Chapter D1. Soil examination and structural rating

PURPOSE OF THIS CHAPTER

To describe the how to examine and rate your soil

CHAPTER CONTENTS

- gathering farm and paddock information
- examining surface soil

ASSOCIATED CHAPTERS

- A3 ‘Features of soil’
- B1 ‘Common problems’
- B6 ‘Does my soil need gypsum?’
- B8 ‘Dispersion’
- B9 ‘How do I control erosion?’
- D2 ‘Soil texture tests’
- D3 ‘Chemical tests’
- D4 ‘Slaking and dispersion’
- D5 ‘Sodic soil management’
- D7 ‘Cultivation and soil structure’
- D8 ‘Landforming and soil management’
- E1 ‘Key checks for productive irrigated soils’

SOIL TESTING AND STRUCTURAL RATING

This part of the SOILpak involves observations and measurements that can be done to gauge the condition of your soil as a medium for vegetable growth. The following topics are discussed in this section.

1. FARM AND PADDOCK INFORMATION

Before you examine the soil profile, spend a little time describing the paddock. Such background information will help you to place in context the features that you find on and beneath the soil surface.

Table D1–1 and the other tables in this chapter give examples of how you would fill in details for section 1 of the soil description sheet found in Appendix 2.

Farmer, property, paddock

Record the location of the inspection. If this is your own property, the name of the farmer may seem unnecessary, but a horticulturist using the sheet may visit many farms and will need a record of the location.

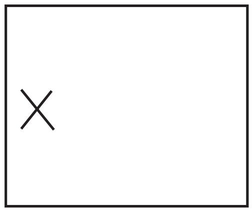
Table D1–1. Farm and paddock information

1. Farm and paddock information

Farmer: *Trevor Fosdyke* Property: *"Carlton"* Paddock: *Driveway* Date: *13/2/97* Inspected by: *Trev*	Paddock history: *previous crops, yield, fertiliser, tillage, disease?* Reason for inspection: *Check for any probs. before sowing vegies – suspect a "plough pan" from prior cultivations*

Sketch a map of site, extra notes etc.

Paddock was disced when wet. May be a plough pan



Reason for inspection

Clarify why you are examining a soil. The reason for inspection often suggests a cause of the current paddock condition, and that in turn suggests which features to examine first. After examining those features, you can reassess your first impression.

Paddock history

Sometimes the first sign of a soil structural problem is poor crop growth. Seedling emergence may be sparse; seedlings may be slower to emerge and develop; plants may be shorter than plants in other paddocks; or there may be variation in plant height within one paddock. A crop may appear to run out of soil moisture because its roots cannot penetrate a hard layer to reach moisture lower down, or moisture from irrigation does not penetrate very far into the soil.

Take into account the effect that the previous crop may have had on soil fertility. For example, a previous crop may have depleted the soil nitrogen. Did you apply enough fertiliser? If you didn't use fertiliser, was the bare fallow long enough to mineralise organic nitrogen? How many crops since a legume phase? Any periods of waterlogging? Was the ground compacted during harvest?

Accurate and detailed records are a great help in determining the cause of poor crop growth. From your farm diary (if possible, for the last five years), note:

- crops grown
- their yields
- if applicable, their protein content
- plant diseases
- monthly rainfall for the same period

- lime or gypsum applications
- fertiliser applications.

Of course, poor growth may be due to many factors other than a degraded soil structure: cold weather, disease, inadequate soil water, poor nutrition, waterlogging and so on.
Make a sketch of the site as a record. You may want to go back to the same site and investigate further.

2. INITIAL OBSERVATIONS

Initial observations

- record depth at which layers/horizons seem to change
- record some features of any observable horizons in Table D1–2.

