Affordable soil moisture detectors development

Eleonora Iaccheri1\*, Annachiara Berardinelli3, Marco Tartagni4 and Luigi Ragni1,2

1Department of Agricultural and Food Science, Alma Mater Studiorum, University of Bologna, Cesena (Italy)

2Interdepartmental Centre for Agri-Food Industrial Research, Alma Mater Studiorum, University of Bologna, Cesena (Italy)

3Department of Industrial Engineering, University of Trento, and Centre Agriculture Food Environment, Trento (Italy); Centre Agriculture Food Environment, University of Trento, Via E. Mach, 1, 38010 S. Michele all' Adige, TN, Italy

4Department of Electrical, Electronic and Information Engineering ¨Guglielmo Marconi¨- University of Bologna, Via dell' Università, 50, Cesena 47521, Italy

\*Corresponding author: Eleonora.iaccheri4@unibo.it

**Keywords.** Soil, moisture, sensor, electric technique.

**Abstract.** Monitoring water content in soil is very important for farmers to define soil conditions and irrigation affecting agricultural efficiency. Cheap and reliable instruments are essential. Traditional drying methods are destructive and time-consuming, not applicable directly in the field. Analysis of the electromagnetic wave’s interaction is a way for water quantification in soil. For many years several sensors were developed, but some limits were encountered, such as interferences due to soil constituents and cost not always affordable. In this way, two different instrumental chains were developed based on the response of the soil to the electromagnetic wave in the frequency range from 50 kHz to 3GHz.

Very low-cost components were assembled and used: a miniaturized commercial Vector Network Analyzer and two different handmade probes, a cavity antenna, and a dipole antenna. The cavity antenna should just be placed in contact with soil without being inserted in, while the dipole antenna enclosed in a plastic pipe must be inserted into the soil. Tests were conducted in laboratory conditions on silty clay loam soil with different moisture content from 5% to 28%. Good results in terms of coefficient of determination were obtained: R2 up to 0.978 and RMSE 1.30 and R2 up to 0.989 and RMSE 0.57 for dipole antenna (significance of coefficient, p-level<0.05). In the light of the obtained results, a validation will be performed for field moisture soils estimation. The user-friendly devices and the affordable cost can be very attractive for final users.