Practical Soil Health

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Westcountry Rivers Trust

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Practical Soil Health

- **3 components of Soil Health and how to assess them**

(within context of Farming Rules for Water & SFI)

- SFI Improved Grassland Soil Standard – Cost Benefit Analysis

Assessing Soil Health – 3 components

Soil Chemistry - Focus on Nitrogen and Phosphorous

- Soil chemistry is <u>complex</u> – impacted by chemical composition, chemical properties and chemical reactions within the soil
- Macro and micro nutrients essential for healthy crops and livestock

<u>N & P risk harming natural habitats (nutrient enrichment) and need removing at water treatment works</u>

- **Nitrogen (N) is soluble – changes quickly**

risk of **leaching** through groundwater

- **Phosphorous (P) is largely insoluble – changes slowly**

risk of loss via **soil erosion** and **surface run-off**

Legal requirement to monitor N & P under <u>Farming Rules for Water</u> and is a feature of SFI

Relevant regulations - ‘Farming Rules for Water’

Regulations brought in April 2018 to reduce and prevent agricultural diffuse pollution

1. **Organic manures and fertilisers - storage & application**
2. **Soil management - soil erosion (poaching, cultivations, position of troughs)**

Applications of dung, slurry and fert must meet crop need (nutrient planning).

- **Consider soil and crop need for Nitrogen based on annual crop cycle**
- **Avoid applying manures that raise Phosphorus Index above target value** (2 for grassland)
- At Index 3 or above, must be working to reduce Phosphate. Unless there is proof it is not reasonably practical and appropriate measures have been taken to mitigate against diffuse pollution. Apply on for crop need

- **Periods of limited application rates (Nitrogen leaching)**
  - High RAN manures (slurry) less than 30m3/Ha every 21 days
    - **Grassland - between 15th Oct and end of Feb**
    - Tillage land between 1st Oct and end of Feb

https://www.gov.uk/government/publications/applying-the-farming-rules-for-water/applying-the-farming-rules-for-water

https://www.gov.uk/government/publications/farming-rules-for-water-in-england

Nutrient Planning - P, K, Mg, pH

pH – log scale
5.7 is 10 x acidic than 5.8
5.7 100 x acidic than 5.9

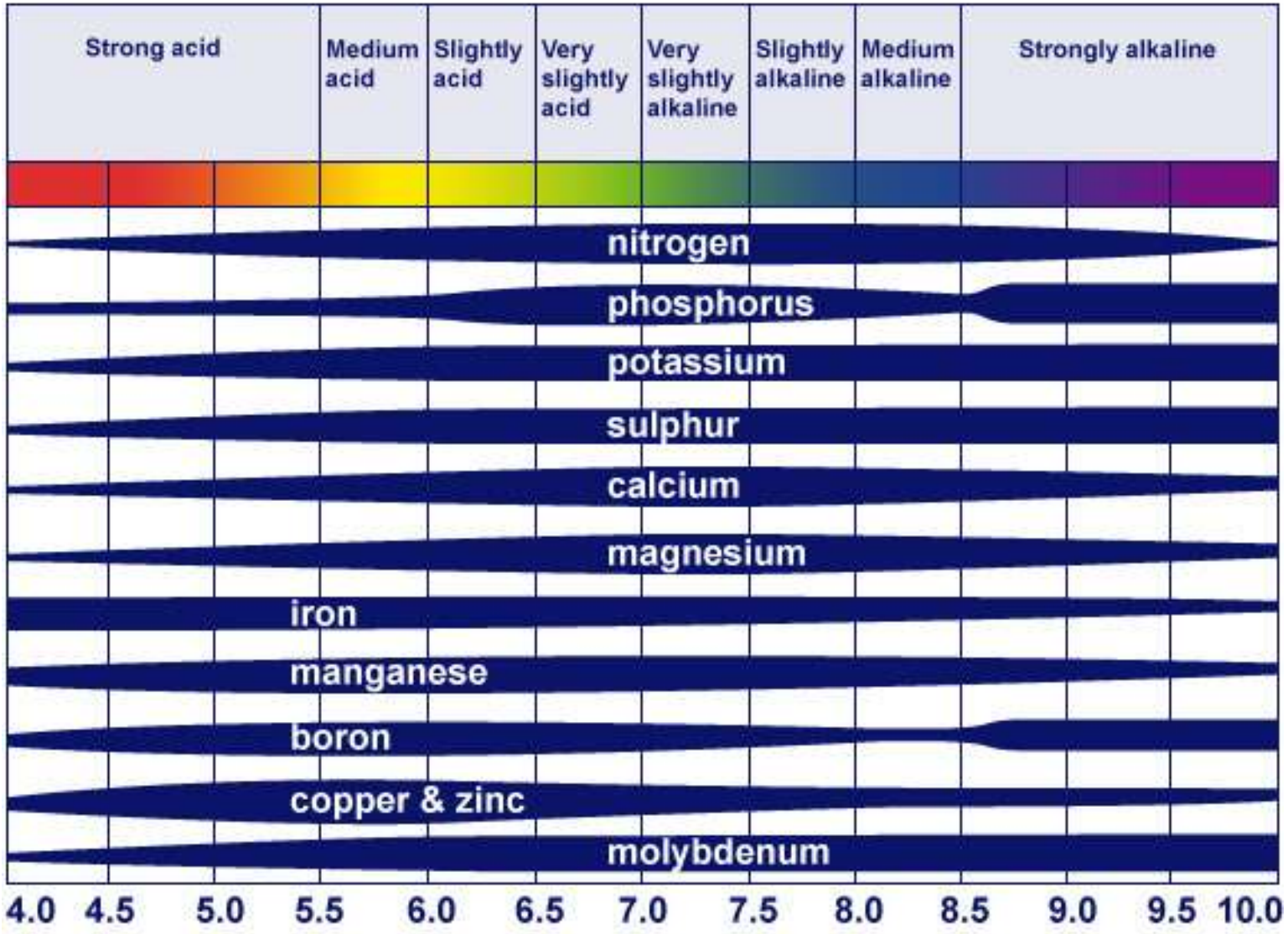
- Standard soil sampling every 5 years
- At target index, only apply for crop need
- Understand nutrient content of manures (RB209 or manure analysis)
- Low K more a problem than low P on Dartmoor

