

Soil structure and earthworm assessments masterclass

Strategic Farm Week 2020 Webinar

Anne Bhogal, David Aglen and Amanda Bennett

Housekeeping













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#strategicfarm

Strategic Farm Week 2020 ahdb.org.uk/sfweek2020

BASIS/NRoSO Points



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Format





David Aglen @DavidAglen

Introduction to soils at Strategic Cereal Farm Scotland



Anne Bhogal @anne_bhogal Soil structure and earthworms



Anne Bhogal & Amanda Bennett @ajbennett_tweet Soil health scorecard & Soil Biology and Soil Health Partnership



Your host... Chris Leslie @Farming_Daft



Learn how to assess soil structure and earthworm numbers across the farm and how to use this information to inform management decisions

Q: What would you like to know by the end of this session?





Strategic Cereal Farm Scotland

David Aglen, Strategic Cereal Farm Scotland Host

Farm Details

- 170 suckler cows
- 92ha wheat
- 174ha oats
- 100ha spring beans
- 290ha spring barley
- 50ha kale/ forage cover crops
- 170ha brassica vegetables/carrots/potatoes
- 300ha grass
- Sandy silt loam



Watch an introduction to the Strategic Cereal Farm Scotland at **ahdb.org.uk/SFweek20**



Our future lies in how we treat our soils



Strategic Farm Investigations at BHF

- Expand cropping opportunities for successful direct drilling.
- Increase cover cropping options in our climate.
- Investigate more integration of livestock in the arable rotation.
- Build a more resilient production system around a regenerative farming system.
- Essentially improve our soils, repair them and allow them work at their best and provide for us.





Our future lies in how we treat our soils









Soil Structure and earthworms

Anne Bhogal, ADAS



Outline

- Introductions, aim & quick survey
- Soil structure as an indicator of soil health
 - Importance
 - Practical assessment methods & their interpretation
 - VESS
 - VSA
 - Strategies for improvement
- Earthworms as an indicator of soil health
 - Importance
 - How to assess & interpret findings
 - Strategies for improvement
- Integrating findings soil health scorecard approach



Aim

 To provide guidance on how to assess soil structural condition and earthworm populations and interpret what you find!



Quick poll 👍 👎

- Do you routinely assess soil structural condition?
- If yes, do you use a 'formal' method and score what you see?
- Do you count earthworms?

Soil structure

- Soil structural 'form' arrangement of soil particles & aggregates.
- Soil structural 'stability' resilience of soil structure
- Soil compaction is a major 'threat' to soils







51% of farmers who assessed their soil found compaction in top 30cm; Defra Farm Practice Survey (2012)

Assessing soil structural condition



Visual Soil Evaluation – the spade is a vital tool!

- VESS (Visual Evaluation of Soil Structure)
- VSA (Visual Soil Assessment)





Visual Evaluation of Soil Structure

Soil structure affects root penetration, water availability to plants and soil aeration. This simple, quick test assesses soil structure based on the appearance and feel of a block of soil dug out with a spade.

The scale of the test ranges from Sq1, good structure, to Sq5, poor structure.



When to sample:

Any time of year, but preferably when the soil is moist. If the soil is too dry or too wet it is difficult to obtain a representative sample. Roots are best seen in an established crop or for some months after harvest.

Where to sample:

Select an area of uniform crop or soil colour or an area where you suspect there may be a problem. Within this area, plan a grid to look at the soil at 10, preferably more, spots. On small experimental plots, it may be necessary to restrict the number to 3 or 5 per plot.





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Method of assessment:					
Step	Option	Procedure			
Block extraction and examination					
1. Extract soil block	Loose soil	Remove a block of soil ~15 cm thick directly to the full depth of the spade and place spade plus soil onto the sheet, tray or the ground			
	Firm soil	Dig out a hole slightly wider and deeper than the spade leaving one side of the hole undisturbed. On the undisturbed side, cut down each side of the block with the spade and remove the block as above.			
2. Examine soil block	Uniform structure	Remove any compacted soil or debris from around the block			
	Two or more horizontal layers of differing structure	Estimate the depth of each layer and prepare to assign scores to each separately.			
Block break-up					
 Break up block (take a photograph - optional) 		Measure block length and look for layers. Gently manipulate the block using both hands to reveal any cohesive layers or clumps of aggregates. If possible separate the soil into natural aggregates and man-made clods. Clods are large, hard, cohesive and rounded aggregates.			
4. Break up of major aggregates to confirm score		Break larger pieces apart and fragment it until a piece of aggregate of 1.5 - 2.0 cm. Look to their shape, porosity, roots and easily of break up. Clods can be broken into non-porous aggregates with angular corners and are indicative of poor structure and higher score.			
Soil scoring					
5. Assign score		Match the soil to the pictures category by category to determine which fits best.			
6. Confirm score from:		Factors increasing score:			
	Block extraction	Difficulty in extracting the soil block			
	Aggregate shape and size	Larger, more angular, less porous, presence of large worm holes			
	Roots	Clustering, thickening and deflections			
	Anaerobism	Pockets or layers of grey soil, smelling of sulphur and presence of ferrous ions			
	Aggregate fragmentaion	Break up larger aggregates \sim 1.5 – 2.0 cm of diameter fragments to reveal their type			
7.Calculate block scores for two or more layers of differing structure		Multiply the score of each layer by its thickness and divide the product by the overall depth, e.g. for a 25 cm block with 10 cm depth of loose soil (Sq1) over a more compact (Sq3) layer at 10-25 cm depth, the block score is $(1 \times 10)/25 + (3 \times 15)/25 = $ Sq 2.2.			

