

The Double Spade Method: a ‘mini-profile’ visual soil evaluation technique

J.P. Emmet-Booth^{1*}, P.D. Forristal², O. Fenton³, G. Bondi³, N.M. Holden¹

¹*School of Biosystems and Food Engineering, University College Dublin, Belfield, Dublin 4, Ireland*

²*Crop Science Department, Teagasc Oak Park, Carlow, Co. Carlow, Ireland*

³*Teagasc Environment Research Centre, Johnstown Castle, Co. Wexford, Ireland*

* corresponding author: jeremy.emmet-booth@ucdconnect.ie

Introduction

Visual Soil Evaluation (VSE) methods are established for soil quality assessment and focus on the examination of soil structure and associated anthropogenic impacts. VSE techniques, of which numerous types exist, are successfully used internationally both in soil research and as sustainable soil management tools. Techniques are generally categorised into profile and spade methods. Profile methods examine entire soil profiles in soil-pits to depths of ~ 1.5 m, exploring interactions between inherent soil features and anthropic management at specific sample points. Spade methods examine the upper soil profile, often by extracting sample blocks of topsoil by spade and focus on anthropic impacts. The VESS method (Guimarães et al., 2011) is a widely used spade method and involves assessment of soil sample blocks to 25 cm depth. However, in arable soils, important structural features may occur just below this depth such as plough pans, which VESS may not capture. The SubVESS method (Ball et al., 2015) follows principles of VESS but allows assessment to ~ 1 m depth. However, the later involves soil-pit excavation by mechanical means, which may be destructive, costly, time consuming and limit replication. When used in on-farm situations by farmers or advisors, full soil-pit excavation may not be desirable. Here we describe a method previously outlined (Emmet-Booth *et al.* 2018) called the Double Spade Method (DS) designed to examine mini-profiles in soil pits to 40 cm depth, therefore capturing potential structural features below the VESS assessment depth, without requiring full soil-pit excavation.

Materials and Method

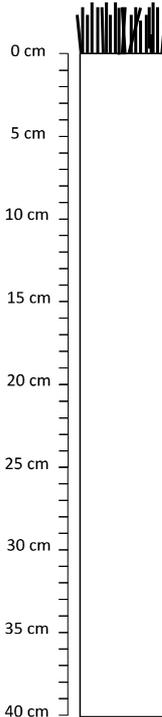
DS is derived from VESS and SubVESS, using principles from both. At a desired sampling location, a soil-pit is excavated to 40 cm depth by spade, ensuring that one side, or profile face, of the pit is undamaged. This soil-pit can be an extension of a pit resulting from deploying VESS, as the methods can be used together. As with SubVESS, layers of varying structure are initially identified by inserting a trowel tip or knife at intervals down the profile face and noting changes in perceived penetration resistance. Layers are marked with plastic tags and their depths are recorded on a score sheet (Figure 1). Each layer is then assessed separately by individually examining and scoring seven soil properties. The scoring system and classification is based on VESS, with three condition scores applied in each case, representing good (1), moderate (3) or poor (5) quality, but intermediate values are also possible (2 or 4). Perceived penetration resistance is first considered in terms of ease of trowel insertion within the layer. Redox morphology is next examined, indicated by layer colour, followed by aggregation. This is conducted by levering intact aggregates or fragments out of the profile face and their size and shape are considered. Internal visible porosity is examined within the aggregates or fragments and in doing so, rupture resistance is assessed while breaking. Finally rooting is considered within the layer either by examining broken aggregates or soil fragments or exposing roots within the profile by trowel. The individual property scores for each layer are added and divided by 7, giving mean layer scores. As with VESS, the addition of layer scores multiplied by corresponding layer depths, divided by the

overall profile depth, gives a single overall score. This can be calculated for different zones of interest, for example 0 to 20 or 20 to 40 cm depth. The latter may just be desirable if DS is used in conjunction with VESS.

Double Spade Method

Sample Point

Record the position of identified layers below



(A) Penetration Resistance ✓

	Layer 1	Layer 2	Layer 3
1 Easy to insert trowel / knife	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2 Intermediate value	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3 Requires some force to insert trowel / knife	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4 Intermediate value	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5 Requires considerable force to insert trowel / knife	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

(B) Redox Morphology ✓

	Layer 1	Layer 2	Layer 3
1 No mottling evident	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2 Intermediate value	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3 Distinct orange mottles present	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4 Intermediate value	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5 Grey / blue zones present	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

(C) Aggregate / Fragment Size ✓

	Layer 1	Layer 2	Layer 3
1 Aggregates predominantly small (< 3 cm)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2 Intermediate value	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3 Aggregates predominantly large (> 5 cm)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4 Intermediate value	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5 No aggregation, only fragments from a solid block obtainable (or single grain)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

(D) Aggregate / Fragment Shape ✓

	Layer 1	Layer 2	Layer 3
1 Predominantly rounded (can include granular)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2 Intermediate value	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3 Mixture of sub-angular and angular	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4 Intermediate value	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5 Predominantly angular with smooth faces (or single grain)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

(E) Intra-aggregate porosity ✓

	Layer 1	Layer 2	Layer 3
1 Many fine pores visible	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2 Intermediate value	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3 Some cracks and fissures visible	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4 Intermediate value	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5 No pores, cracks or fissures visible	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

(F) Rupture Resistance ✓

	Layer 1	Layer 2	Layer 3
1 Crumbles easily between forefinger and thumb	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2 Intermediate value	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3 Requires one hand to break	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4 Intermediate value	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5 Requires considerable effort or two hands to break	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

(G) Rooting ✓

	Layer 1	Layer 2	Layer 3
1 Roots unrestricted and growing throughout	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2 Intermediate value	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3 Roots few, restricted or distorted	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4 Intermediate value	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5 No roots evident	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Layer Scores

Score Total	Layer Score
Layer 1 <input style="width: 40px;" type="text"/> ÷ 7 = <input style="width: 40px;" type="text"/>	<input style="width: 40px;" type="text"/>
Layer 2 <input style="width: 40px;" type="text"/> ÷ 7 = <input style="width: 40px;" type="text"/>	<input style="width: 40px;" type="text"/>
Layer 3 <input style="width: 40px;" type="text"/> ÷ 7 = <input style="width: 40px;" type="text"/>	<input style="width: 40px;" type="text"/>

Figure 1: The Double Spade Method score sheet

Conclusion

DS allows the assessment of soil structure to 40 cm, a critical depth in arable soils. This is deeper than VESS assesses but without the need for mechanical soil pit excavation needed for SubVESS. Refinement of the procedure is required. The inclusion of reference images to the score sheet would be beneficial as well as further testing.

References

- Ball B.C., Batey T., Munkholm L.J., Guimarães R.M.L., Boizard H., McKenzie D.C., Peigné J., Tormena C.A., Hargreaves P., 2015. The numeric visual evaluation of subsoil structure (SubVESS) under agricultural production. *Soil & Till. Res.*, 148, 85-96.
- Emmet-Booth J.P., Forristal P.D. Fenton O. Bondi G., Holden N.M., 2018. The influence of depth of observation on the information conveyed by visual soil evaluation. *Soil Till. Res. Under Review*.
- Guimarães R.M.L., Ball B.C. Tormena C.A. 2011. Improvements in the visual evaluation of soil structure. *Soil Use & Man.*, 27, 395-403.