Conservation tillage practices (minimum or no-till) are characterized by minimal soil disturbance and mixing and have been used more frequently in recent years to reduce off-site losses of nutrients associated with eroded particles, including phosphorus (P). However, by maintaining crop residues and fertilizers on the soil surface, the relatively immobile nutrients that do not readily move down the soil profile remain at or near the soil surface. Therefore, no-till (NT) management systems often result in high concentrations of nutrients at the soil surface (0–5 cm) but sharply decreasing concentrations below this depth. Studies have shown that NT management has induced the stratification of soil organic carbon (C), potassium, and P. Stratification of P is of particular environmental and agronomic concern. Studies that characterize P stratification and determine its causes can guide producers to use management practices such as tillage and fertilization so that plant nutrient requirements are met while minimizing the potential for P loss.

In a recent study published in the July–August 2014 *Journal of Environmental Quality*, a research group from Agriculture and Agri-Food Canada (Ste. Foy, Quebec and Swift Current, Saskatchewan) and Université Laval (Quebec) investigated the impact of tillage practices and P fertilization on soil P forms using a long-term corn–soybean rotation experiment established in 1992 in Québec. The experimental setup was a split plot with two tillage practices (NT and moldboard plow) assigned to main plots and nine fertilization combinations consisting of three nitrogen (0, 80, and 160 kg N ha⁻¹) and three P (0, 17.5, and 35 kg P ha⁻¹) applications to subplots, with four replicates. Samples were collected in fall 2010 from three depths (0–5, 5–10, and 10–20 cm) and were analyzed for total P, total C, total N, pH, and Mehlich-3 P; P forms were characterized with solution ³¹P Nuclear Magnetic Resonance (NMR) spectroscopy.

The results showed that total P significantly varied with soil depth under the NT treatment, where it accumulated in the top unfertilized soil layer (0–5 cm) and in the 0- to 10-cm layer where P fertilizer was applied. Additionally, pH, total C were significantly higher in the topsoil (0–5 cm) than in the deeper layers under the NT treatment than in the deeper layers. Total N accumulated in the surface 10 cm. Distributions were homogenous along the soil profile under moldboard plow management. This suggests that stratification in NT results from the retention of crop residues at the soil surface. Likewise, the ³¹P-NMR spectra showed concomitant stratification of orthophosphate (P, P₄O₁₀⁻) was applied. Stratification also occurred for *scyllo*-inositol hexakisphosphate (IP₆) and associated compounds (pyrophosphate, nucleotides). The *scyllo*-IP₆ and nucleotides accumulated more in the deeper layers, possibly due to their preferential movement through the soil column, whereas the pyrophosphate and DNA concentrations were greater at the surface (0–5 cm) soil layer than the deeper layers. Total C and N were similarly affected, suggesting that DNA was synthesized in greater amounts under NT owing to the higher organic matter accumulated at the soil surface compared with conventional tillage.

Overall, it appears that labile inorganic P (orthophosphate) accumulated at the surface of NT soil and decreased with depth, whereas organic P, pyrophosphate, and nucleotides, increased deeper in the soil profile. Consequently, NT may increase the potential for P loss in surface runoff and lead to the loss of organic P esters draining through different hydrological pathways.

Adapted from Abdi, D., B.J. Cade-Menun, and L-É. Parent. 2014. Long-term impact of tillage practices and P fertilization on soil phosphorus forms as determined by ³¹P nuclear magnetic resonance spectroscopy.