SOIL ANALYSIS REPORT

Laboratory Sample Reference	Field Details		Soil pH	Index			mg/l (Available)		
	No.	Name or O.S. Reference with Cropping Details		P	K	Mg	P	K	Mg
515856/21	1	[redacted] Silage 1 Cut into Silage 1 Cut	5.3	5	1	2	84.0	84	81
515857/21	2	[redacted] Silage 1 Cut into Silage 1 Cut	5.5	5	1	3	74.8	92	122
515858/21	3	[redacted] Silage 1 Cut into Silage 1 Cut	5.6	4	0	2	62.2	57	80

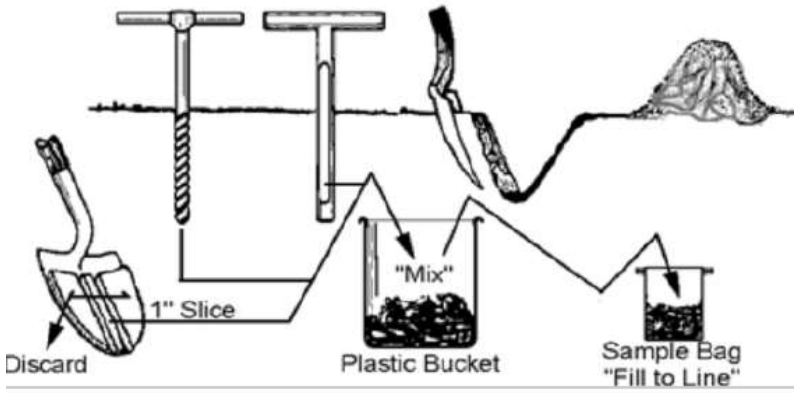
Field number/name	pH	Phosphate	Potassium	Magnesium
Target for productive grassland	**6**	**2**	**2-**	**2**
Target for productive arable	6.5	2	2-	2
Target for species-rich grassland	variable	0 - 1	1 – 2-	2