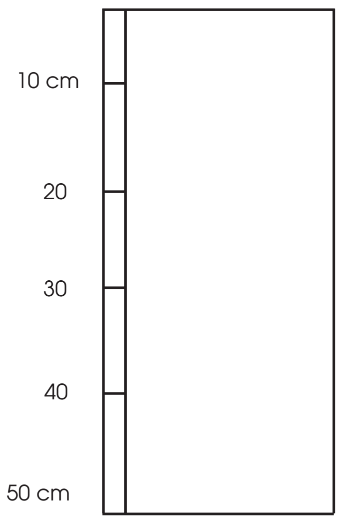
Table D1–2. Initial observation recording sheet

2. Initial observations

(i) record depth at which layers/horizons seem to change
(ii) record some features of any observable horizons in table

Observable horizon depth	Moisture	Colour	Texture	Bleaching	Lime or Gypsum	Cementing	Dispersion (0 – 16)

Indicate where horizon boundries occur (if any), and any additional info.on profile diagram



Soil Group (see introduction chapters for description of soil groups)

- Sandhill soil ☐
- Red-brown earth ☐
- Transitional red-brown earth ☐
- Alluvial soil ☐
- Self-mulching clay ☐

The initial observations are used to gain a basic understanding of the soil you are dealing with. From these observations the soil can be also grouped into one of five soil groups used in this SOILpak. Since many of these features, such as colour, texture and horizon depth, are unlikely to change quickly, this observation need only be carried out once at the same site.

Method

1. Pick a site. This may be representative of the paddock or an area of particular interest.
2. Dig a hole. The deeper the better, but at least 40 cm. The hole should be large enough to get a clear view of one side of the hole.
3. Using a knife, flick out small amounts of soil from the soil face to remove smearing caused by the shovel.
4. Using colour and texture, try to determine different layers in your soil. The soil texture test is described in Chapter D2. Record these layers (horizons) on your soil description sheet.
5. Measure the depth at which boundaries between horizons occur, and record this on the soil description sheet, along with the colour and texture of each horizon.
6. Make an assessment of the soil moisture, bleaching, and lime or gypsum for each horizon, and record the details.
7. Take soil samples from each layer to conduct dispersion tests. Slaking and dispersion tests are required when assessing surface structure (the next section of the soil description sheet). The dispersion test for soil from each horizon can be conducted when assessing surface soil dispersion.
8. Using the information obtained from your initial observations and Chapters C1 to C5, place the soil that you examined into one of the five soil groups listed on the soil description sheet.

Remember: The depth and texture of the topsoil (if there is any topsoil) are important in determining the soil group.

Colour

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To assess intact soil colour, break a moist aggregate and judge the colour. Use broad categories.

The assessment of intact soil colour is for the colour of intact aggregates, as distinct from the smallest aggregates. Colour may be useful for distinguishing between soil horizons. Red colours can indicate a freely drained soil (unless sodic). Yellow, greenish or bluish colours may indicate poor drainage. Plant residues buried in wet soil may induce a bluish colour in the surrounding soil; decomposition of the organic matter uses up oxygen and creates an anaerobic zone for a short time. Mottling (blotches of colour different from the main soil colour) indicate that the soil may have been periodically waterlogged in the past, but not necessarily now.

Texture

Soil texture is an estimate of the amount of clay, silt, and sand in a soil. Soil texture is assessed by the behaviour of a small handful of soil when moistened and kneaded into a ball and then pressed out between thumb and forefinger. It depends mainly upon the proportions of gravel, coarse sand, fine sand, silt and clay in the soil.

When to assess surface soil texture

Texture is a basic property of a soil. It changes extremely slowly (over thousands of years). However, operations such as deep tillage may bring up subsoil, and earthworks may expose subsoil, changing surface soil texture.

It is important to repeat the assessment at various depths. Texture at various depths is, together with soil colour, an indicator of soil type. Soil type is important in determining soil management.

Soil moisture

Soil moisture can be rated as:

- dry
- moderately moist
- moist
- wet.

Tillage at the wrong soil moisture content can degrade soil structure. You can also assess moisture for sowing. If you are contemplating deep tillage, a knowledge of subsoil moisture will help you decide on the likely effect.

Bleaching

Look for a layer that is paler than the upper part of the topsoil. It need not be white—just a paler colour. It may be a continuous layer, or may occur as scattered patches across a paddock.

Some soils have a bleached layer in the lower part of the topsoil. This bleached layer is paler than the upper part of the topsoil, but is still part of the topsoil.

The bleaching is caused by waterlogging, usually because a poorly permeable subsoil prevents the topsoil from draining.