Scoring: Scores may fit between Sq categories if they have the properties of both.

Scores of 1-3 are usually acceptable whereas scores of 4 or 5 require a change of management.





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 or re of ~	and description of natural educed fragment 1.5 cm diameter	0 1	unhunhunh
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.	2 3 4 5	<u>nuhudududududu</u>
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	1 cm	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	1 cm	Aggregate fragments are fairly easy to obtain. They have few visible pores and are rounded. Roots usually grow through the aggregates.	10	,
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	1 cm	Aggregate fragments are easy to obtain when soil is wet, in cube shapes which are very sharp-edged and show cracks internally.	15	5
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.	m	

VESS – identifying the limiting layer







VESS – Sq and soil management



Threshold Sq values for sustained agricultural productivity

Sq score	Soil structural quality	Management needs
1-2	Good	No changes needed
3-4	Moderate	Long-term improvements
4-5	Poor	Short-term improvements



- i. Soil structure and consistence (x 3)
- ii. Soil porosity (x 3)
- iii. Soil colour (x 2)
- iv. Soil mottles (x 2)
- v. Earthworm count (x 2)
- vi. Tillage pan (x 2)
- vii. Degree of clod development (x 1)
- viii. Degree of soil erosion (x 2)

Soil Quality Assessment	VSA Score
Good	> 25
Moderate	10 – 25
Poor	< 10



Visual soil assessment (i)



Soil structure and consistence



GOOD CONDITION VS = 2 Good distribution of friable finer aggregates with no significant clodding

MODERATE CONDITION VS = 1 Soil contains significant proportions of both coarse firm clods and friable, fine aggregates



(Shepherd, 2000)

Assessing baseline soil structural condition @ AHDB strategic farm east (autumn 2017 & spring 2020)



- 9 field split into zones of contrasting texture 'soil management zones'
- VESS & VSA @ 3 points per zone





Assessing baseline soil structural condition @ strategic farm east - autumn 2017



VSA





14% of fields in good condition (VSA > 25) 86% of fields in moderate condition (VSA 10-25) 19% in good condition ('intact' sq2) 81% of fields had a firm or compact layer (sq3 or 4)

VESS



Managing soil structure

- Managing soil compaction:
 - Avoidance
 - Alleviation

Avoiding soil compaction

- Avoid working the soil when wet
- Rotation & crop choice
- Low ground pressure tyres
- Enhance SOM levels to build resilience
- Reduce the trafficked area
 - Controlled traffic farming (CTF)











Any Questions?





Benefits of a healthy earthworm population A AHDB

- Incorporate organic matter into the soil
- Release nutrients
- Improve soil structure:
 - Create aeration & drainage channels
 - 'Biopores' channels for roots to explore
- Enhance biodiversity (food source for birds)



Earthworms are sensitive to pH, waterlogging, compaction, tillage and organic matter management, so provide a good overall indicator of soil health

Types of earthworms in soils; 'Ecotypes'



Surface worms ('Epigeic' or litter dwelling)

- Small (<8cm), bright-red or reddish-brown worms (but not stripy), often fast moving.
- Feed on crop residues and are weak burrowers.
- Short lived (2-3yrs), rapid reproducers!
- Important prey for birds



Types of earthworms in soils; 'Ecotypes'



Topsoil worms ('Endogeic')

- Most common type of earthworm in the UK.
- Pale coloured (pink, grey, green or blue), up to 10cm long
- Often curl up when handled, green worms may emit a yellow fluid
- Live for about 5 years
- Make horizontal burrows, improve soil aggregation & mobilise nutrients



Types of earthworms in soils; 'Ecotypes'



Deep-burrowers ('Anecic')

- Black- or red-headed worms, typically >12cm in length
- Make permanent, deep vertical burrows (up to 2m in depth)
- Live for 5-10 years, with slow reproduction rates
- Feed at night on surface litter
- Often found below surface earthworm 'casts' or 'middens' (piles of leaf litter)
- Important for soil aeration, water infiltration and root development ('biopores')



How to assess earthworms

- Autumn or spring (warm & wet!) link to soil structural assessment (use the same block of soil!)
- 3-5 'pits' per soil management zone
- Count all worms from 20cm³ cube of soil in 5 minutes
 - compare to AHDB 'soil health scorecard' thresholds (based on VSA guidance)

Number per 20x20cm spadeful		Description
Arable	Grass	
<4	< 15 and predominantly 1	Depleted
	species	
4-8	15-30 1-2 species	Intermediate
>8	>30 and 3 or more species	Active





How to assess earthworms - the detailed approach

For more detail (5-10 pits):

