Perennial forages release phosphorus during snowmelt runoff in Manitoba

Lake Winnipeg has been the focus of increased attention, both nationally and internationally, due to its extensive algal blooms and deteriorating water quality, largely resulting from high phosphorus (P) levels. Scientists and policy makers alike have identified the reduction of P loading as the key to improving surface water quality, and have identified agriculture as one of the primary contributors.

Crop selection and associated fertilization and tillage practices all influence nutrient loss from agricultural land. Currently, canola and wheat are two prevalent crops grown in Manitoba, while perennial forage, such as tame hay, is also widely grown. Conversion of marginal annual cropland to perennial forage has been promoted as a beneficial management practice (BMP) in many parts of world, because perennial forage improves soil quality, prevents soil erosion and reduces the need for chemical inputs such as fertilizer. The question is – Should this be a recommended BMP in Manitoba?

A local field-scale study in the South Tobacco Creek Watershed in south-central Manitoba was carried out collaboratively by Agriculture and Agri-Food Canada, Environment Canada, University of Manitoba and Deerwood Soil and Water Management Association as part of the Watershed Evaluation of Beneficial Management Practices (WEBs) project. The study found that P export to the watershed from perennial forage included in an extended forage-cereal-oilseed rotation was 1.6 times greater than from the cereal-oilseed portion of the rotation during snowmelt runoff (Figure 1). After examining the nutrient sources (soil, vegetation and snow) and nutrient transport factors (flow rate, runoff volume and duration of runoff), the researchers concluded that nutrient release from vegetation during freeze-thaw cycles was the greatest contributor to P export from perennial forage fields (Figure 2).

Manitoba has long cold winters and multiple freeze-thaw cycles every year. The freeze-thaw process ruptures plant cells, triggering the release of P which is then transported to surface water in runoff. In late fall, the perennial forage field can feature lush vegetation, part of which is the new re-growth following the final cut. This fresh vegetation is high in P and water content and the P is very susceptible to release and export. Therefore, rather than acting as a nutrient sink, perennial forage vegetation can become an important phosphorus source during snowmelt runoff.

It is important to note that the forage stands in the study had been established three to five years as part of a crop rotation and further work is required to determine if similar effects are seen when cropland is converted to perennial forage over a longer period of time. While the conversion of annual cropland to perennial forage offers considerable soil-protection benefits, particular management may be needed to address water quality concerns. The inclusion of a late final forage cut to limit fall re-growth and winter kill may reduce nutrient transfer, while maintaining the quality of agricultural soils.

This factsheet is based on information from the peer-reviewed publication "Nutrient and Sediment Losses in Snowmelt Runoff from Perennial Forage and Annual Cropland in the Canadian Prairies" by Kui Liu, Jane Elliot, David Lobb, Don Flaten and Jim Yarotski, in the Journal of Environmental Quality.

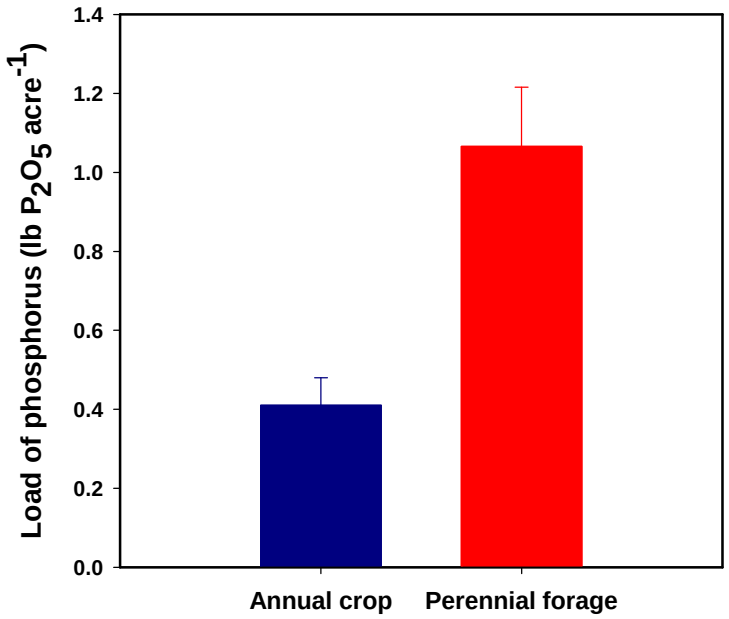

Figure 1. Average annual phosphorus losses from annual crop and perennial forage fields during snowmelt runoff in the South Tobacco Creek Watershed, Manitoba, 2005-2011.

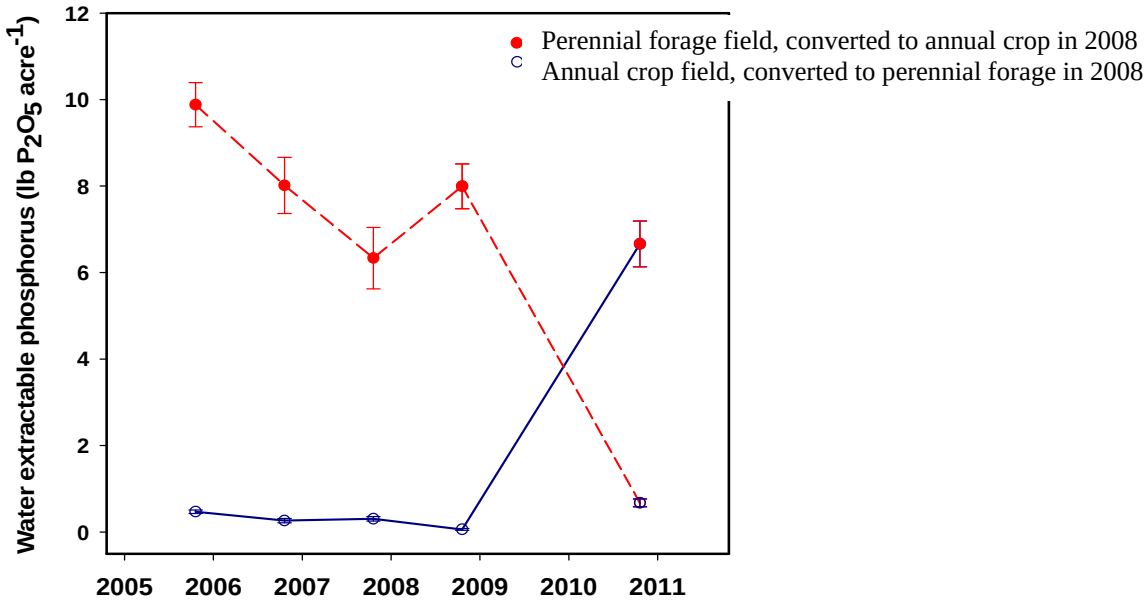

Figure 2. Water extractable phosphorus from frozen-thawed plant vegetation in the studied perennial forage and annual crop fields of the South Tobacco Creek Watershed, Manitoba.

Field 1 (the dashed line) was under perennial forage until late fall 2008, and then converted to annual crops. Field 2 (the solid line) was annually cropped until the late fall of 2008, and then converted to perennial forage. The graph shows that after an initial period of transition, Field 1 produced far lower levels of phosphorus after being converted to annual crop, and that the reverse is true of Field 2.

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