A bleached layer alerts you to past waterlogging. The subsoil may be restricting drainage from the topsoil, as well as restricting root growth. Subsurface drainage may be necessary.

Cementing

Look for a hard layer. You can distinguish a cemented layer from a plough pan (compacted layer) as follows. A cemented layer does not slake when a dry piece is placed in water, and it does not soften when it is wet. The opposite is true of a plough pan. Sometimes soils have a layer of naturally hard material. The layer is chemically cemented and may consist of lime, iron or silica. Such a layer impedes drainage and root growth.

Deep tillage is the accepted way to break up a cemented layer.

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See Chapter D4 for more information on slaking and dispersion.

Lime or gypsum

Lime can occur as particles too small to see, or as white nodules up to 5 cm across. If the soil fizzes when a dilute acid (dilute hydrochloric acid or vinegar) is dropped on it, lime is present.

Gypsum occurs as crystals that are colourless, white or tinged pink. The crystals are usually needle shaped, but are occasionally are shaped like whole fingernails.

Both lime and gypsum are sources of calcium. Lime is calcium carbonate, and gypsum is calcium sulfate. Lime may occur in neutral or alkaline soils. It is a good sign if it is found close to the surface, since it helps to promote structural stability.

Gypsum will occur deep in the soil profile (usually below 70 cm), and so will not be seen with a shallow hole.

3. SURFACE SOIL

Table D1–3. Structural features of the soil surface

3. Soil surface

Structural features of the soil surface (for each feature, enter notes or simply tick)
Hard-set ....
Crusted ....
Pugged (damage from stock) ....
Cracked ....
Self-mulched ....
Cloddy ....
Friable ....

Cover % (crop, stubble, weeds):	Slaking (0 –4):	Dispersion (0–16):

Significance of surface structure

The structural form of surface soil influences water infiltration, run-off of water and, therefore, soil erosion and seedling emergence. Some soils can appear very well structured but still have infiltration problems. This is why it is important to do the slaking and dispersion tests, and to note whether the soil shrinks and swells. A soil that disperses is likely to form a surface crust and may also set hard on drying. A soil that slakes badly may do the same. A soil that shrinks and swells is able to repair its structure.

What does 'soil surface' mean?

The soil surface is the soil and surface cover that you see without digging. Surface cover (vegetation and plant residues) can be considered to be part of the soil surface, because surface cover influences soil surface properties. You may need to separate the components of the soil surface by removing the surface cover to see the actual soil.

How to assess surface soil structure

To examine the surface soil you may need a screwdriver or blunt knife to prise pieces out. Dig until you come to soil that has a different structure from the surface. Note the depth of the surface soil. The surface soil may be a 1 cm thick crust above better structured soil, or it may be a recently cultivated layer 10 cm thick above uncultivated soil.

The surface soil may take one of the following forms:

- The tilled layer in a recently cultivated soil that has not had rain to settle it. Such a surface layer may consist of fine aggregates or coarse clods. However, if rain on a cultivated soil creates a crust, then the crust is the surface soil because its structure is different from that of the soil below. The soil below is then referred to as subsurface soil.
- The loose material above a firm (not recently tilled) topsoil. Such a layer may consist of loose, fine aggregates on a self-mulching soil, or a layer of separate grains of sand.
- Compacted, crusted or hardset soil, before you come to better structured soil. If the thickness is up to 1 cm, it is a crust. If the thickness is much greater, possibly the full depth of the topsoil, it may be a hardsetting soil.

To describe the surface structure follow these steps:

1. Note on the soil description sheet any of the surface features listed (Table D1–3).
2. Assess the amount of surface cover on the soil surface and record your assessment in the box on the soil description sheet.
3. Take samples of the surface soil for slaking and dispersion tests. Record the results on the soil description sheet.
4. Enter depths on the sheet for zones in the soil profile that you identify as being different from layers above and or below.
5. Conclusion: What are the main structural features of this soil (if any) that may be restricting maximum plant growth? Using information gathered in the sections 1–4 of the soil description sheet, state what soil group you have examined.

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See Chapter D4 for more information on the slaking and dispersion test.