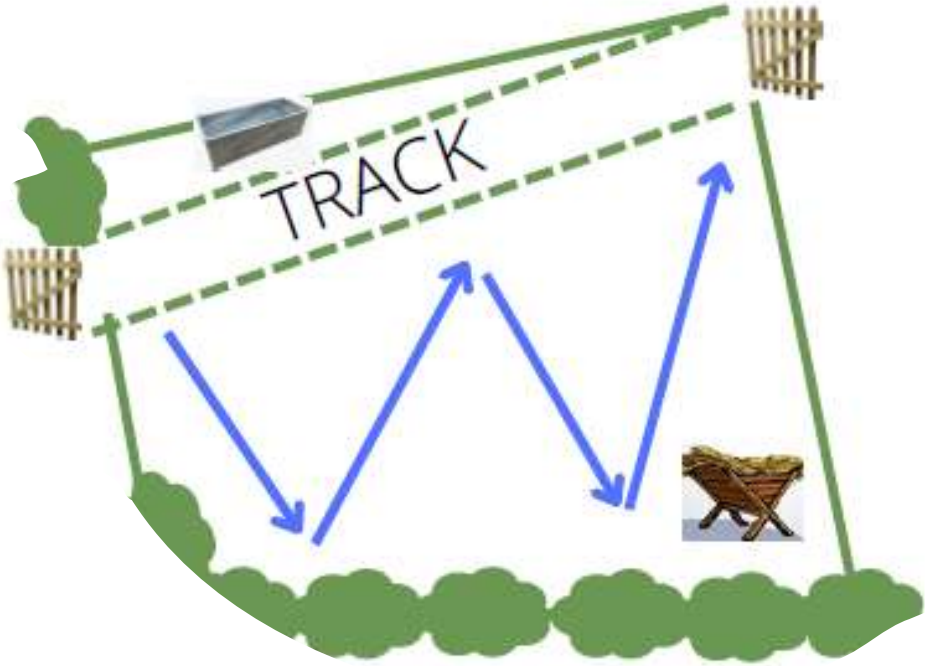
Nutrient planning - Importance of pH



Nutrient Planning – Standard soil sampling P, K, Mg, pH

- Take 25 samples across a field in a ‘W’ pattern (avoid uncharacteristic areas: troughs/feeders, tracks, gateways, hedges)
  - Permanent grass – 7.5cm depth
  - Temporary grass – 15cm depth
- Mix up sample and send to lab for analysis (~£20/sample)
- Historic features – permission to sample?



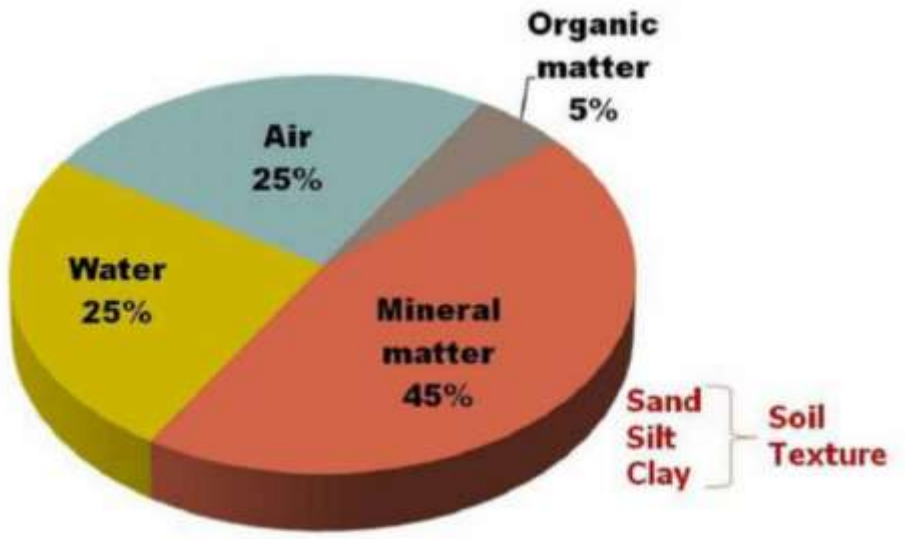


Nutrient Planning – Nitrogen

- Soil Nitrogen Supply (SNS) used to determine nitrogen requirements for coming season
    - Rainfall, soil type, previous cropping, and expected cropping + yields
- Understand nutrient content of organic manures and fertilisers – matching application with crop and soil need.
- Calculated using RB209 Nutrient Management Guide
    - Manure analysis and SMN

PHYSICAL Soil Health - Texture & Structure (+ Topography)

Soil should act as a sponge!
Soil texture - Size and proportion of mineral particles



<u>Natural properties of soil types</u>

Light soils (sandy) – Vulnerable to erosion

Medium soils (loams) – Medium risk of erosion

Heavy soils (clays) – Low risk of erosion

Soil Type - Soil maps: MAGIC, Cranfield University https://www.landis.org.uk/soilscapes/
Soil Texture – in field by hand (texturing chart) or lab (NRM, Molevalley etc)

Your Organic Matter Results Interpretation

Land use	Rainfall	Soil type	Very Low	Low	Target	High
Arable	Low <650mm	Light	<=1.0	1.1-2.1	2.2-3.2	>=3.3
		Medium	<=1.7	1.8-3.3	3.4-5.0	>=5.1
		Heavy	<=2.2	2.3-4.4	4.5-6.5	>=6.6
	Moderate 650-800mm	Light	<=1.0	1.1-3.0	3.1-4.5	>=4.6
		Medium	<=1.9	2.0-4.0	4.1-6.0	>=6.1
		Heavy	<= 2.7	2.8-5.2	5.3-7.6	>=7.7
	High 800-1100mm	Light	<=1.3	1.4-3.7	3.8-6.1	>=6.2
		Medium	<=2.5	2.6-5.0	5.1-7.5	>=7.6
		Heavy	<=3.6	3.7-6.2	6.3-8.8	>=8.9
Grassland (Lowland)	All	Light	<=2.1	2.2-4.9	5.0-7.9	8.0-14.9
		Medium	<=3.4	3.5-6.4	6.5-9.3	9.3-19.9
		Heavy	<=4.6	4.7-7.6	7.7-10.5	10.6-19.9

Assessing Soil Structure

Dig a hole!

