# CHARACTERISING SOILS FOR PLANT AVAILABLE WATER CAPACITY - CHALLENGES ON SHRINK/SWELL SOILS

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## Abstract

To parameterise the water balance module (SoilWat) of the APSIM (Agricultural Production Systems Simulator) model requires calculation of the plant available water capacity of the soil (PAWC). PAWC relies on the determination of the upper storage limit (USL) and the crop specific lower limit of water availability (CLL). A methodology suitable for the heavy clay soils of the northern cropping region has been developed. This centres on a) the ponding of water for a period sufficient to achieve near-maximum soil wetness and the sampling of gravimetric water content and calculation of bulk density (BD), and b) measuring the lowest limit of water extraction by a particular crop. The problem of deciding when the soil is at near-maximum wetness, options for the determination of BD and ways of improving the estimation of CLL are described and discussed.

*Key words: FARMSCAPE, plant available water capacity, crop lower limit, upper storage limit, saturation, pore water pressure, tensiometer, soil water balance, modelling.*

Recent research (4) has shown that farmers originally sceptical about the potential of computer simulation to assist their management can come to value simulation as a tool when things of importance to them can be realistically simulated for specific paddocks and actual soil conditions. However this requires basic soils data that does not generally exist. This paper reports on an aspect of a regional program to characterise the major cropping soils for PAWC to provide a data base of inputs to support customised simulation analysis.

The characterisation of shrink/swell soils provides some unique challenges. The techniques of slow water application, using trickle irrigation, and the use of the Neutron Moisture Meter (NMM) in tracking water entry (1) have been successful in overcoming the problems of slow water infiltration inherent to these soils. The refinement of techniques discussed in this paper have been shown to further improve the reliability and accuracy of measurement of USL, BD and CLL and made the determination of BD more accessible to researchers and consultants.

## Results and Discussion

### *Refinements in determining upper storage limit (USL)*

Currently the decision to sample at what is thought to be USL is made on the basis of reaching an apparent steady state of moisture (measured using a NMM). The estimation of steady state is difficult because, as the profile nears USL, the increase in soil water content becomes smaller than the precision of water content measurements with the NMM. Thus, there is a tendency to underestimate USL in some soils, particularly at depth. To confirm USL, a portable, electronic tensiometer (2, 5) is used to check pore water pressure, in a test core, prior to the main destructive sampling. The core, of 50 mm diameter, is removed from the sampling tube, wrapped in plastic sheeting and kept in the shade to avoid condensation and evaporation. Small diameter (4 mm) holes are bored at right angles to the length of the core at set points along its length equating to the mid-points of the standard depth intervals used in routine sampling. The ceramic probe of the tensiometer is inserted. The tensiometer is allowed to equilibrate (from 2 to 5 minutes) before pore water pressure is read from the counter. Where pore water pressure is at or above –10 kPa, the soil is considered to be at USL and ready for sampling.

### *Bulk density*

In soils that exhibit shrink/ swell characteristics, BD is measured at USL. This avoids the complications associated with accounting for the cracks at lesser moisture contents. Commonly sampling is done with coring tubes of large diameter (up to 125 mm) (1) which are pushed into the soil using hydraulics. Evidence from the characterisation of a number of soils (>50) (N. Dalgliesh, unpublished data), where total porosity (PO) was calculated from measured bulk density, indicate that the difference between PO and USL is too small to be a sensible estimate of USL. Where this is the case the most likely explanation is that core compaction has resulted in an over-estimation of BD.

Analysis of the above data also shows a close relationship between the measured BD and the gravimetric water content of the wet soil, corresponding to an air filled porosity of 3.2% ($R^2$=80.8%) (2). This indicates that the soils are conforming to expected shrink/swell behaviour described by Gardner (3) albeit at a lower value of air filled porosity than his assumed 5%. Using this relationship enables BD to be calculated (i), thereby avoiding the problems of compaction in field measured samples.

The practical use of this relationship has enabled BD to be estimated much more conveniently and cheaply. Current practice is to test for proximity to USL using the tensiometer and to then sample for gravimetric water content (using a standard 50 mm coring tube) and calculate BD.

BD (g/cc) = (1-e)/(1/ad +qg)??? (i)

*where:* qg = gravimetric moisture content (g/g); ad = assumed absolute density of the solid matter in the soil (2.65 g/cc); e = air filled porosity at qg (~0.032)

*Crop lower limit*

The use of terminal profile water content as an indicator of CLL is valid only where confirmation can be made, that the potential rooting zone of the soil profile was wet prior to crop extraction and that crop roots accessed water from a particular part of that zone. This is done by measuring gravimetric water content at the time of rain shelter installation (generally around anthesis) (1, 2) and comparing these data with the final water extraction data obtained at crop maturity. CLL is only described to the depth where there is evidence of water extraction by the current crop. Measurement for CLL should be undertaken in a number of seasons to ensure that the maximum potential water extraction for the particular soil x crop configuration is obtained.

## Conclusions

Measuring water characteristics is difficult in shrink-swell soils, however the practical application of these techniques has provided increased confidence in the validity of soil characterisation data and improved the efficiency of data acquisition. These gains assist in improving the value and confidence that farmers place in the use of simulation in their management.

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