MURRAY DAIRY - AUTUMN START-UP WORKSHOPS.

Technical Note: EFFECTIVE ROOT ZONE DEPTH & AVAILABLE WATER CONTENT.

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Description of the issue and importance: Effective Root Zone Depth (ERZ), measured in millimetres (mm) and the Available Water Content (AWC) measured in mm/cm of soil, should be recognised in the process of identifying a crop or pastures water requirement and irrigation scheduling. The variability in these factors should also be understood to identify and understand the reasons behind non-uniform plant growth or yield.

Variability in growth within irrigation bays and across a property is a challenge and the abovementioned parameters play a major role.

The AWC is calculated by multiplying the depth of each layer within the crop root zone by an available water factor. An example of Available Water Factors that can be adopted are listed in Table 1. Data is compiled from a range of references including Kramer (1983), Weatherby (1992), Dalgliesh & Foale (1998) and Lawrence & Dalgliesh (2013). These guidelines are subject to variation depending on soil parameters unique to individual sites such as soil structure.

Table 1. Available water in mm/cm for various soil texture classes.

Soil Type (Texture)	**Wilting Point** (mm/cm)	**Field Capacity** (mm/cm)	**Available Moisture** (mm/cm)
Sand	0.2	0.4 - 0.8	0.2 - 0.6
Loamy Sand	0.4	0.8 - 1.7	1.4 - 1.3
Sandy Loam	0.8 - 1.3	1.7 - 2.5	0.8 - 1.3
Fine Sandy Loam	1.2 - 1.7	2.5 - 3.3	1.3 - 1.6
Clay Loam	1.2 - 1.7	2.5 - 3.3	1.3 - 1.6
Clay	1.7 - 2.5	3.3 - 5.0	1.6 - 2.5

Where variability occurs, difficulty may be experienced with achieving uniform yield and quality and soil type may not necessarily depict the boundaries of zones with variable AWC. Soils mapped by Skene and Poutsma (1962) have been modified extensively and within soil type the AWC may vary by up to 20mm. Depth of topsoil and land-forming practices play a major role in influencing AWC.

Identification of the ERZ and AWC: ERZ and AWC are measured by visual assessment by inspection of a pit, where soil horizons, textures and the depth of the root zone can be assessed. The ERZ is not the deepest extent of a plant root observed in a soil profile, but the point where roots are likely to extract all the available water from a soil at any time from the presence of plant roots. The AWC can be calculated mathematically based on soil data and an AWC factor covering various soil moisture levels.

Table 2 summarises the ERZ and AWC values of three representative profiles in the Goulburn Valley, highlighting the variability in AWC in each soil horizon at 40 kPa of each profile as a guide to the level of variability that can be expected.

Table 2. Effective Root Zone Depth and approximate Available Water Content for typical soil profiles in the Goulburn Valley.

	SITE 1 Lang Site 1	SITE 3 Emmett Site 1	SITE 5 McDonald Site 1
A_1 Horizon	Depth 0-9cm, total 9cm. Texture SCL AWC at 40 kPa = 0.62 mm/cm Total AWC = 5.58mm	Depth 0-14cm, total 14cm. Texture FSCL AWC at 40 kPa = 0.66 mm/cm Total AWC = 9.24mm	Depth 0-10cm, total 10cm. Texture FSCL AWC at 40 kPa = 0.66 mm/cm Total AWC = 6.6mm
B_1 Horizon	Depth 9-30cm, total 23cm Texture MC AWC at 40 kPa = 0.46 mm/cm Total AWC = 10.58mm	Depth 14-50cm, total 36cm Texture MC AWC at 40 kPa = 0.46 mm/cm Total AWC = 16.56mm	Depth 10-40cm, total 30cm Texture MC AWC at 40 kPa = 0.46 mm/cm Total AWC = 13.8mm
B_2 Horizon	Depth 30-60cm, total 30cm Texture MC AWC at 40 kPa = 0.46 mm/cm Total AWC = 13.8mm	Depth 50-70cm, total 20cm Texture MC AWC at 40 kPa = 0.46 mm/cm Total AWC = 9.2mm	Depth 40-80cm, total 40cm Texture MC AWC at 40 kPa = 0.46 mm/cm Total AWC = 18.4mm
B_3 Horizon	**ERZ 65cm.** Depth 60-65cm, total 5cm Texture SC AWC at 40 kPa = 0.46 mm/cm Total AWC = 2.3mm	**ERZ 75cm.** Depth 70-75cm, total 5cm Texture SC AWC at 40 kPa = 0.46 mm/cm Total AWC = 2.3mm	**ERZ 80cm.**
Indicative AWC (mm)	**32.26 mm**	**37.3mm**	**38.4mm**

Management options: The potential ERZ depth of a soil profile is an inherent property, limited by the depth to unfavourable or hostile subsoil. The AWC is often lower than the potential where impedances exist in the upper horizons, restricting root growth. Any physical impeding layer within 300mm of the surface can be ripped. The AWC should be calculated based on the depth to hostile material, plus a root zone depth of no more than 100mm into a hostile layer.

Deeper subsoil constraints below 300mm are difficult to treat and caution should be taken with the assessment and cost effectiveness of this process.

There are no set range of options available to increase the ERZ and AWC resulting from a shallow depth to unfavourable or hostile material. The primary option is to improve cycles of wetting and drying, or swelling and shrinking. Shrinkage of clays promotes cracks and structured units, allowing for the movement of topsoil, organic matter, nutrients and soil ameliorants to depth with the movement of moisture. This is similar to the process that occurs in self-mulching clay soils, where surface material falls to depth through cracks, promoting improved growing conditions deeper in the profile. In this case of duplex, Red-Brown Earths, a similar process should be emanated to encourage deeper rooting of irrigated pastures and crops.

