SOIL PORE CHARACTERISTICS, HYDRAULIC CONDUCTIVITY AND SOIL BULK DENSITY AS INFLUENCED BY AGROFORESTRY AND GRASS BUFFER CONSERVATION PRACTICES.

Ranjith P. Udawatta
Research Assistant Professor

Stephen H. Anderson
Professor of Soil Science

Harold E. Garrett
Professor of Forestry

Despite improvements in the use of soil conservation practices, crop rotation and nutrient management programs, significant concern still exists regarding soil erosion and nutrient losses in runoff from row crop production. In the US, states are required to implement water quality standards based on USEPA guidelines or other scientifically defensible methods (Ice and Binkley, 2003). Agroforestry has recently been suggested as an alternative to traditional row crop production in the temperate zone that also generates additional environmental and economic benefits (Gold and Hanover, 1987). It is hypothesized that incorporation of agroforestry practices would improve soil physical properties and thus reduce runoff, sediment, and nutrient losses from row crop agricultural watersheds. However, the effects of agroforestry and grass buffer strips, on soil pore parameters, saturated hydraulic conductivity, and soil bulk density have not been extensively studied for surface and subsurface soils in temperate regions on a watershed scale.

The objective of the study was to measure x-ray computed tomography (CT)-measured pore parameters, saturated hydraulic conductivity, and bulk density to compare differences among buffer treatments.

The study was conducted at the University of Missouri-Greenley Memorial Research Center (Fig. 1). Grass buffers were established in 1997. Pin, bur, and swamp white oak trees were planted at 3-m intervals in the center of the grass buffers. Treatments were row crop, grass buffer, and agroforestry. Soil cores were collected at 10 cm depth intervals from the surface to 50 cm. Soil cores were processed, treated, and scanned with a CT scanner. Scanned images were analyzed with *Image-J* and data were analyzed using SAS. Saturated hydraulic conductivity (K_{sat}) and soil bulk density were determined for the core samples.

Results:
The CT-measured number of pores, porosity, number of macropores, and macroporosity were significantly different between the crop and grass buffer or agroforestry treatments (Fig. 2). The agroforestry treatment exhibited greater number of pores and porosity in the subsurface than the other three treatments (Fig. 2). Saturated hydraulic conductivity values were different between the crop and two buffer treatments. Agroforestry and grass buffer treatments were significantly different from the crop treatment at 5 and 1% level, respectively (Fig. 3A). The Ksat for the surface 0-10 cm depth for the grass buffer and agroforestry buffers were 38 and 26 times larger as compared to the crop treatment (Fig. 6). The agroforestry treatment had the lowest bulk density while the row crop treatment had the highest bulk density (Fig. 3B).

Results of this study show that agroforestry and grass buffers treatments improve CT-measured soil physical properties and saturated hydraulic conductivity and reduce soil bulk density. These properties are influential for nonpoint source pollution reduction from agricultural watersheds.