Describing the surface features

Hard set

Self-mulching clays do not hardset. In these soils a hard surface layer may be due to pugging or dispersion.

Loams may hard set when the organic matter content is low. Check the paddock history. A long history of cropping with little or no pasture may be the cause. Retain stubble or sow pasture to protect the soil surface from raindrop impact, and to improve organic matter content.

Tillage to break the hardset layer may be required to establish plants, but till when the soil is close to the plastic limit to avoid dust formation, compaction or smearing. Minimum tillage or no till is of most benefit after the soil has been restored to good structure.

Crusted

Self-mulching clays: A fragile crust may occur, but is usually not significant enough to cause plant growth and infiltration problems.

Non self-mulching clays: a crust is likely due to the dispersive nature of these soils.

Red brown earths and transitional red brown earths: A crust may be due to low organic matter content, particularly in a fine sandy loam or a silty loam. If this is a cropping paddock, look at your paddock history to see how long it has been since the paddock was down to pasture. Have there been seedling emergence problems? A surface cover may reduce the tendency to crust. Increase the surface roughness to form hollows that will detain water and assist infiltration. Harrows will break a thin crust and may assist seedling emergence.

Cloddy

Self-mulching clays: A cloddy tilled layer will mellow (improve in structure with wetting and drying, or frost). Further tillage before mellowing is unlikely to improve soil structure. After the soil structure has mellowed, till only the depth of dry soil.

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See Appendix 1 for a description of 'plastic limit'.

Red brown earths and transitional red brown earths: A cloddy layer may require further tillage (only when a seedbed is required) when the soil is close to the plastic limit. A cloddy surface soil may be favourable for water infiltration.

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See Chapter D4 for more information on slaking and dispersion testing.

Dispersive

Determine the slaking and dispersion score of the surface soil. Record this in the separate boxes at the end of section 3 of the soil description sheet. It may help to determine whether gypsum will improve a crusted or hardset soil.

Cracked

A description of the intensity of cracking may be useful. It may influence your decision on the appropriate action for other features.

Pugged

Cracking clays recover from pugging as they dry and crack. Pugging damage on a cropping paddock can be alleviated by tillage when the soil is dry. Pugging damage to a self-mulching clay is probably best left to repair itself.

Loamy topsoils (red brown earths, transitional red brown earths) under heavy grazing pug when wet and pulverise when dry. Till a pugged cropping paddock when the soil is at the plastic limit. A pugged loam pasture will improve in time. Reduce the grazing pressure and allow root growth to open up the soil.

Friable

A friable surface is well structured. Provided that there are no root-restricting layers in the soil profile, this is a suitable soil for minimum tillage.

Significance of surface cover

The surface cover reduces the impact of raindrops, thereby protecting the surface structure. Cover also slows down water running over the surface, thereby increasing the intake of water to the soil at each irrigation or rainfall event. Large amounts of surface cover at sowing time can pose a problem to some planting implements.

4. SOIL PROFILE FORM AND RATING

The form of soil structure is a description of the arrangement of soil particles into larger units, and of the pore spaces between the units. It affects the movement of water through the soil, the movement of air into and out of the soil, and the ease of penetration by roots. Soil structural form is distinct from other aspects of soil structure such as structural stability and structural resiliency. In common usage, 'soil structural form' is often referred to simply as 'soil structure'. It does not take into account the effect of cultivation and traffic and how the soil structure will respond.

Of a number of paddocks with similar soil texture, those paddocks with good soil structure are more versatile than those with poor soil structure. You have a greater range of options when the soil structure is good.

Poor soil structure indicates the need for different management strategies: perhaps a change in irrigation frequency, minimising tillage or reduced stocking rates on wet soil.

Section 4 of the soil description sheet has columns for recording your assessments of several soil structural features. These assessments are used to form structure scores for individual zones or horizons in the soil profile.

The features, from left to right on the soil description sheet, are in priority order. They start with aggregate size, the feature that has the most influence upon the suitability for plant growth. After assessing and recording the structural features for each horizon, use Table D1–4 to decide upon structure scores for each zone or horizon.