Use **surface observations** and **Visual Evaluation of Soil Structure (VESS)**

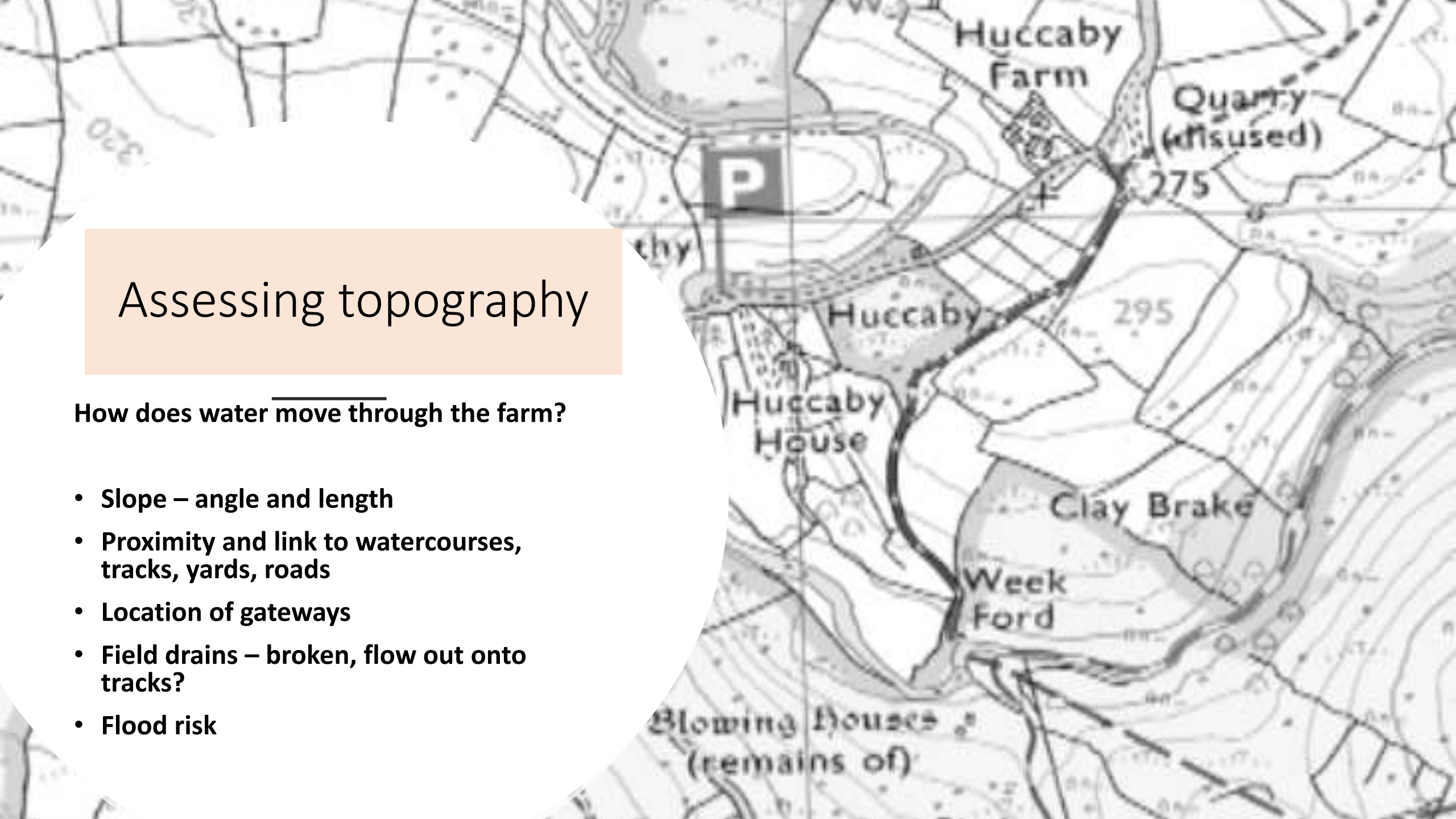
- Colour & smell (organic matter levels, functioning biology)
- Porosity
- Aggregate size & shape: crumbly or blocky?
- Mottling/gleying (waterlogging/lack of oxygen/leaching)
- Rooting depth
- Fissures/cracks (vertical and horizontal)
- Earthworm channels and worm numbers

- Slake test, bulk density test

Assessing topography

How does water move through the farm?