• Divide into adults and juveniles (look for the 'saddle')

Return juveniles to the pit

- Split adults into ecotypes & count
- Calculate the % occurrence of each ecotype (number of pits containing each type)
- Ideally (optimal population) >70% of pits contain all 3 groups
- For more info:

https://ahdb.org.uk/knowledge-library/how-to-count-earthworms http://www.wormscience.org/

Photos from https://www.opalexplorenature.org/earthwormguide







Assessing baseline earthworm numbers @ Strategic Farm East (autumn 2017 & spring 2020)



Earthworm numbers per 20cm³ pit

	2017		2020		
Field	Cropping	Earthworm number	Cropping	Earthworm number	
Barn Field	Winter wheat	7	Spring beans	14	
Big Lawn	Winter wheat	7	Winter wheat	4	
Kells	Stubble/bare soil	3	Winter wheat	7	
Retters	Winter wheat	9	Spring beans	9	
Rushbottom	Cover crop	8	Winter wheat	8	
Shrubbery	Grass ley	9	Winter wheat	8	
Wallys	Winter wheat	8	Winter wheat	3	
West Farm	Winter wheat	4	Spring linseed	7	

Earthworm numbers have been colour coded according to the Soil Health Scorecard. Red indicates earthworm numbers are depleted, orange that intermediate population size and green active population.

Managing soil biology



- 'Feed' the soil through plants and organic matter inputs
- Only move soil when you have to
- Diversify plants in space and time







Questions?

Soil health scorecard approach



- A 'health check for soils'
 - > Indicators of chemical, physical & biological condition of agricultural soils
 - Relevant & practical with clear interpretation scheme; use with farmers to guide soil management

Physical (17 'candidates')	Chemical (14 'candidates')	Biological (14 'candidates')	
Visual Assessment of Soil Structure (VESS)	рН	Earthworms	
Penetration resistance	Routine nutrients	Respiration	
Bulk density	Soil organic matter (SOM)	Microbial biomass	



AHDB-BBRO Soil Biology and Soil Health Partnership: <u>https://ahdb.org.uk/greatsoils</u>

Benchmarking & interpretation



Indicators	Benchmarks	
pH & routine nutrients (Ext P, K, Mg)	The nutrient management guide-RB209	
Visual Soil Assessment of Soil Structure (VESS)	Limiting layer score; SRUC guidance	
Soil organic matter (loss on ignition)	Comparison with 'typical levels' for soil & climate	
Earthworms	VSA guidance; numbers/pit	

Assessing baseline soil health at Strategic Farm West

 Using the scorecard to benchmark soil health at the outset and track changes over time





Field 25: Rob's soil map

- Field 25: Sampling zones:
- 1. 'heavy red'
- 2. 'Medium/heavy loam'
- 3. 'heavy clay'

Soil sample & physical evaluation

Scorecard for field 25 10.5ha; Spring barley @ harvest 2019



Zone	1	2	3
% clay	37	43	51
SOM (%LOI)	5.0	4.7	4.4
рН	7.5	8.1	8.1
Ext. P (mg/l)	18	13	21
Ext. K (mg/l)	344	375	433
Ext. Mg (mg/l)	849	708	675
VESS score (limiting layer)	3	4	4
Earthworms (No./pit)	6	1	2

Investigate				
Monitor				
No action needed				

Note: benchmarks are subject to review

Key issues (field 25): soil structure & earthworm numbers (particularly zones 2 & 3 – heavier textures & below average SOM)

Thank you!

For more info:

AHDB-BBRO Soil Biology and Soil Health Partnership:

https://ahdb.org.uk/greatsoils

These publications explain how



Simple recording sheet to used on



Healthy grassland soils



SRUC VESS guidance:

https://www.sruc.ac.uk/info/120625/visual_evaluation_of_soil

structure

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Questions?

Anne Bhogal, Amanda Bennett, David Aglen



Resources



- All of the soils information is available at ahdb.org.uk/GREATsoils
- Strategic Farm West handout
- Strategic Farm East handout



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Strategic Farm Week 2020



Watch Strategic Farm research videos



Take part in the webinars



Listen to the podcast special

Download the 'how to' resources

All at: ahdb.org.uk/sfweek2020



Still to come in Strategic Week 2020.....

Thursday 4 June

09:00 – 10:30 Crop establishment considerations

12:00 – 13:30 Soil structure assessments masterclass

19:00 – 20:30 Mole drainage and soil loosening masterclass

Friday 5 June

- Strategic Farm Week closing video with Martin Grantley-Smith
- Strategic Farm resources

All available at ahdb.org.uk/SFweek2020

Previous Strategic Farm webinars

- How to monitor crop development and disease
- How to monitor for key insect pests and beneficials
- How to decide when to lower inputs

Videos and resources

- Trials and demonstrations for harvest 2020 at Strategic Cereal Farm East
- Trials and demonstrations for harvest 2020 at Strategic Cereal Farm West
- Introduction to Strategic Cereal Farm Scotland
- Strategic Farm week podcast

Thank you









Contact Chris Leslie with any further questions Chris.leslie@ahdb.org.uk

ahdb.org.uk/sfweek2020