Impacts of drainage systems on phosphorus dynamics and crop productivity in the Red River Valley, southern Manitoba

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Agricultural runoff, characterized by the discharge of nutrients, pesticides, and sediment, substantially threatens the ecological balance of freshwater ecosystems. Agricultural lands in the Red River Valley mostly rely on drainage systems for productivity, which highlights the need to understand how drainage systems influence legacy phosphorus loss. This study assessed the integrated effects of drainage systems (surface and tile drainage) on phosphorus transport within the soil profile and overland flow over a 3-year period in the typical landscapes of the Red River Valley in southern Manitoba, using farm-scale experiments and edge-of-field runoff monitoring stations. Total phosphorus (TP), water-extractable phosphorus (WEP), and Modified Kelowna Phosphorus (MKP) were measured in soil samples. Additionally, water samples were analyzed for different forms of phosphorus and sediment concentrations during runoff events. Results showed that tile-drained plots exhibited higher retention of soil TP, WEP, and MKP than surface-drained plots. Furthermore, phosphorus concentrations declined with soil depth, indicating limited phosphorus mobility to lower soil layers. For crops, wheat yields were consistent across drainage types, while canola exhibited variability, which could be influenced by management practices. This study highlights the need for integrated drainage management to optimize yields while minimizing nutrient loss that can provide valuable insights for sustainable farming practices.