Journal of Hydrology (N.Z.) Vol. 23, No. 1, 1984

CALIBRATION OF NEUTRON MOISTURE METERS ON STONY SOILS (NOTE)

R. V. Stocker

Winchmore Irrigation Research Station
Private Bag
Ashburton

INTRODUCTION

Laboratory methods (Greacen, 1981), as well as field methods (Watt and Jackson, 1981) for calibrating neutron moisture meters in stone-free soils have been described. None of these methods is practical in soils stony enough to prevent augering or repacking of the soil. This note describes a technique to calibrate neutron moisture meters in soils with stone content up to 60%.

The slope of the relationship between neutron count ratio and soil water content of a neutron moisture meter varies by up to 10% for a range of Canterbury stony-soil types. This variation means that calibrations are site specific. The method of calibration is to measure the count ratio on an *in situ* soil and then to determine the volumetric moisture content of the measured soil. This is repeated over a range of soil moistures to derive a linear regression between soil moisture and count ratio.

INSTALLATION AND PROCEDURE

At each site two access tubes are installed to a depth of approximately 1.2m as long before calibration as possible. As the calibration process involves digging up the tubes, they can not be used for long term measurements.

One wet and one dry profile provide the range of soil moisture conditions necessary for a calibration. During a period when the soil profile is dry, the soil around one tube is wetted thoroughly by ponding water around it for a distance of approximately 1 metre; the soil around the other tube is left dry. Provided that the soil sampling is done soon after the wet soil profile is measured with the neutron moisture meter, the wetted soil profile does not have to be left to drain to its field capacity state.

Measurements with the neutron moisture meter to determine count ratio are taken at the centre of 150mm intervals down each access tube, starting at 225mm below the surface. The profile for a 75mm radius sphere around the probe centre at each reading is considered to be the profile interval corresponding to that reading. A pit for access is dug beside the tube, with the tube about 300mm away from one face of the pit.

For each depth interval a flat horizontal bench is formed around the tube at the top of each depth interval, by digging from the face of the pit across to the tube. The bench should be as flat and level as possible, and wide enough to allow access for a spade all around the tube.

Starting from the surface of the bench, all material around the tube in a cylinder approximately 75mm in radius and 150mm in length (depth of profile interval) is loosened, dug out and retained. The exact size and shape of the cylinder is not important and will vary depending on where stones are encountered, but it is important to retain all material dug out from the hole. This retained material, including stones, is weighed, dried at 105°C for at least 6 hours and re-weighed.

The volume of the hole is measured by pouring dry sand from a measuring cylinder until the hole is full, and recording the volume of sand used. As sand can pack down nearly 5% from its loose state when it is disturbed, the sand in both the measuring cylinder and the hole are settled either by tapping the cylinder or by poking the sand in the hole with a stick. The sand is levelled to the top of the hole.

The volumetric content, M.C. (v/v), of the sample is:

$$\text{M.C. (v/v)\%} = \frac{100 \times [\text{initial weight (g)} - \text{oven dry weight (g)}]}{\text{hole volume (ml)}}$$

and incidentally, the profile bulk density, B.D., is:

$$\text{B.D. (g ml}^{-1}) = \frac{\text{dry sample weight (g)}}{\text{hole volume (ml)}}$$

TABLE 1—Typical calibration results for a Lismore Stony Silt Loam

Depth (mm)	Count ratio	Sample volume (*l*)	Sample initial weight (g)	Oven dry weight (g)	Sample moisture content V/V (%)
150-300	0.65	3.37	6249	5113	33.7
300-450	0.60	5.40	10889	9118	32.8
300-450	0.44	4.54	10236	9335	19.8
600-750	0.35	6.20	13886	13145	12.0
750-900	0.27	8.08	19248	18527	8.9
150-300	0.45	5.28	10511	9271	23.5
300-450	0.33	4.88	10326	9649	13.9
450-600	0.27	4.36	9644	9274	8.5
600-750	0.27	7.10	16782	16377	5.7
750-900	0.26	7.00	15635	15129	7.2

M.C. V/V (%) = -11.432 + 72.064 x C.R. $r^2 = 0.98$

Depth (mm)	Count ratio	Sample volume (*l*)	Sample initial weight (g)	Oven dry weight (g)	Sample moisture content V/V (%)
0-150	0.58	2.52	4148	3366	31.0
	0.53	2.30	4499	3818	27.9
	0.70	4.46	7946	6252	38.0
	0.37	2.24	3950	3519	12.2
	0.63	2.64	4903	4072	20.4
	0.46	2.55	4503	3929	14.6

M.C. V/V (%) = -11.205 + 71.462 x C.R. $r^2 = 0.99$

A linear regression of count ratio on volumetric soil moisture is derived, commonly with correlation coefficients above 0.96.

Typical results are shown in Table 1.

SURFACE CALIBRATION

The radius of the sphere of influence of moisture content on the measured count ratio exceeds 75mm with a Troxler Model 3223 neutron moisture meter. The 0 - 150mm depth interval will thus have a different calibration curve from the rest of the profile, as some neutrons will escape into the atmosphere. Therefore data from the 0 - 150mm depth interval are not used for the profile calibration. A separate calibration curve can be established for the 0 - 150mm depth interval.

To calibrate the 0 - 150mm depth interval extra measurements from short access tubes are made, and the data combined with data from the 0 - 150mm depth interval from the full depth access tubes. This model neutron moisture meter has a source strength of only 10 miCu making the radiation dose rate to the user within accepted health limits when doing 0 - 150mm interval readings.

REFERENCES

Greacen, E. L. 1981: Soil Water Assessment by the Neutron Method. CSIRO Australia.

Watt, J.P.C.; Jackson, R. J. 1981: Neutron Probe Access Tubes: Equipment and Procedure for installation. N.Z. Soil Bureau Scientific Report 50.