KEEPING PHOSPHORUS ON THE LAND:
MAIN TAKEAWAYS FOR MANAGING SOIL PHOSPHORUS IN THE PRAIRIES

Management of the phosphorus (P) in prairie soils faces a challenging dilemma. Phosphorus is critical to continued agronomic productivity. Yet, management of P in prairie landscapes is also crucial to the protection of prairie lakes and reservoirs, which are highly vulnerable to issues of nutrient pollution and harmful algal blooms.

In our workshop, "Keeping Phosphorus on the Land" (February 22 & March 2, 2021), we worked to bridge the disciplines of water quality, and agronomy, and better understand issues, and opportunities within and across these areas of work as they relate to managing soil P. After two half-days of meetings that engaged researchers and practitioners in government, industry and universities, we gained a long list of ideas to act on, and a number of crucial new insights. This two-page synthesis highlights several key points that came from the workshop. Readers are directed to our full report to learn about these key points and other areas in more detail, and for a full list of recommendations resulting from the meeting.

What we heard and what we learned:

There is concern about soil P deficiency for crop production in many areas of the prairies. At the same time, water quality concerns due to excess P are widespread. Innovative solutions are needed to address this challenging dilemma and manage P for agronomic and environmental benefits.

- Based on current agronomic recommendations, many soils on the Prairies are deficient in P. In addition, harvesting of agricultural crops results in exports of P from agricultural lands. Hence agricultural cropland requires additions of fertilizer or manure to sustain crop production. At the same time, some soils have excessive P accumulations that need to be reduced.

- Many aspects of crop response to soil and fertilizer or manure P are difficult to generalize due to variable soils and changing weather conditions, cropping systems, and crop species and varieties or hybrids. The level of soil P fertility required to maintain crop production needs to be revisited with consideration of changes in prairie agriculture, and environmental considerations.

- High concentrations of P in runoff have led to significant water quality problems across much of the Prairies. Solutions for water quality problems will vary from one place and time to another. While our conversations focused on levels of soil P, there was a recognition that managing soil P alone, is likely inadequate to meet water quality goals. Broader concepts of 4R stewardship of P are important, as are soil and water conservation practices.

- We need place-based and time-based targeting of beneficial management practices (BMPs) at multiple scales. This means considering which watersheds, which fields, and which landscape positions are best for targeting different practices. Functionally, we need the right BMP in the right place in the right watershed at the right time – which requires considerable local insight in terms of agronomic needs and water quality concerns, as well as BMP benefits and trade-offs.

- There is major promise in work to identify P hotspots, identify critical time periods, and better target BMPs.

- Technologies, like variable rate nutrient applications, also hold major promise to advance both agronomic and environmental goals.

In the Canadian Prairies, there is a substantial, linear increase in runoff P with increases in soil test P, even within the typical range of soil test P values (0-45 mg Olsen-P / kg^{-1} in the 0-5 cm soil depth).

This is different from many regions of the world, where 'change-point' behavior tends to be shown. This means that even in well-managed prairie soils (where concentrations of soil test P are within recommended agronomic ranges) increasing soil test P will incrementally increase P concentrations in runoff. This adds challenges to soil P management because these concentrations are often high enough to create water quality problems within prairie lakes (i.e., P in runoff is typically above eutrophication thresholds).

- The good news is that decreasing soil test P in high P soils can lead to water quality benefits by reducing P in runoff within the period of a few years, without impacting crop yield. Overall, we see that there is less 'legacy P' in prairie soils than in other regions, suggesting we can more rapidly attain water quality improvements. Managing soil P is an important part of any nutrient, soil and water management toolbox for water quality solutions.

- Managing soil P requires balancing agronomic and environmental goals, and strategic thinking, such as targeting zones with high connectivity to water.

- To better manage soil P in the Canadian Prairies we need to better understand key agronomic thresholds for P in the context of new crops and common observations of increased P stratification in soils. The data used in setting these thresholds are often very old and based on a narrow range of traditional crops, lower-yielding varieties or hybrids and less stratified/more intensely cultivated soils. Continued consideration of how variable moisture conditions will affect yield benefits of different P management approaches remains important. There may also be potential to manipulate our cropping systems in the future to use P more efficiently and address the rate dilemma.

Industry, via crop input suppliers, certified crop advisors and agronomists, are the primary advisors for producers on P management.

This means we need to more effectively network across government, industry, and academia to ensure we all understand the diverse needs, and effects of changing P management.

- Producers want to engage in solving environmental problems, which means building close networks of scientists, producers and advisors who can discuss workable solutions from farms to lakes. We need continuing conversations with industry and a sustained network for exchanging information.

There is the need to increase awareness of environmental P management in making P recommendations, and in extension work more broadly. Declaration: This report is prepared by Dr. Jian Liu (University of Saskatchewan – Global Institute for Water Security; University of Manitoba – Department of Soil Science), Dr. Helen Baulch (University of Saskatchewan – School of Environment and Sustainability and Global Institute for Water Security), and Dr. Jane Elliott (Environment and Climate Change Canada), based on discussions carried out during the workshop. We thank all workshop participants for their valuable inputs. We are especially grateful to Dr. Don Flaten (University of Manitoba, retired), Dr. Tom Bruulsema (Plant Nutrition Canada), John Heard (Manitoba Agriculture and Resource Development), Len Kryzanowski (Alberta Agriculture and Forestry, retired), Etienne Shupena-Soulodre (Saskatchewan Water Security Agency), Dr. Henry Wilson (Agriculture and Agri-Food Canada), Sharon Reedyk (Environment and Climate Change Canada), and Trevor Wallace (Alberta Agriculture and Forestry) whose expert knowledge guided workshop planning and reporting, and to Stephanie Merrill (formerly with University of Saskatchewan) and Lukas Smith (formerly with University of Saskatchewan) for their technical support. The workshop was financially supported by a Capacity Building Award (Seed Funding) provided by the University of Saskatchewan's Global Institute for Water Security and the Global Water Futures Program, Agricultural Water Futures project, and CareerLauncher Internships.

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