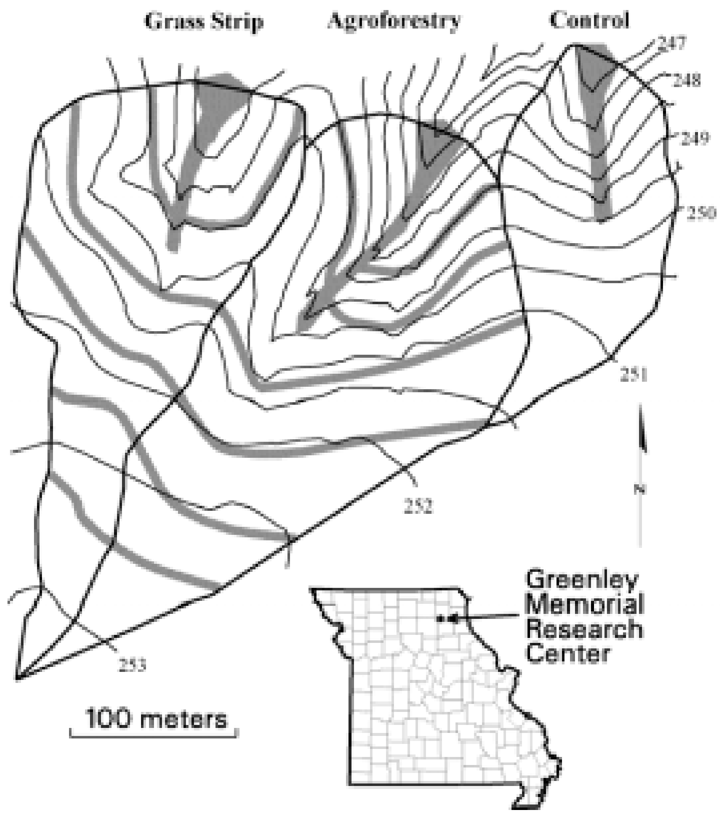

Figure 1. Study watersheds with 0.5 m interval contour lines and site location in Missouri. Gray bands indicate agroforestry (grass+tree) on the agroforestry watershed, grass strips on the grass strip watershed, and grass waterways.

