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Expert soil moisture Wireless Sensor Network for the feed-back control of irrigation in heterogeneous crop systems

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New technologies in agriculture present the opportunity to create intuitive and user-friendly decision support systems, and to improve the productivity of the systems requiring water and energy. In the last few years, the adoption of these technologies have been increasing through third mission activities, and the collaboration between researchers, consultants, agri-food managers and farmers.

The general objective of the proposed dissemination activity carried out by the AgrHySMo laboratory of the University of Pisa, was to transfer a soil moisture-based wireless sensor network (SM-WSN) to a commercial pear orchard named Illuminati Frutta (Arezzo, Italy), for the feedback control of irrigation.

The plan of the third mission activity was designed by the following phases: i) the team evaluated the hydraulic performance and management of the irrigation system in the pear orchard; ii) the use of proximal sensing provided the NDVI for the biophysical characterization of the crop in a pilot area extended thirteen ha; iii) the open-source QGIS suite program was used to elaborate the collected images, to assess a zoning analysis, and to discretize homogeneous areas inside the orchard. These zoning maps were used to define the topology of the SM-WSN.

The orchard was characterized by four homogeneous zones, inside which at least one sensor of soil water content (FDR Drill and Drop probe, Sentek Inc.) was installed. A total of 6 probes were installed in the pilot area. The hardware and the smartphone of the dedicated sensor network applications, AgriNET, were provided by Tuctronics (Walla Walla, Washington, USA). The measurements of volumetric soil water contents are sent to a platform using the MODBUS RTU protocol interfaced with a communication board and then delivered, using the cellular 3G data network, to a MySQL database operated by AgriNET/Tuctronics accessible from the web. According to the ordinary scheduling of irrigation, the expert system allowed the farmer to maintain the soil water content within a pre-defined optimal range, which upper limit corresponds to the soil field capacity and the lower is the threshold below which water stress occurs. During the first

experimental growing season, by considering the results obtained in the pilot plot, compared with the ordinary irrigation scheduling the farmer saved up to 35% of the water and energy supply. In the future, the proposed feedback control of irrigation protocol will be extended to the entire farm. Thus, the adoption of this new technology aimed at identifying the most appropriate irrigation management, have the potential to generate positive economic returns and to reduce the environmental impacts.