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Geophysical surveys combined with laboratory soil column experiments to identify and explore risk areas for soil and water pollution in feedlots

Antonio Jesus Espejo-Pérez (1), Claudia Mabel Sainato (2), John Jairo Márquez-Molina (2), Juan Vicente Giráldez (1), and Karl Vanderlinden (3)

(1) Dept. of Agronomy, Hydraulic Engineering Area. University of Cordoba. Aptdo. 3048, Córdoba, Spain.E-mail: g82espea@uco.es; phone (+34) 957212241; fax (+34) 957218569 , (2) Department of Agricultural Engineering and Land Use. School of Agriculture. University of Buenos Aires. Buenos Aires. Argentina E-mail: csainato@agro.uba.ar, (3) IFAPA, Centro Las Torres-Tomejil, Ctra. Sevilla-Cazalla, km 12.2, Alcalá del Río (Sevilla), Spain. E-mail: Karl.vanderlinden@juntadeandalucia.es

Changes of land use without a correct planning may produce its deterioration with their social, economical and environmental irreversible consequences over short to medium time range. In Argentina, the expansion of soybean fields induced a reduction of the area of pastures dedicated to stockbreeding. As cattle activity is being progressively concentrated on small pens, at feedlots farms, problems of soil and water pollution, mainly by nitrate, have been detected. The characterization of the spatial and temporal variability of soil water content is very important because the mostly advective transport of solutes. To avoid intensive soil samplings, very expensive, one has to recur to geophysical exploration methods.
The objective of this work was to identify risk areas within a feedlot of the NW zone of Buenos Aires Province, in Argentina through geophysical methods. The surveys were carried out with an electromagnetic induction profiler EMI-400 (GSSI) and a Time domain Reflectometry (TDR) survey of depth 0-0.10 m with soil sampling and measurement of moisture content with gravimetric method (0-1.0 m). Several trenches were dug inside the pens and also at a test site, where texture, apparent density, saturated hydraulic conductivity (Ks), electrical conductivity of the saturation paste extract and organic matter content (OM) were measured. The water retention curves for these soils were also determined. At one of the pens undisturbed soil columns were extracted at 3 locations.
Laboratory analysis for 0-1.0 m indicated that soil texture was classified as sandy loam, average organic matter content (OM) was greater than 2.3% with low values of apparent density in the first 10 cm. The range of spatial dependence of data suggested that the number of soil samples could be reduced. Soil apparent electrical conductivity (ECa) and soil moisture were well correlated and indicated a clear spatial pattern in the corrals. TDR performance was acceptable to identify the spatial pattern of moisture, although the absolute values were far from the real values obtained by gravimetric method due to the effect of the high OM. The lower zone in one of the pens showed greater values of ECa and soil moisture, in agreement with a major water retention and a lower Ks. The water retention was higher in the other corral with higher variability in Ks. A general decrease of soil moisture was found near 0.2 m soil depth. Leaching experiments detected greater volumes with higher electrical conductivity in low lying areas of the pen. Although differences were not observed as clearly as before, the low and intermediate low areas of the pen showed a faster rate of leaching. In summary geophysical surveys allowed identifying risk areas of high ECa and moisture which in fact had higher volumes of leachate with elevated electrical conductivities. This may be a good approach to control and reduce soil and groundwater contamination and to model in future works the process in order to establish management decisions.