- **Slope – angle and length**
- **Proximity and link to watercourses, tracks, yards, roads**
- **Location of gateways**
- **Field drains – broken, flow out onto tracks?**
- **Flood risk**



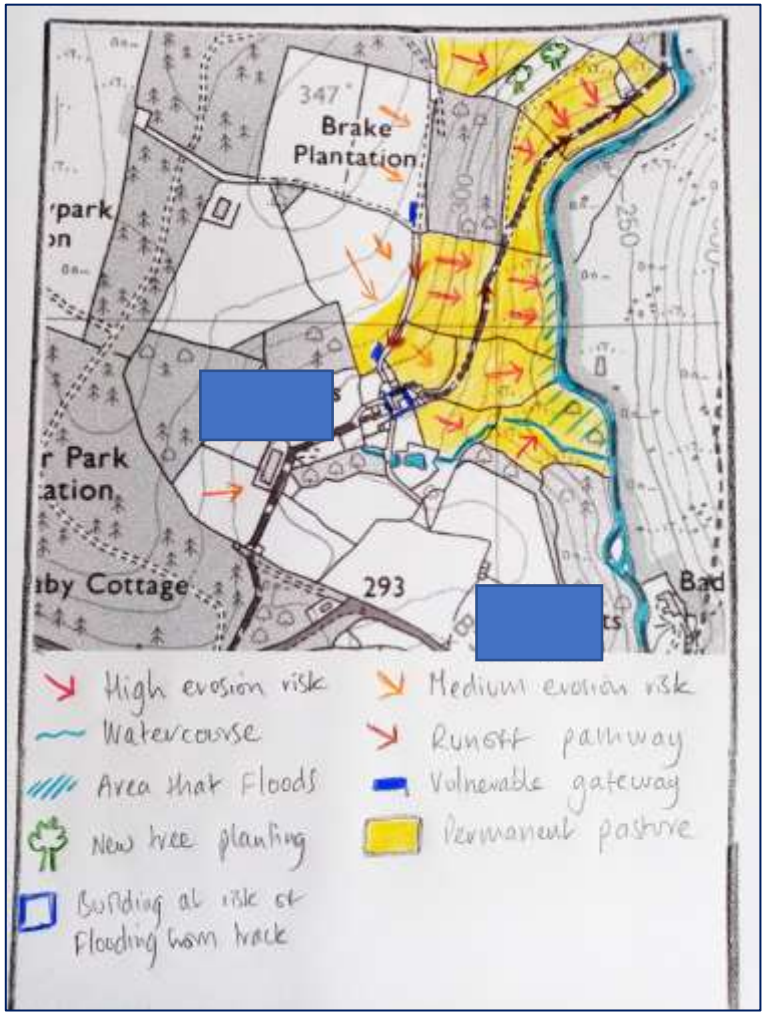
Creating a Soil Risk Assessment (SFI)

Part 1. Inherent Risk

- Soil type – light, medium, heavy, peat
- Slope (steepness and length) (gentle 2-3deg, mod 3-7deg, steep >7deg)
- Proximity to: waterbody/yard/tracks/roads
- Location of gates and field drains (broken?)
- Historic features (SFI) (request HEFER)

Part 2 Managed Risk – Field Management

- **Visual Evaluation of Soil Structure + Surface Capping**
- Field management – cultivations, crop selection
- Field history – flooding, ponding etc



Field or part field reference	Field details	Risks and problems identified in the soil assessment	Proposed management actions
Field 1, part 1 ST0000 0000	Lower risk of runoff and erosion. Medium textured well-drained stable soil in combinable crop rotation. Slopes under 3 degrees. Soil structure good, no signs of runoff or erosion.	None identified	Maintain current management. Reconsider if cropping changes.
Field 2 SY0000 0000	High runoff and erosion risk. Erodible light sandy soil in combinable crop	Soil/sediment deposition. Risk of compaction increasing runoff	Include cover crop in rotation to improve soil organic matter