Table D1–4. Structural form and rating

4. Soil profile: structural form and rating

Depth (cm) (%)	Aggregate size (cm)	Ease of fracture	New roots	Aggregate shape	Fracture faces	Peds within aggregates	Porosity (0–2)	Colour of smallest aggregates	Structure score (0–2)

When to assess soil structure

It is possible to record differences due to a single cultivation, as well as long-term changes. Use your assessment as a systematic way to check past decisions and plan future management. For example, before deciding to deep till, examine the soil to see if there is a real need for that operation. If there is a hardpan, measure its depth so that you can set the depth of the cultivation tines to break the pan. Check again after a short run with the machine to see if it is doing the job.

Depth

Enter depths on the sheet for zones in the soil profile that you identify as being distinctive. These zones may be the same as those described in the initial soil observations (section 2). However these horizons may need to be subdivided if structure varies greatly within each horizon.

Aggregate size

Small aggregates indicate a good tilth; large aggregates indicate cloddiness.

When you are examining wet soil it can be difficult to determine the natural fracture plane between aggregates, and hence their size. Very dry soil can have high strength because of interlocking aggregates. Use enough force to expose natural faces: hitting a dry lump with a hammer may be the best technique.

How to assess aggregate size

Break a lump of soil into smaller and smaller pieces, using moderate hand pressure. Take note of the size of the lump just before you begin tearing through the fabric of the soil, leaving a fine grainy surface. This is the point at which you are no longer breaking the soil along natural fracture planes: you are tearing the aggregate apart.

Note the most common size or note size differences where you have aggregates of widely varying size. For example, in a cloddy tilled layer, some clods may be larger than 4 cm, with the remainder of the soil made up of clods smaller than 1 cm or dust.

Ease of fracture

How to assess ease of fracture

Well structured soil parts along natural faces (the aggregates ‘part’ from one another). Poorly structured soil breaks where you apply the force: rather than along natural faces.

When you are examining dry soil, distinguishing between ‘parting’ and ‘breaking’ requires some experience. Think of dry, poorly structured soil as snapping apart. Dry, well structured soil crumbles into small aggregates: it is friable.

When examining wet soil, parting of aggregates from one another is easier to detect. Don’t squash the soil, but tease it apart. If it fractures easily, it is well structured. If it will not part but stretches like dough or plasticine, or tears apart, such a piece of soil is poorly structured.

New roots

Significance of new roots

Roots, where present, are the best indicators of soil structure. New roots are indicators of current structure. Roots grow where they can: along the easiest path. A prolific growth of new roots **throughout the soil** indicates good soil structure. Where roots follow cracks and grow around aggregates rather than penetrating them, the structure is poor. Good soil structure allows roots to grow straight. Roots may bend or branch above a compacted layer. Unrestricted roots are round in cross section, where as roots in a compacted soil may show flattening or bulging.

How to assess roots

Follow some plant roots as you dig through the soil. Note any abrupt change of direction. This is a good way to detect a hardpan. If the soil is too hard for plant roots to grow vertically, they may turn and grow horizontally. Check also that roots growing vertically are not deformed. If there is evidence of healthy root growth well below the plough layer, there is no need to dig further.

Caution: Roots bend for reasons other than a restricting soil layer. Herbicide damage, soil diseases, and unfavourable soil pH can all cause roots to bend or branch. Also, do not confuse branching due to compacted soil with proliferation of lateral roots on a well structured soil.

Aggregate shape

How to assess aggregate shape

Look for undisturbed lumps of soil from the side of the hole that you dug, or from the middle of a new spadeful.

Using the description of aggregate shape and size in Figure D1–1, observe and record the aggregate shape and size for each horizon. The shape of aggregates depends upon the forces acting on the soil. Tillage and traffic change the shape from what is considered natural.

