Soil matters

Monitoring soil water and nutrients in dryland farming

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Foreword

The cliché—'Farming is no longer a way of life; it's a business'—takes on more meaning as prices for produce become more competitive while our soil resource is becoming depleted. Today, farming is indeed a business of producing crops, pastures, and livestock from limited resources. It involves complex interactions between labour, capital and land on the one hand and the variable inputs of production on the other. Efficiencies have to be sought at all stages.

The greatest efficiency to be gained is in the use of water—the most scarce resource in the production capacity of our land. Next would be the use of plant nutrients obtained from the soil. Our rural industry is moving from resource exploitation to resource maintenance—words such as 'sustainability' become more prominent in our farming vocabulary.

With this backdrop, it is highly appropriate that the APSRU team should produce *Soil Matters* for the northern cropping region of New South Wales and Queensland.

Soil Matters describes 'best practice' for those monitoring soils for water and nutrients. It should be used by farmers and consultants in the field, and is especially relevant to those wishing to apply their data to the APSIM crop simulation program. The use of APSIM can revolutionise the way farmers think about efficiencies in water and nutrient use and in strategies for risk management. Like any other computer simulation model, the output of APSIM depends greatly on the quality of information being applied.

Soil Matters provides clear and well illustrated instructions on how to achieve the high-quality data needed.

This manual is a starting point for the linkage between applied research and the needs of industry to make better use of our soil resources. Adoption of its methods and the subsequent use of the results by farmers will represent a great advance in soil monitoring and cropping potential. It should result in a much better understanding of what is happening in their soil and plant environment, of their opportunities and risks, and should lead to better resource management.

Jim Hitchener
IAMA Limited, Toowoomba

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These supporters helped us to recognise the value that they saw in improved soil monitoring and the impact that it could have on their farming enterprises. This initial support led to expanded interest and acceptance from the wider farming community for both the direct benefits of soil monitoring and for its role in simulation of crop and pasture production relevant to an individual paddock or farm.

Thanks to our colleagues at APSRU, the researchers who provided advice and input into the content of the manual, and to those who assisted in the preparation of the manuscript—particularly Lisette Ackhurst, Dean Hargreaves and Mackey Vogler. Special thanks to Lisette for the preparation of the many diagrams and figures.

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Neal Dalgliesh

Mike Foale

APSRU, Toowoomba
November 1998

Frequently asked questions

Quick answers are given to some of the questions that farmers frequently ask about soil. More detailed information is available in the suggested modules.

Soil type

What soil types do I have? Brief descriptions of the major soils of the Darling Downs and soil water characteristics for a wide range of soils of the northern grain region are given in Module 5. A soil map of the central Darling Downs is enclosed. Detailed descriptions of soil types for your district can be found in *Land Management Manuals* from the Queensland Department of Natural Resources. Southern users should contact their local agronomist.

Module 5

Appendix 5

Soil sampling

How many cores do I need to take to check water and nutrients in a paddock? A 40 ha paddock of reasonably uniform soil requires 8 cores, bulked together, to get within 20% of the true nitrogen level. Water content is less variable, requiring only 5 cores.

Module 2

Where in the paddock do I sample to get the best estimate of water and nutrients? In a fallow, cores may be located randomly or in set patterns. In-crop or post-harvest sampling may need a more set pattern to represent both inherent variability and that caused by unequal extraction of water and nutrients across the row.

Module 2

How deep do I need to sample to check the soil water and nitrogen available to a crop? Sample to the full depth of the root zone, being aware that this depth may vary across the paddock and is likely to be deeper than many of us expect.

Module 2

How deep can crop roots go? Cereal crops and cotton have the potential to grow beyond 1 metre depth, while grain legumes can grow to 120 cm. Rooting depth may be limited by soil type, acidity at depth, salinity, shallow soil profile, and also the lack of deep soil water.

Module 1, 2, 5

How can I check the depth of rooting in my crops? Take a soil core and check for roots as you break off pieces along its length. A hand lens is useful for identifying roots.

Module 2

What depth intervals should I use? Depth interval depends on the reason for sampling. Shorter intervals are used at the surface for nutrients such as phosphorus and zinc. Intervals of 30 cm or greater are generally used at depth. Shorter intervals give more detail about the location of water and nutrients.

Module 2

What if I damage the tube or the core jams during sampling? Tubes with a formed cutting tip are easily heated and re-formed if damaged. Jammed cores can be removed by first using a wood auger, and then inverting the tube and bumping it on a solid wooden block to remove residue.

Where do I get information on fabrication or sourcing of soil sampling equipment? Several Darling Downs companies make sampling rigs and coring tubes. Plans for fabrication of tubes are presented.

Appendix 1, 2

Soil properties

Module 1, 2, 3, 4, 5

Why is bulk density (BD) important? BD is needed to calculate soil water (as mm/100 mm of soil depth) and nutrient content (in kg/ha). A low BD indicates high pore space and greater potential to store water. Roots extend more readily through a soil of low BD.

Module 1

What are salinity and sodicity? Salinity is an accumulation of dissolved salts in a soil layer; these can restrict rooting depth and prevent the roots taking up water. Many clay soils are saline at depth, preventing access to deep water and nutrients. Sodicity is an accumulation of sodium ions.

Module 1

How does sodicity affect the soil? Sodicity in the soil induces lack of cohesion between the fine soil particles. Instead of remaining as cohesive peds, the particles disperse when wet, filling pore space between larger soil particles, and preventing penetration by roots and reducing capacity to hold water. Sodic soil has a very high Bulk Density.

Soil water

Module 1, 3, 4, 5

What is plant available water capacity? Plant available water capacity (PAWC) is a measure of how much water a soil can supply to a crop. It is calculated as the difference between the amount of water that a fully-wet soil can hold and the amount left after a crop has matured under severe water stress.

Module 4, 5

Do I need to calculate PAWC for my soil? First check Module 5 to see if your soil type has already been measured. If it has not, follow the instructions in Module 4, or enlist the aid of a consultant.

Module 2, 3

Can I calculate the water available to my crop and check how efficiently it is being used? Soil water status can be calculated by measuring soil water content at sowing. After allowing for in-crop rainfall and run-off, and deducting remaining soil water at maturity, water use efficiency is calculated by dividing yield (kg) by water used (mm).

Soil nitrogen

Module 1, 3

How can I calculate how much nitrogen to apply? Application rates are calculated from the nitrogen needed for the expected yield and protein content less the amount already available in the soil at sowing.

Module 1, 3

How do I calculate the nitrogen available in the soil? Multiply the mg/kg value (from soil analysis) by bulk density and the thickness of each layer of soil analysed, and add these values for all depth layers.

Module 1, 2

What causes a nitrogen bulge in the soil? Mineral N from near the surface moves down freely with water entering the profile. Unused N from one season can be carried to depth and, if not used by following crops, will accumulate in the lower profile.

Module 2, 3

How do I know if there is a nitrogen bulge? This can be detected by deep sampling; it may be expected if you have applied fertiliser during periods of low crop yield or in land recently brought into crop production.