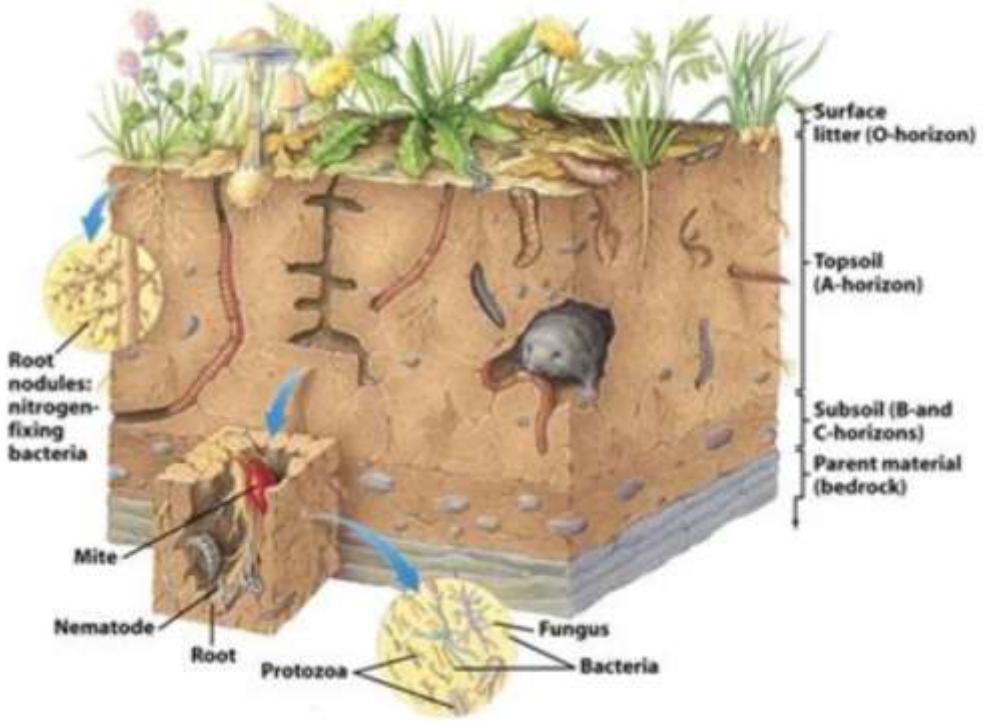
Land App

Applicants can use the table below to record the runoff and soil erosion risk of their field parcels.

Field parcel	Inherent risk	Connection to waterbody	Managed risk	Overall risk
AB12345678	Moderate	Little or no connection	Lower	Low
AB23456789	High	Adjacent	Moderate	Mod/High

SOIL BIOLOGY – Soil Organic Matter

- **Food web** - microbes (bacteria, fungi, protozoa) & micro-organisms (earth worms as indicators)
- Survival of food web reliant on **decomposition of organic matter** into <u>soil organic matter,</u> impacts (C:N ratio)



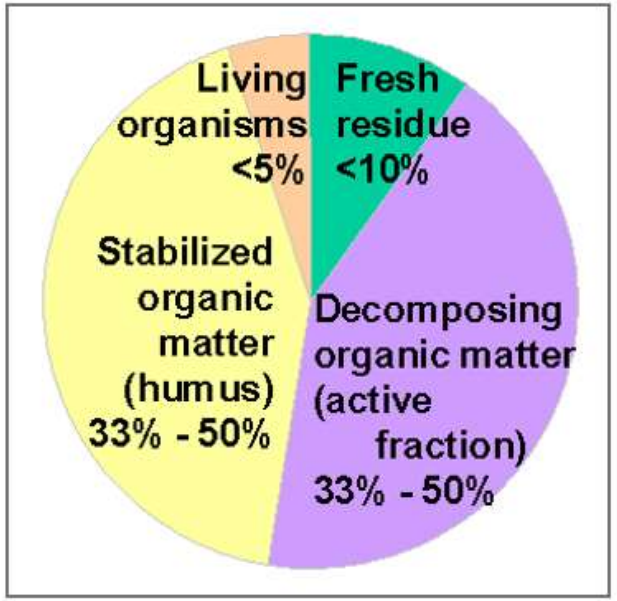
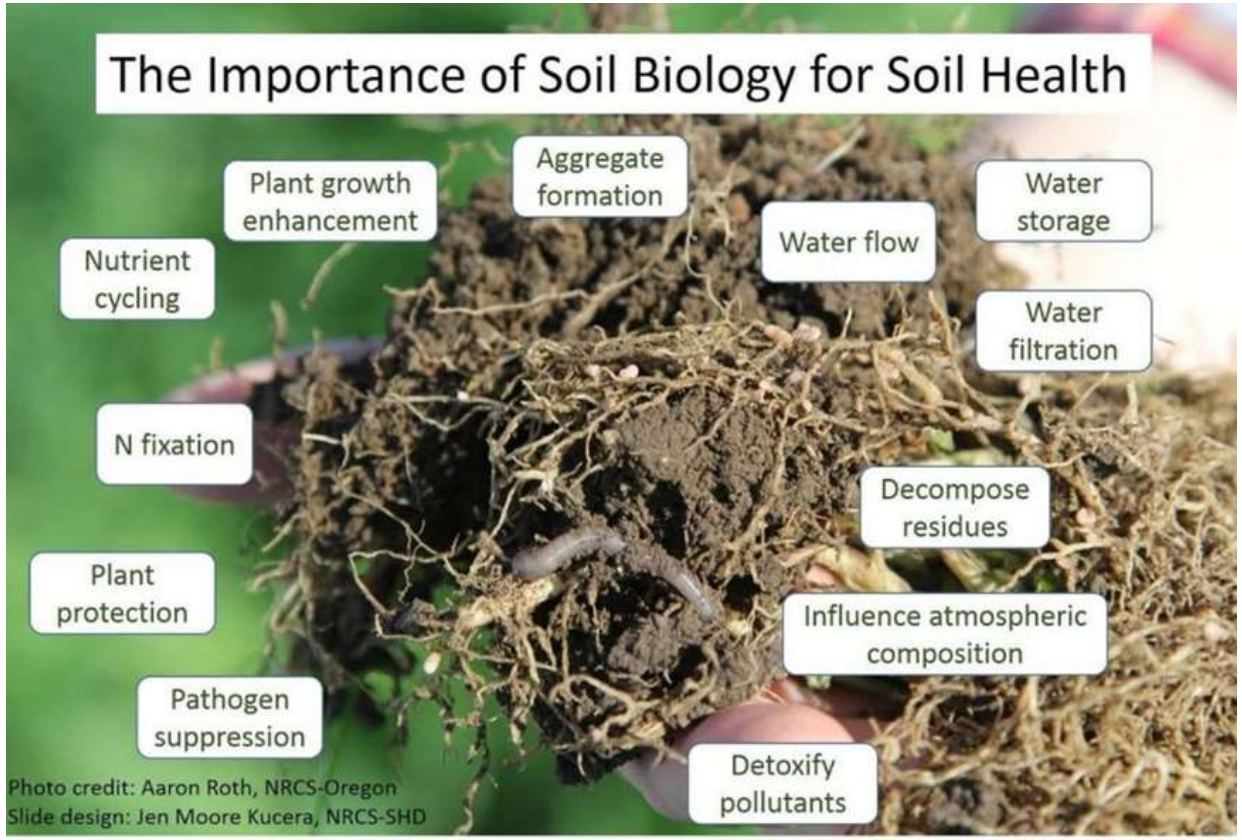


