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The use of visual soil assessment schemes to evaluate surface structure in a soil monitoring program

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ABSTRACT

The use of visual soil assessment schemes has been shown to be effective in identifying the structural condition of soils, especially in identifying the degree of sodicity and self-mulching for a range of soils. The visual soil assessment scheme developed by Shepherd (VSA) and the SOILpak score are both strongly related to soil structural condition for the range of soils tested. The proposed use of the aggregate display from a drop test as used in the VSA test to develop a quantitative estimate of friability has also shown indications of being a potentially useful test to distinguish the self-mulching behaviour and sodicity of surface soils, especially clay surface soils. The results provide evidence that the combination of soil texture and the degree of sodicity and self-mulching provide a useful system of predicting soil behaviour and soil condition in the field for a soil monitoring program. Future work is required to test the behaviour of a wider group of surface soils including weakly sodic loam and clay loam surface soils and some of the friable/oxic surface soils.

1. Introduction

The monitoring of soil condition has been seen as a priority after the Natural Resources Commission of New South Wales identified the improvement of soil condition as one of the major targets of natural management for New South Wales (NRC, 2005). To facilitate this process a program to monitor soil condition was undertaken across New South Wales in south eastern Australia in 2008. The soil properties monitored included soil carbon levels, pH, sheet and rill erosion, gully erosion, wind erosion and soil structure (Bowman et al., 2009). Soil structure is a key factor in the functioning of soils and their capacity to support plant and animal life and moderate the environment. It especially affects critical environmental functions such as carbon sequestration, control of soil erosion and the maintenance of water quality.

The monitoring program's methodology to examine soil structure relied largely on various general visual soil assessment approaches as this was considered to be the most effective to identify broad changes in soil structural condition based on the work of Shepherd (2008), Shepherd et al. (2008) and of McKenzie (2001a,b). The measurement of single soil structural properties such as bulk density, as well being more expensive and time consuming, did not provide the broad overall assessment available from the visual assessment procedures.

Three visual assessment procedures were assessed to determine their value for monitoring the condition of the structure of surface soils at the regional or Statewide scale:

1. A scheme for classifying surface soils was developed in the late 1990s by Lawrie et al. (2002, 2007). The scheme has been used in the field by advisory officers in Central Western New South Wales to assist in giving advice on recommended tillage and soil structure management and in this paper, the scheme is termed the Central West Surface Soil Scheme (CWSS).
2. The specific visual soil assessment method developed by Shepherd (2008) and Shepherd et al. (2008), referred throughout this paper as VSA, uses observations of several key soil "state" indicators of soil quality to produce a score of soil condition. Shepherd developed this methodology in New Zealand but has since applied it in several locations around the world including Europe.
3. The SOILpak scheme (McKenzie, 1998, 2001a, 2001b) uses soil structure features such as size and shape of peds, grade, colours and mottling and root behaviour to rate soils. It was originally developed as a scheme to assist cotton farmers and their advisors, but its use has since expanded.

A pilot program was undertaken to develop and test the adaptation of these VSA procedures for estimating soil structure

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Table 1
List of soils used in the pilot study. The codes for the Central West Surface Soil (CWSS) surface soil classification from Table 2 are also shown.

Soil number	Group	Label	CWSS surface soil type	Classification
Bugwah 1	Riverine Lower	Bugwah clay	LCws	Grey Vertosol, Downstream Bugwah, backplain
MER 31	Macquarie Valley	Loam red soil, crop	Ln	Red Chromosol, Eastern Carrabear, meander plain
MER 32	(Duncan et al., 2008)	Loam red soil, pasture	Ln	Red Chromosol, Eastern Carrabear, meander plain
MER 91		Clay surface soil, crop	LCwm	Grey Vertosol, Eastern Carrabear, backplain
MER 92		Clay surface soil, pasture	LCwm	Grey Vertosol, Eastern Carrabear, backplain
MER 10		Clay surface soil, crop	LCwm	Grey Vertosol, Eastern Carrabear, backplain
MER 40		Merri sodic surface soil	LCws	Grey Vertosol, Merri Carrabear, backplain
MER 11	Permian/Carboniferous Basalt Soil (Banks, 1995)	Gunnedah self-mulching clay, alluvium/colluvium, pasture	LCsm	Black Vertosol, strongly self-mulching, Maryland Soil Landscape

condition as part of the State-wide monitoring program. The objective of this paper was to obtain scores for this set of VSA measures from a range of soils with contrasting structures and compare them with some fundamental soil properties.