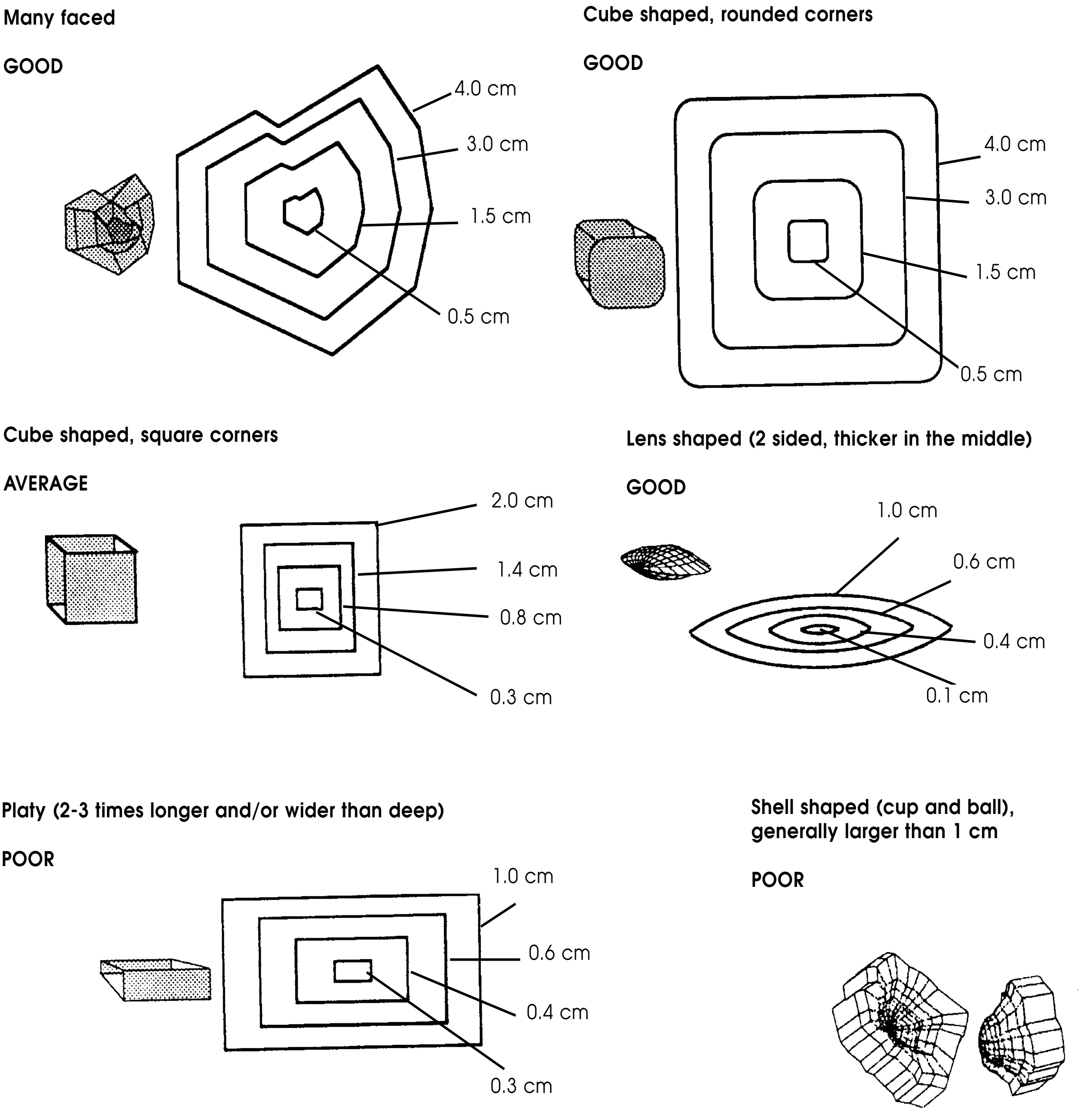
Massive. Massive aggregates are dense and have few pores. They appear dull. 'Featureless' would be an apt description. Massiveness is a sign of poor structure.

Many-faced aggregates. Many-faced aggregates are a sign of good structure. They may be loosely joined as a thin, fragile crust (not usually strong enough to inhibit seedling emergence) or bound into a very porous, crumbly aggregates.

Cube with square corners. These aggregates occur naturally in non-self-mulching clays and have sharp edges, but may also be the products of a massive block fractured by drying. Knowledge of similar soils in the area helps here: look under trees or pasture to see if that soil type naturally has aggregates with square corners.

