United States Department of Agriculture
Research, Education and Economics

Agricultural Research Service
Date: August 6, 2009

Natural Resources Research Update

ARS would like your feedback as to the value of this technical update. You can provide feedback about this specific update by responding to this email or send your comments to NRRU.update@ars.usda.gov and refer to technical update number: 238757

Title: Long-term effects of manure application on soil properties and nutrient transport

Contributing Scientists: John E. Gilley

Location: Agroecosystem Management Research Unit, Lincoln, NE

Text: Manure can be effectively used for crop production and soil improvement because it contains nutrients and organic matter. Soil physical properties such as infiltration, aggregation, and bulk density can be improved by long-term manure application. Changes in soil properties can have a substantial impact on runoff, soil loss, and nutrient transport from cropland areas receiving long-term manure application. If the beneficial effects of long-term manure application can be quantified, its value as a nutrient source and soil amendment can be enhanced. However, the application of manure at rates that exceed crop nutrient requirements can result in P accumulation in the soil and increased nutrient transport by overland flow. If the long-term effects of manure application on nutrient transport by overland flow can be estimated, remediation measures to minimize nutrient delivery to surface waters can be implemented. The objectives of this project were to: 1) determine the long-term effects of manure application on selected soil properties, and 2) measure the effects of long-term manure application on nutrient transport by overland flow. Duplicate soil samples (32) were collected from the top 0.1 m of selected plots of a long-term (since 1953) manure and fertilizer application field experiment and later placed in $1m^2$ soil pans. Manure and fertilizer were mixed with 16 of the soil samples, while no manure was applied to the other 16 soil samples (long-term effect). Simulated rainfall was then applied to the soil during initial and wet (24 hours later) events. A second study was conducted to assemble and summarize historical information quantifying the effects of manure application on runoff and soil loss resulting from natural precipitation events. In a third study, composted beef cattle manure or inorganic fertilizer were added over a four-year period to meet P or N requirements for corn and incorporated following application. Field tests were then conducted to identify the residual effects of compost applications on nutrients in runoff after four years of corn production following the last compost application. The long term (since 1953) application of manure to a Tripp sandy loam soil located near Mitchell, Nebraska increased soil P, NO_3-N, and EC levels in the top 0.1 m of the soil profile. After four years of corn production following the last N-based compost application to a Sharpsburg silty clay loam soil located near Mead, Nebraska, soil P

content, EC, and pH were significantly greater than the check plots. For selected locations at which manure was added over several years, runoff was reduced from 2 to 62%, and soil loss decreased from 15 to 65% compared to non-manured sites. Runoff and soil loss values were reduced substantially as long-term manure application rates increased. The long-term application of manure had no significant effect on runoff concentrations of dissolved P, particulate P and total P when the last manure application was the previous year. When the last manure application was the previous year, similar concentrations of dissolved P, particulate P, and total P were measured on the manure and no-manure treatments. Four years following the last application of compost to meet P or N requirements for corn, concentrations and total amounts of P in runoff were similar on compost and inorganic fertilizer plots. The long-term application of manure at rates required to meet crop nutrient requirements did not increase P transport to levels greater than those occurring on inorganic fertilizer plots.

Gilley, J.E., B. Eghball, J.M. Blumenthal, and D.D. Baltensperger. 1999. Runoff and erosion from interrill areas as affected by the application of manure. Trans. of the ASAE. 42(4):975-980.

Gilley, J.E. and L.M. Risse. 2000. Runoff and soil loss as affected by the application of manure. Trans. of the ASAE. 43(6):1583-1588.

Gilley, J.E., and B.Eghball. 2002. Residual effects of compost and fertilizer applications on nutrients in runoff. Trans. of the ASAE. 45(6):1905-1910.