The process may require a kick-start using a dryland crop or pasture for sacrificial purposes. The pasture or crop will need to suffer drought stress or function below the point of Deficit Available Water (DAW) to utilises water from depth and shrink subsoil clay.
Agronomic practices may be modified in some situations to promote greater capacity to store winter rainfall. Winter crops may be planted earlier, or irrigation adjusted to ensure the soil profile is not at field capacity leading into winter. This is easier said than done, however opportunities often present which can be capitalised on. Periods of prolonged saturation of the subsoil should be avoided. Under these circumstances, plant roots often establish a shallow root system and perform or yield below their potential.

Measurement of a soils ERZ and calculation of the AWC on a range of profiles is essential for understanding the variability that exists. Variable Rate Technology (VRT) can be applied to specific zones of production for improving efficiency of nutrients to meet yield potential. Irrigation water application can also be better managed under pressurised irrigation systems, including sprinkler or drip.

Moisture probes are of greater benefit to the landholder and agronomist in the interpretation of soil water content, drawdown and refill where they are calibrated to a soils AWC in mm, specific to soil horizons or set depths. Matching crop water requirement to a soils AWC per horizon aids the understanding of the water volumes being utilised in each soil horizon.

Figure 1 highlights the horizons and ERZ depth for a typical Lemnos Loam soil in the Goulburn Valley post deep ripping.

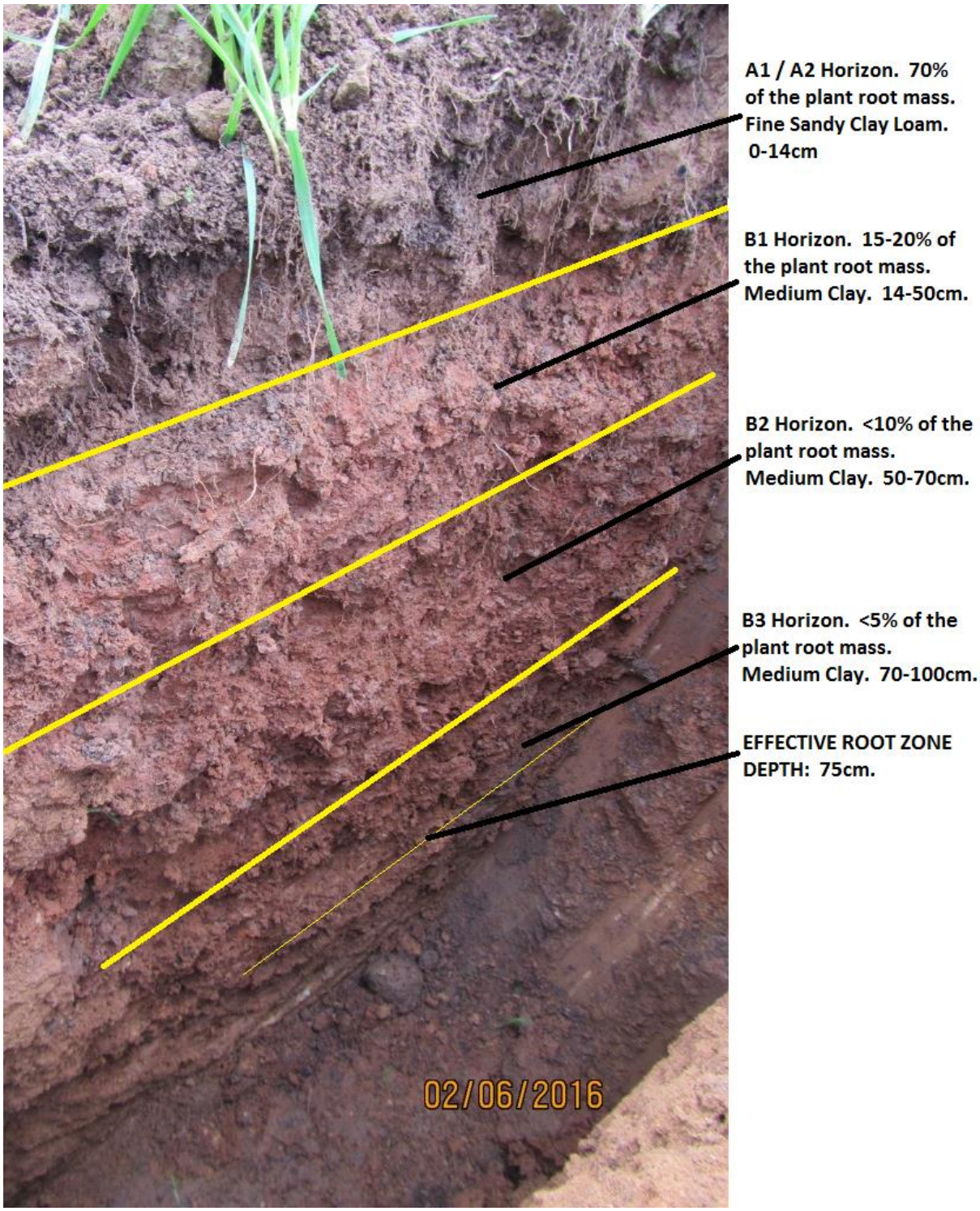

Figure 1. Horizons of a Lemnos Loam with the ERZ highlighted.