Platey aggregates. Platey aggregates (Figure D1–2) show as obvious horizontal layering in the soil profile, or may show in the way a lump of soil parts. Prise a lump from the soil and remember its orientation. Break it into smaller pieces by forcing it in different directions. If it parts more easily along horizontal fractures than in other directions, and produces flat plates, it is platey. Platiness is a sign of poor soil structure.

Figure D1–1. Common aggregate shapes and sizes



A thick platey layer is worse than a thin one. Platiness is common under wheel tracks and does not usually occur deeper than 30 cm below the surface.

Cube with rounded corners. These aggregates occur naturally, together with many faced aggregates, below the surface. They may fit together in larger aggregates and are a good sign.

Lens-shaped aggregates. Lens-shaped aggregates occur naturally in clay subsoils and are a sign of good structure. Such aggregates may be hard to find, because often we see only part of a large lens-shaped aggregate (half a lens appears as wedge-shaped). Lens- or wedge-shaped aggregates usually part into smaller aggregates. They occur at all angles in the soil, although larger aggregates typically have a face at 45° to the horizontal.

Figure D1–2.

Platey aggregates. (Justin Hughes)

Shell-shaped aggregates. Shell-shaped aggregates are another sign of degradation in clays. You may find clods that separate along a cup-and-ball-shaped fracture, suggesting that one clod has been pressed into another. This is a sign of poor soil structure. Shell-shaped aggregates are distinct from lens-shaped ones: shell-shaped aggregates are tightly curved and have dull faces.

Fracture faces

In clays, the fracture faces may be shiny, indicating a natural fracture plane between aggregates, or dull, indicating that the soil has been remoulded (Figure D1–3). In loams, rough faces with many pores indicate good structure.

Figure D1–3.

Dull and shiny aggregates. (Justin Hughes)

What to look for

Examine the faces of a lump of soil removed from the side of a hole. Break the lump apart to reveal the faces between the aggregates. A good way to learn to recognise the different kinds of fracture face is to compare soils that have been treated differently: for example, compare soil from a pasture with soil from a wheel track, or soil from a plough pan with soil from below the pan.

Moderating factors

Do not confuse natural shiny faces with the shiny smeared layers made during cultivation.

Proportion of small aggregates (peds)

Significance

This observation refines the observation of aggregate size by demonstrating the internal structure of larger aggregates. It confirms other observations, such as ease of fracture, aggregate shape and fracture faces.

Moderating factors

Moisture content has a large influence on the soil's behaviour in this test. However, it is possible to distinguish soils that are puggy when wet, or brittle when dry, from those that are friable.

How to assess the proportion of smallest aggregates

Roll an aggregate gently between the thumb and forefinger to break it down. Record the proportion of the breakdown products that are shiny faced (in clays) or that are more than single grained (in loams).

Porosity

What to look for

Look at the soil and feel how it breaks. Attempt to break a lump into smaller and smaller pieces. The feel of the soil (crumbly for good structure; doughy, flinty or powdery for poor structure) also tells you if the soil is porous. Rate porosity by the potential pathways for root penetration. Score porosity as 0 (no visible pores), 1 (moderate number of pores) or 2 (many pores).

What is porosity?

Porosity refers to the number of pores in the soil. Pores are the spaces between and within aggregates. Macropores are relatively large and most can be seen with the naked eye. They include the spaces between aggregates caused by cultivation, shrinking and cracking, and channels made by plant roots and insects and earthworms.

Significance of porosity

Pores large enough to see are the means by which water, nutrients and air are able to move into and through the soil. Root growth is sparse within non-porous clods, consequently limiting nutrient and moisture extraction.

Moderating factors

In dry soils it is more difficult to feel porosity, because even well structured soils are hard when dry. It is best to assess the soil when it is moderately moist.

Colour of smallest aggregates

Significance

Well structured soils generally have strong colours because of their high organic matter content and/or high iron content. Therefore, dark grey or reddish brown colours indicate good structure. Pale colours such as light grey or a slight brown indicate less well structured soil. Bluish colours indicate a tendency to waterlogging. **Note** that this observation is the lowest priority in scoring the overall structure.

Structure score

The structure score is determined by the scores assessed as per Table D1–5.

