Phosphorus management in agricultural systems

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The accelerated eutrophication of freshwaters and to a lesser extent some coastal waters is primarily driven by phosphorus (P) inputs, predicating its management in point and nonpoint sources. While efforts to identify and limit point source inputs of P to surface waters have seen some success, nonpoint sources have remained more elusive and more difficult to identify, target, and remediate. As further reduction in point sources of P discharge via innovative wastewater treatment technologies becomes increasingly costly, attention has focused more on nonpoint source reduction and particularly the role of agriculture. This attention was heightened over the last 10 to 20 years by a number of highly visible cases of nutrient-related water quality degradation; including the Baltic Sea, Chesapeake Bay, Florida Everglades, and Gulf of Mexico. Compounding the concerns derived from these cases is the more recent admission that impaired water quality has not seen as great an improvement as predicted by model predictions and expected from widespread adoption of conservation management strategies. Thus, there has recently been a strategic shift from treating water quality impairment through unilateral catchment conservation measures to targeting management to critical sources of P loss.

In the past, separate strategies for improving either nitrogen (N) or P management have been developed such that advice given to control P loss can conflict with advice given to control N loss. These conflicting recommendations must be brought into alignment. Because of different critical sources, pathways, and sinks controlling N and P export from catchments, remedial strategies directed at either N or P control can negatively impact the other nutrient. For example, basing manure application on crop-N requirements to minimize nitrate leaching to ground water, has increased soil P and enhanced the potential P for loss. Whatever strategies are implemented, they should be done in an adaptive manner, as the complexities imparted by spatially variable landscapes, climate, and system response will require iterative, locally relevant solutions. For example, system response can vary from a year to several decades and this time generally increases as spatial scale increases. At a field and farm level, research has demonstrated edge-of-field reduction in nutrient and sediment loss can occur within months of changing P-management. However, the spatial complexity of catchment systems increases this response time for P as a function of slow release of legacy P stored in soils and fluvial sediments to surface flow pathways. Even so, it is difficult for the public to understand or accept this lack of response. When public funds are invested in remediation programs, rapid improvements in water quality are usually expected and often required. Thus, future programs must address this, as well as the involvement of farmers to demonstrate what conservation measures work, along with their socio-economic consequences. Finally, this paper will discuss the environmental sustainability of conservation measures in relation to what we have learnt from past implementation efforts and the realities of day-to-day farm management decisions.