EXPERIENCE WITH A NEUTRON SCATTERER FOR MEASUREMENT OF SOIL MOISTURE

P.D. Fitzgerald,

Winchmore Irrigation Research Station

This note is promped by a reference (J.of Hydrology 2 (1),1963:36) to the use of a neutron scatterer at Makara. I have been using one of the instruments for some time at Winchmore Irrigation Research Station and our experience with it may be of interest to others. Our meter is a commercial model based on the Dominion Physical Laboratory design.

Up to the present we have concentrated on calibrating the meter as a surface probe. In order to preserve continuity of results, calibration has been with our normal 0-4in. gravimetric sampling. It is realised that the volume "seen" by the neutron probe depends on the moisture content of the soil but for practical reasons correlation with 0-4in. sampling was desirable.

Although, due to a wet season, the full range of soil moisture levels was not covered, the correlation looked extremely good. Two settings were used: 100 counts and 1000 counts, and six readings were taken in each border, both irrigated and dry. These borders are long parallel strips separated by low mounds or dikes, and are about 20 ft wide by 400 ft long. As would be expected the correlation with 1000 counts was better than with 100 counts. However it may be possible to shorten the reading time and obtain an equally high correlation by taking a higher number of readings at 100 counts. This is being investigated.

When the instrument is in use as a surface probe a number of fast neutrons are lost to the air. The count rate can be increased by the use of suitable reflectors. Pawliw and Spinks (1957) used a one inch steel reflector and reported an increase in count rate of 2.5. We have had a steel reflector made, but have only increased our count rate by 1.4. This difference may be due to (1) different geometry of reflectors, or (2) difference in source size. Our source is 5 millicuries, while Pawliw's was 50 millicuries, of Ra-Be.

I am sceptical of the use of a paraffin shield to increase count rates. The count rate will increase but this increase will be due to thermalizing of neutrons by the paraffin. The count rate of neutrons from the soil will at best be the same; but, depending on the geometry of the shield, could even be lower. An advantage claimed for this type of Shield (van Bavel,1961) is that the depth of measurement is decreased. However this may in some cases be a disadvantage, particularly in dry soils, as the

ratio, counts from paraffin/counts from soil, is likely to be inversely proportional to the soil moisture. If it is necessary to increase count rates reflectors not absorbers should be used.

It is necessary in this type of work to have a standard so that any variations in count rate, due to changes in the circuit or battery weakening, can be compensated for. A suitable standard for a surface probe can be made from a paraffin block of adequate thickness. A drum of water with a built-in access tube can be used as a standard for depth probes. Access holes have been drilled and lined with aluminium tubing at a number of sites on the station and, shortly, calibration of the scatterer as a depth probe will be accomplished.

These moisture meters can usually be used with a Geiger counter and a source of gamma rays to determine soil density. The method most used is the transmission method in which the source of gamma rays is placed in one hole and the Geiger counter in another hole at some specified distance - usually 1ft. The transmission of gamma rays is then related to the soil density.

A source sometimes recommended is 5 millicuries of Cobalt 60. We have found, with 1ft separation, that 5 millicuries of Co 60 results in excessively high count rates. It has also been discovered that the radiation exposure from this source is greater than with the Radium source. For these two reasons we are changing this source to 1 millicurie of Cobalt 60 which will be adequate for this work.

REFERENCES

Pawliw, J.; Spinks, J.W.T. 1957: Neutron Moisture Meter for Concrete. Canad.J.Technol.:503-513.

Van Bavel, C.H.M. 1961: Neutron Measurement of Surface Soil Moisture. J. Geophys. Res.66(12): 4193-4198.