Note that sodic layers have an ESP > 6: see 'Chemical tests', Chapter D3; or DI > 8: see 'Dispersion index' on page D4–6; these are likely to score less than 1.

Now that you have assessed you soil structure you can minimise structural damage by using the correct implements and tilling techniques (Figure D1–4).

Figure D1–4.

The Connor Shea 8000™ series minimum tillage seeder, showing flat coulter discs for cutting stubble and narrow T-boot tines. This machine can sow pasture seed directly into the cover crop stubble or pasture that has been sprayed off and helps minimise structural damage. (Ben Rose)

Table D1–5. A numeral system for classifying soil structure

Features **Firm soil, moist**	**Score** **Firm 0 (F0)** **Poor structure**	**Firm (F1)** **Moderate structure**	**Firm 2 (F2)** **Good structure**
Aggregate size: width of natural subunits produced by moderate hand pressure	Mostly more than 50 mm wide	5–50 mm wide	Mostly less than 50 mm wide
Ease of fracture	Difficult for a spade or knife to penetrate; soil made up of large, tightly fitting blocks; breaks like plasticine	Moderate hand pressure needed to part blocks	Parts readily into porous subunits
New roots	Very few new roots	Medium number of new roots	Prolific growth of new roots throughout the sample
Aggregate shape	Massive, platey or shell-shaped	Mixed shapes	Many-faced, cube with rounded corners, lens or wedge
Fracture faces	Soil breaks along the line of force applied in any direction into units with sharp corners; internal faces have no protruding subaggregates	Some natural separation planes with shiny faces, but most fracturing is along the line of force to produce angular corners and smooth, dull internal faces	Natural fracture planes dominate; most of the faces are smooth and shiny. Often there are protruding, many-faced, round-cornered aggregates
Peds within aggregates: proportion of smaller aggregates revealed by rolling the sub units between thumb and forefinger	Less than 10% of breakdown products are shiny-faced aggregates (clays) or larger than single grains (loams)	50% of breakdown are shiny-faced aggregates (clays) or larger than single grains (loams)	More than 90% of breakdown products are shiny-faced aggregates (clays) or are larger than single grains (loams)
Porosity: internal porosity of smallest aggregates	Porosity rating mostly 0	Porosity rating mostly 1	Porosity rating mostly 2
Colour of smaller aggregates	Bluish	Light grey or slightly brown	Dark grey to strong, deep red
Extra notes for dry soil	Requires a very strong blow with an implement to break the blocks, revealing smooth, dull faces with sharp corners; flinty	Hard hand pressure required to break the blocks	Falls apart with light hand pressure to produce small, natural aggregates
Loose soil, moist Features	Loose 0 (L0) Poor structure	Loose 1 (L1) Moderate structure	Loose 2 (L2) Good structure
Aggregate size	Diameter of the dominant fraction usually more than 20 mm	Diameter of the dominant fraction usually between 5 mm and 20 mm	Diameter of the dominant fraction usually less than 5 mm

Table D1–5. A numeral system for classifying soil structure (continued)

Features **Loose soil, moist (continued)**	**Score** **Firm 0 (F0)** **Poor structure**	**Firm (F1)** **Moderate structure**	**Firm 2 (F2)** **Good structure**
Ease of fracture into constituent natural sub-units, if present	At least half the soil is large, dense and massive clods; dull and smooth fracture faces	At least half of the larger compound aggregates can be parted by moderate hand pressure into their constituent natural aggregates	Comprised wholly of natural aggregates that may be separate or compound (very easily parted by hand into their constituent natural aggregates). When broken, the aggregates separate along many-angled, often shiny faces. If shiny faces are not evident, the soil has obvious pores and is friable
Aggregate shape	Cube-shaped with square, sharp edges, or shell-shaped	Mixed shapes	Many-faced, or cube-shaped with rounded edges
Porosity: internal porosity of smallest aggregates	Porosity rating mostly 0	Porosity rating mostly 1	Porosity rating mostly 2
Extra notes for dry soil	A large proportion of large, hard, flinty clods with sharp edges	As above, but compound aggregates are firmer; some are flinty	As above