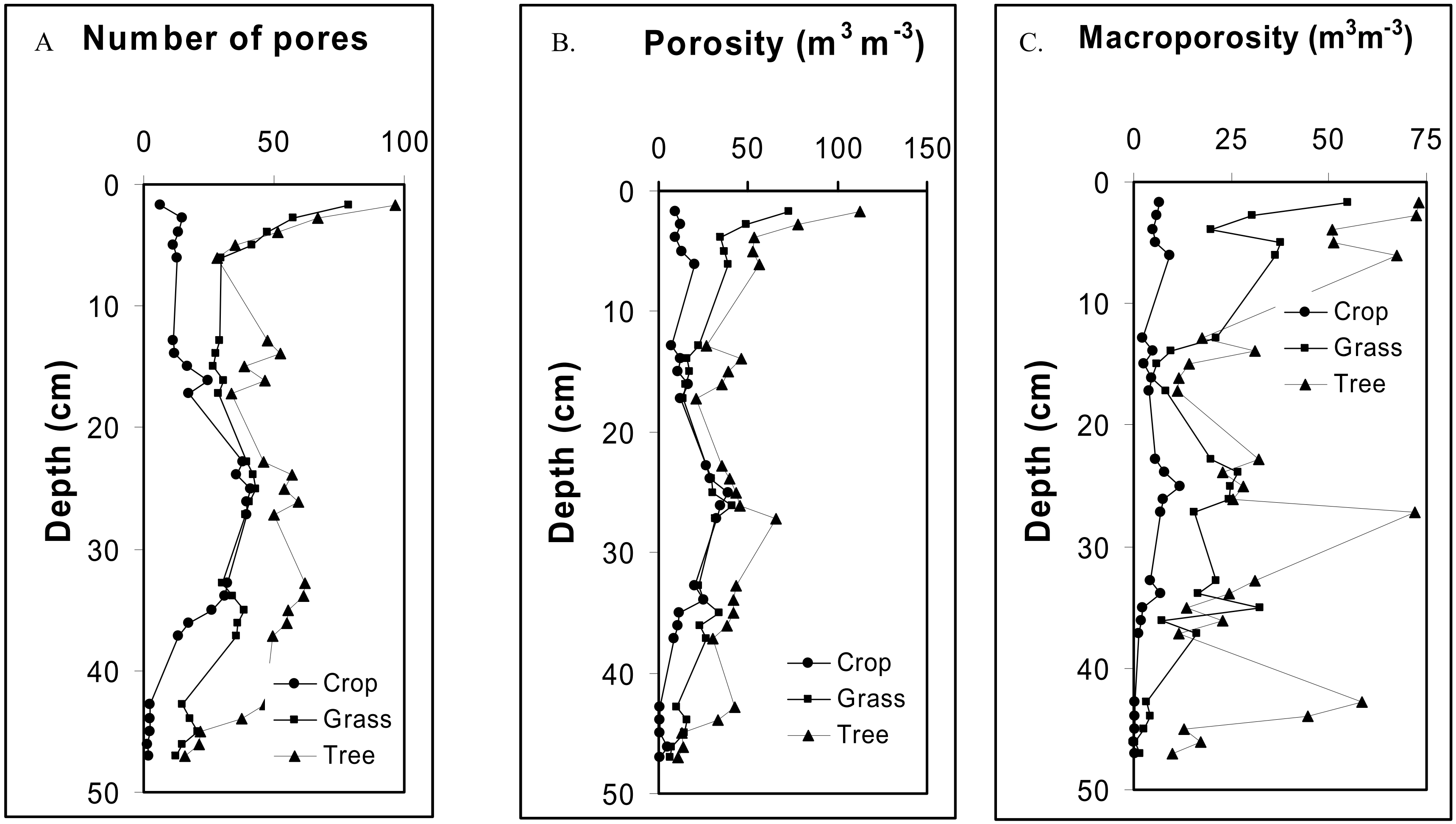

Figure 2. Number of CT-measured pores (A), porosity (B), and macroporosity (C) for crop, grass buffer, and agroforestry treatments.

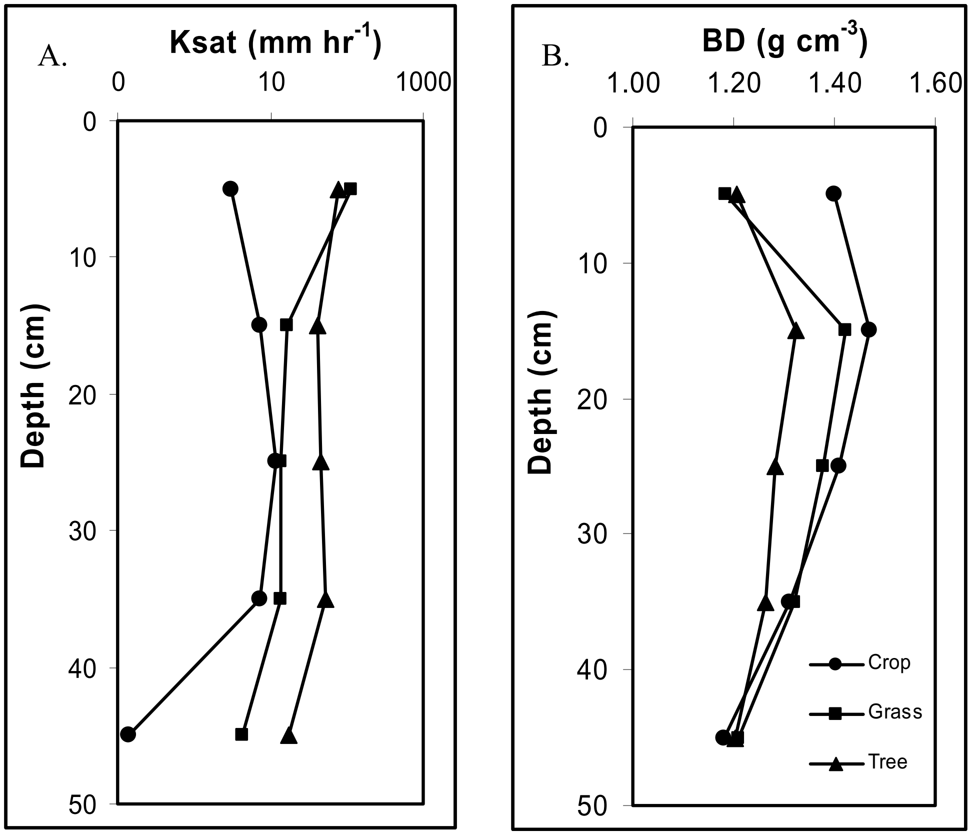

Figure 3. Saturated hydraulic conductivity (A) and soil bulk density (B) for crop, grass buffer, and agroforestry treatments.

References:

Gold, M.A., and J.W. Hanover. 1987. Agroforestry systems for temperate zones. Agroforestry systems. 5: 109-121.

Ice, G., and D. Binkley.2003. Forest stream water concentrations of nitrogen and phosphorus: a comparison with EPA's proposed water quality criteria. J. Forestry 101: 21-28.