Figure 1.—Major components of soil organic matter (Source: Soil Food Web; USDA, NRCS).

In a teaspoon of soil, there are millions of bacteria, hundreds of thousands of fungi, thousands of protozoa and many larger organisms.

Assessing Soil Biology

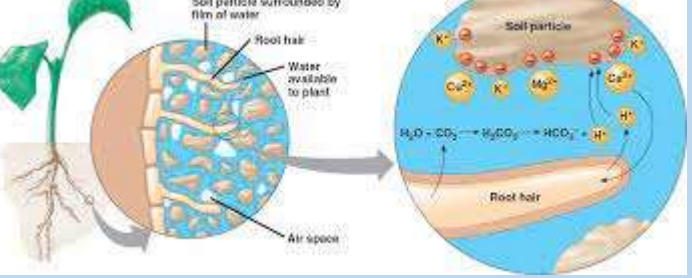


SOM content – soil samples (SFI requirement)

Dig a hole!

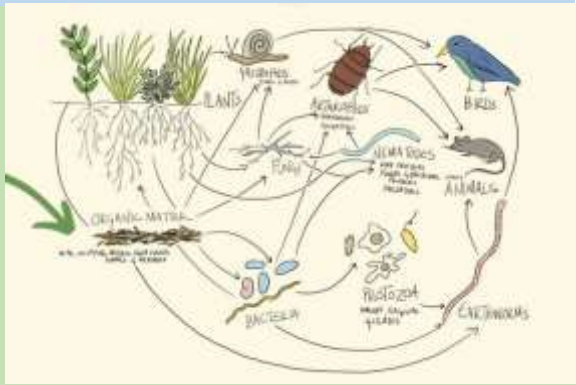
- Smell - does it smell like soil?
- **Earthworm counts** and type
  - ✓ Epigeic – surface, tanned
  - ✓ Endogeic – deep borrowers, pale
  - ✓ Aneceic type – above + below, mixed
- Earth worm channels, casts
- Functioning legumes
- Rhizospheres – soil around roots, where nutrient exchange can occur

Bury some pants!



CHEMISTRY - NUTRIENT BALANCE & AVAILABILITY

- **Nutrient planning –**
  Macro nutrients: N, P, K, Mg
  (regs and subsidy)
- **pH**
- Cation exchange capacity
  (K, Mg, Ca etc)
- Nutrient mobility, lockup



PHYSICAL - SOIL STUCTURE & FARM TOPOGRAPHY

- Influenced by **soil type and texture, landscape** of the farm
- **Spaces for air, water and roots** (porous or compact)
- **Channels & fissures** - vertical, horizontal?
- **Aggregates –** crumbly or blocky?

BIOLOGY - SOIL LIFE

- **Food web** - (bacteria, fungi, micro-organisms (earth worms as indicators)
- Survival of food web reliant on **decomposition of organic matter** into soil organic matter
- Biological process facilitate: **nutrient availability, porosity** and **transport of SOM** through soil profile
- Soil biology = soil's HEART BEAT

How to assess your Soil Health (for SFI and/or FRfW)

CHEMISTRY – NUTRIENT BALANCE

- **Nutrient Planning (N & P for FRfW)**
  - **- Standard soil sampling** P, K, Mg and pH
  - **- Determine SNS + season's nutrient requirements**

Nutrients can be provided by fertilisers

Soil Structure *can* be remediated by cultivation (can also destroy structure)

<u>Soil Biology helps both for free!</u>

PHYSICAL - SOIL STUCTURE

- **Soil Risk Assessment (SFI)**
  - **Inherent Risk – soil texture, topography**
  - **Managed Risk – field management**
- **Dig a hole (VESS)** and look for:
  - crumbly, rounded aggregates
  - <u>Compacted layer</u>
  - roots - depth, variety?
  - pore space & *vertical* fissures
- Slake test – aggregate stability
- Soil bulk density measurements

BIOLOGY - SOIL LIFE

- **Measure SOM (SFI soil samples)**
- **Earthworm count/type**
- Measure respiration rate
- Slake test – aggregate stability (glues and gums from microrganisms)

Whilst digging your hole:
Look for:

- soil around the roots
- functioning legumes
- Bury some pants!

