An instrument for checking soil structure

Australia's ecosystems are ultimately the products of the continent's ancient and fragile soils. Degraded by cultivation and poor land use, and sensitive to a host of influences — among them fire, drought, clearing or introduced animals and plants — soils nevertheless provide a reliable indication of the health of the environment and the best indication of appropriate management strategies.

Until recently, assessing the structure of soils relied on cumbersome techniques that involved measurements of soil particles. In the late 1980s, Dr Ian White and Dr Michael Sully, both of the CSIRO Centre for Environmental Mechanics, and Dr Michael Melville of the University of New South Wales examined the problem afresh. They recognised that the spaces between soil particles — the pores — are more important than the arrangement, size and structure of the particles themselves.

It is the pores that determine a particular soil's ability to transport water, nutrients and gases, to support plants and to cope with natural and man-made pressures. In many cases, soil structure degradation involves a decrease in the number of large pores. This means less water and air can enter the soil and it is harder for plant roots and seedlings to grow. The constant cultivation practised in vegetable gardens and on farms usually affects the number of large soil pores close to the surface.

Dr White, Dr Sully and Dr Melville developed a portable, easily operated instrument that assesses pore structure by measuring how quickly water will soak into a particular soil, applying theory developed more than 20 years ago by Dr Robin Wooding, a CSIRO scientist now working at the Centre for Environmental Mechanics.

The disc permeameter, now manufactured under licence by A.L. Franklin Pty Ltd of Brookvale, N.S.W., was developed with the assistance of the National Soil Conservation Program, the New South Wales Soil Conservation Service and the University of New South Wales.

It has found a market in countries with soil problems differing as widely as those of Holland and the midwest of the United States, and offers major advantages over other instruments. It measures flow as it happens in Nature, where water spreads outwards as well as downwards (unlike instruments that rely on driving a cylinder into the soil); and it can operate even in 'problem' soils — crusted, self-mulching, cracking, saline or stony ones — because it obtains information without mechanically disturbing the soil, freeing researchers from the concern that their measurements reflect an artificial situation rather than natural conditions.

To operate the disc permeameter, the researcher places water on the soil surface, from either a shallow pond or a wet disc (both of which are about the diameter of a dinner plate), which is then forced into the soil under pressure or allowed to flow into the soil under suction. By measuring the rate at which water flows out of the instrument's reservoir, scientists can work out the soil's sorptivity (ability to absorb water) and its hydraulic conductivity (a measure of how water moves through the soil under the pull of gravity). By comparing how quickly water flows under pressure with how quickly it flows under suction, they can assess the degree to which the soil has become degraded.

Soils are riddled with macropores, cracks and tunnels formed by earthworms or old root tracks. Compaction of a soil — say, by heavy traffic, by a steamroller or by agricultural practices — reduces the macropores' size, in the same way that squeezing a sponge forces air out of its pores. Researchers can predict the effect of compaction on soil structure by using the disc permeameter.

The instrument can serve a variety of purposes. It allows scientists to measure: soils' ability to absorb rainfall; their performance under crops; and the impacts of different management practices on water uptake, run-off and erosion. At Tamworth in north-western New South Wales, it is being used to assess different soils' ability to soak up effluent.

It allows engineers to measure the performance of mining dumps and reclaimed land or assess the permeability of construction materials such as concrete or bricks (including mud bricks), roadways, dams and the clays used to line landfill. It even has applications in industry, providing manufacturers, consumer bodies and scientists with a means of measuring the performance of absorbent materials such as nappies.

• Third, no horticultural equipment has been commercially developed for sowing or transplanting into mulches, although suitable equipment does exist. Zero tillage will also require changes to conventional management of crop residues.

• Fourth, the benefits of mulch change throughout the year. Mulches are most important in summer, when soil temperatures are high, while in spring the slower warming of soil beneath mulches can slow growth in early-sown crops. Growers must also leave enough time between the death of the clover and the planting of vegetables to allow for the initial decomposition of clover roots.

• Fifth, some horticultural operations grow crops all year round and cannot afford to have land tied up in the production of mulch crops. This is a difficult problem; short-term economic considerations often dictate that farming methods make the soil less economically viable in the long term, and in some parts of Australia vegetable-farmers are practising shifting cultivation. It may be possible to reduce the length of time the mulch crop is in the ground to about 4 months; on the other hand, the benefits of a good mulch crop can last for more than a year.

Dr White shows how the soil permeameter can be used to provide information on soil strength and structure.

John Holdsworth

Want to try it?

A 'Clever Clover' kit containing two packets of both clover and lucerne seeds and full planting instructions, plus a follow-up questionnaire, is available for $10. Send your order, with payment, to: C.E.M. Clever Clover Kit, G.P.O. Box 821, Canberra A.C.T. 2601.