2. Methodology

2.1. Pilot program

The pilot program to test the soil structure methodology was undertaken in an area known to have a wide range of surface soil types that were expected to have contrasting structural conditions. This was undertaken in the Lower Macquarie Valley, where the geomorphology of meander plains and back plains, in combination with intensive irrigation and land use, has produced a range of soil types and soils in different structural conditions (Duncan et al., 2008). A site on the self-mulching Black Vertosols derived from basaltic alluvium on the Gunnedah Plains of north western NSW (Banks, 1995) was added as a benchmark soil. The soils included in the study are summarised in Table 1.

The pilot methodology involved the following:

1. Classifying the soils according to the Central West Surface Soil Scheme (CWSS).
2. Deriving the VSA Score (Shepherd, 2008; Shepherd et al., 2008).
3. Deriving the SOILpak score (McKenzie, 1998, 2001a,b).
4. Conducting chemical analyses of soils.
5. Conducting physical analyses of soils.

2.2. Central west surface soil classification scheme

Essentially the scheme identifies in which part of the ‘‘surface soil texture and structure spectrum’’ that a particular soil is located (see Table 2) for a wide range of climatic zones and soil conditions. Oades (1984) and Bronick and Lal (2005) recognised the need to distinguish sand-dominated soils (<15% clay) from loams and clay soils in managing soil structure. In the sandier soils, the development of soil structure is almost solely dependent on biotic activity and the shrink-swell activity of clays has little influence on aggregation or soil structure development. In more clayey soil, shrink swell activity and clay type have a dominant effect on aggregation and soil structure development. Both processes are important for the medium textured loams.

This scheme has been used to classify surface soils in the Central Western wheat belt of New South Wales, Australia and hence provide assistance with the selection of tillage practices and equipment. The test integrates dry strength, soil strength–moisture

Table 2
The ‘‘surface soil texture and structure spectrum’’ or the Central West Surface Soil Classification (CWSS) – logic table to determine surface soil type.

Field texture	Modifier	Code	Outcome – surface soil type
Loose sand	Nil	S	Loose sand
Sandy loam	Nil	SL	Fragile light textured surface soil
Fine sandy loam	Normal	FSLn	Fragile light textured soil
	High levels of silt and very fine sand	FSLh	Fragile light textured soil – very hardsetting
Loam	Normal	Ln	Fragile medium textured soil
	Weakly sodic	Lws	Weakly sodic loam surface soil
	Strongly sodic	Lss	Strongly sodic loam surface soil
Clay loam	Normal	CLn	Fragile medium textured soil
	Friable/oxic	CLf	Friable/oxic clay loam surface soil
	Weakly sodic	CLws	Weakly sodic clay loam surface soil
	Strongly sodic	CLss	Strongly sodic clay loam surface soil
Light clay	Friable/oxic	LCf	Friable/oxic clay surface soil
	Strongly self-mulching	LCsm	Strongly self-mulching surface soil
	Weakly self-mulching	LCwm	Weakly self-mulching surface soil
	Weakly sodic	LCws	Weakly sodic/coarsely structured clay surface soil
	Strongly sodic	LCss	Strongly sodic surface soil
Medium – heavy clay	Friable/oxic	HCf	Friable/oxic clay surface soil
	Strongly self-mulching	HCsm	Strongly self-mulching surface soil
	Weakly self-mulching	HCwm	Weakly self-mulching surface soil
	Weakly sodic	HCws	Weakly sodic/coarsely structured clay surface soil
	Strongly sodic	HCss	Strongly sodic surface soil
Highly organic soils	Mineral soils with high organic matter	Om	Mineral soils with high organic matter
	Organic/peat soils	Op	Organic/peat soils