Sustainable Farming Incentive
Improved Grassland Soils Standard

Introductory level (£28/Ha)

- Complete soil assessment and associated management plan/risk assessment
- Test Soil Organic Matter (SOM)
- Minimise bare ground to 5% or less

Intermediate Level (£58/Ha)

- All of above + establish and/or maintain 15% ground in herbal leys
  - 5 grasses, 3 legumes, 5 herbs (avoid >70% ryegrass/ryegrass hybrid)

£20/Ha up to 50Ha max £1000 annually – recently added

Sustainable Farming Incentive

Cost benefit compared to BPS using 60 Ha farm. 24Ha into SFI (10 fields)
Using existing herbal leys – No N saving

Year	BPS		SFI Improved Grassland Introductory level (£28/ha) + £480 admin fee				SFI Improved grassland Intermediate level (£58/ha) + £480 admin fee							
	Annual reduction in BPS payment from 2020 (%)	Estimated Total annual BPS payment (£)	Total SFI annual income(£)	Soil testing costs (£) spread over 3 years*	Total annual value of SFI improved grassland Introductory level (£)	**Estimated % of 2020 BPS payment**	Total SFI annual income(£)	Soil testing costs (£) spread over 3 years*	Establishment cost of 15% of SFI hectares herbal ley (£) spread over 3 years)**	Total annual value of SFI improved grassland intermediate level (£)	**Estimated % of 2020 BPS payment**	Annual nitrogen fertiliser savings for herbal leys (£)	Total annual value of SFI improved grassland intermediate level + annual fertiliser savings (£)	**Estimated % of 2020 BPS payment**
2020		£13,900.00												
2021	5%	£ 13,205.00												
2022	20%	£ 11,120.00												
2023	35%	£ 9,035.00	£ 1,152.00	-£66.67	£ 1,085.33	**8%**	£ 1,872.00	-£66.67	-£458.40	£ 1,346.93	**10%**	£ -	£ 1,346.93	**10%**
2024	50%	£ 6,950.00	£ 1,152.00	-£66.67	£ 1,085.33	**8%**	£ 1,872.00	-£66.67	-£458.40	£ 1,346.93	**10%**	£ -	£ 1,346.93	**10%**
2025	-	£ -	£ 1,152.00	-£66.67	£ 1,085.33	**8%**	£ 1,872.00	-£66.67	-£458.40	£ 1,346.93	**10%**	£ -	£ 1,346.93	**10%**

* Assuming soil organic testing costs approx £20 per sample

** Assuming establishment costs of herbal ley approx £382/ha - latest CS rates

Sustainable Farming Incentive

Cost benefit compared to BPS using 60 Ha farm. 24Ha into SFI (10 fields)
Conversion from using 100kgN/Ha (conventional ley) to herbal leys

Year	BPS		SFI Improved Grassland Introductory level (£28/ha) + £480 admin fee				SFI Improved grassland Intermediate level (£58/ha) + £480 admin fee							
	Annual reduction in BPS payment from 2020 (%)	Estimated Total annual BPS payment (£)	Total SFI annual income(£)	Soil testing costs (£) spread over 3 years*	Total annual value of SFI improved grassland Introductory level (£)	**Estimated % of 2020 BPS payment**	Total SFI annual income(£)	Soil testing costs (£) spread over 3 years*	Establishment cost of 15% of SFI hectares herbal ley (£) spread over 3 years)**	Total annual value of SFI improved grassland intermediate level (£)	**Estimated % of 2020 BPS payment**	Annual nitrogen fertiliser savings for herbal leys (£)	Total annual value of SFI improved grassland intermediate level + annual fertiliser savings (£)	**Estimated % of 2020 BPS payment**
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* Assuming soil organic testing costs approx £20 per sample

** Assuming establishment costs of herbal ley approx £382/ha - latest CS rates

***Assuming current price of nitrogen (£ per kg N) = £2.03 (~£700/ton AN 35%N)**

Thank You, any questions?

Ode to an Earthworm
By Joe Lamp'l

Perceived as lowly,
But actually holy,
The earthworm feeds the soil.

Humble in looks,
Often skewered on hooks,
Silently it toils.

Woven into the dirt,
Never rude nor curt,
It performs its work unseen.

Even its waste
Improves the taste
Of every pea and bean.

Wendy Couch
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