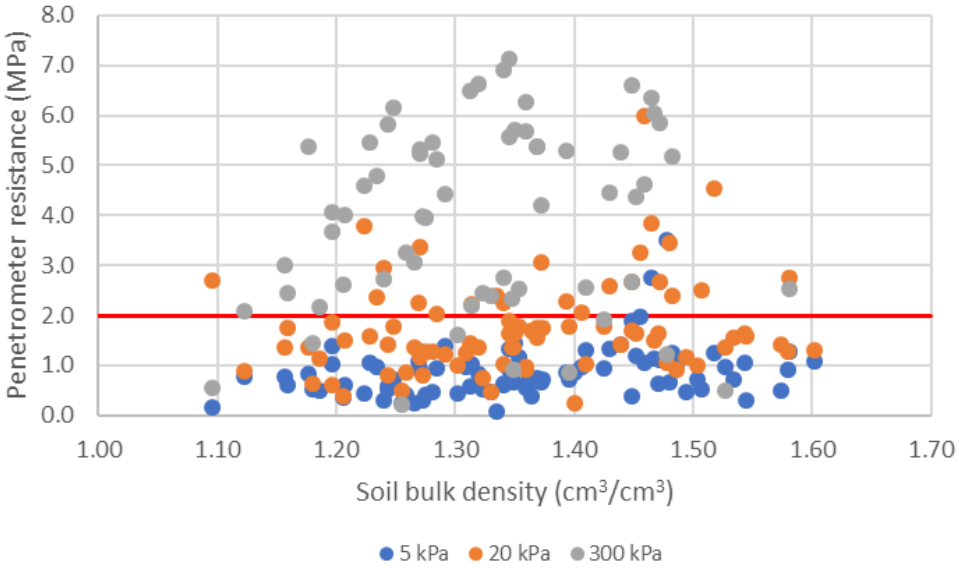


Scottish Government
Riaghaltas na h-Alba
gov.scot

Other data collected - Soil water content and physical limitations to root growth

The James Hutton Institute

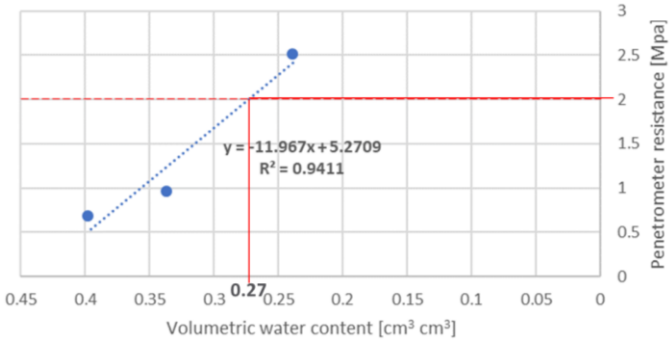
- Root growth limited beyond a penetrometer resistance of 2 MPa
- Root growth physically limited as soils dry
- Plant available water assumes water available to 1500 kPa

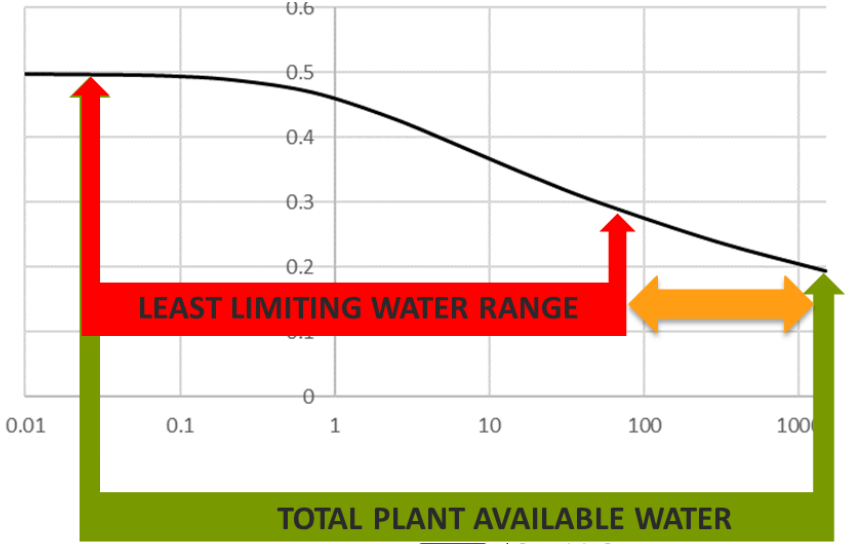


Scottish Government
Riaghaltas na h-Alba
gov.scot

Physics measurements, moving beyond total plant available water - LLWR

- Assumption that water limiting plant growth rather than mechanical impedance
- Least Limiting Water Range corrects for this
- Threshold for impedance of 2 MPa





The James Hutton Institute

Scottish Government
Riaghaltas na h-Alba
gov.scot

Different measures available to assess soil health and function

The James Hutton Institute

- No single tool available to fully assess soil health and quality
- A sandy soil in poor condition may on paper be better than a well managed heavier soil
- Further robust analysis on:
  - Spatial variability both nationally and at field scale
  - Temporal variability – spring and post harvest of winter sown crops
  - Specific soil function analysis
- Soils tested likely to be from very well managed fields, further work on degraded soils would be interesting…..
- From the physical, biological and chemistry data what is most important to you?

Scottish Government
Riaghaltas na h-Alba
gov.scot

Thanks to:
Roy Neilson
Eric Anderson
Tim Daniell
David Roberts
Jim Wilson