nutrient stewardship

4R Nutrient Stewardship
Planning Guide

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1 Introduction

The Red River Valley and the Lake Winnipeg Watershed

The Lake Winnipeg watershed extends from the Rocky Mountains to within a few kilometers of Lake Superior, and from the northern tip of the lake south to South Dakota. It is the second largest watershed in Canada and spans about 1 million square kilometers including parts of four Canadian provinces and four U.S. states. Large cities such as Winnipeg, Regina, Saskatoon, Edmonton, Calgary and Fargo are in the watershed which is dominated by agricultural land use. The western part of the watershed is predominantly cropland while forested areas are located on the eastern side of the lake in the Boreal Shield region.

The three major rivers feeding Lake Winnipeg are the Saskatchewan, Red (including the Assiniboine) and Winnipeg rivers. Lake Winnipeg is the 6th largest lake in Canada and the 10th largest freshwater lake in the world. It measures 23,750 square kilometers in area. It is shallow relative to other large lakes with an average depth of 9m in the south basin and 13.3 m in the north basin. The 2 basins of Lake Winnipeg are separated by the narrows through which waters from the south ultimately flow north. The outflow and water levels of Lake Winnipeg have been regulated for hydroelectric power since 1976. Lake Winnipeg is the third largest hydroelectric reservoir in the world.

The lake has substantial socio-economic and cultural importance and it supports many shoreline communities and sustains a variety of uses including fisheries, recreation and hydroelectric power which are also crucial components of Manitoba's economy.

Over time, Lake Winnipeg water quality has deteriorated as evidenced by the increasing frequency and intensity of algal blooms. Increased nutrient loading of phosphorus and nitrogen into Lake Winnipeg is one of the main reasons for the algal blooms.

Many people are conducting research and monitoring on the lake including Environment Canada and Manitoba Water Stewardship. A report entitled "State of Lake Winnipeg" was produced to summarize the current scientific knowledge on the lake. In addition, in September 2010, Environment Canada and Manitoba Water Stewardship signed a "Canada-Manitoba Memorandum of Understanding Respecting Lake Winnipeg and the Lake Winnipeg Basin" to help guide future research and monitoring on Lake Winnipeg and its water shed and identify solutions to reduce nutrient loading and halt eutrophication.

The province of Manitoba is committed to protect water quality and has passed legislation to this effect including the Livestock Manure and Mortalities Management Regulation 1998 under the Environment Act 1998, the Nutrient Management Regulation 2008, under the Water Protection Act 2008 and the Save Lake Winnipeg Act 2011. (Source: State of Lake Winnipeg: 1999 to 2007, 2011)

1 Introduction

Steps to Follow When Developing a 4R Nutrient Management Plan

The 4R Nutrient Stewardship approach is a framework that helps you organize your decisions about nutrients by focusing on what is important; the Right Source @ Right Rate, Right Time, Right Place®. It is about using fertilizer more effectively and efficiently. For growers this translates into getting more value for every dollar spent on fertilizer and reducing negative environmental impacts at the same time.

The core of the 4R Nutrient Stewardship system is applying the Right Source at the Right Rate, Right Time and Right Place. The key to successful 4R Nutrient Stewardship is including a nutrient management plan that is rooted in all 4Rs. This is because the 4Rs are based on scientific principles and the best available local evidence. The result is a series of Best Management Practices or BMPs that allow you to convert principles to practical knowledge that fits local conditions.

The 4Rs are not independent. In fact they are highly interrelated and that is why when implementing BMPs you need to consider what the impact of a decision in one 'R' has on the other three. Because the 4Rs are integrated they can work together synergistically, but they can also be antagonistic, in some cases. So always consider 4Rs as a system when developing BMPs and like any system you need to consider how changing one of the components affects the performance of other components. By filling out a 4R Nutrient Stewardship Management Plan, you are able to set goals for incremental improvement.

There are a few things that distinguish 4R Nutrient Stewardship from regular nutrient applications. The first is that the 4Rs are a comprehensive approach to sustainable nutrient management. That is to say, they do not focus on the economic returns, or the environmental impacts, or the social ramifications of nutrient use in isolation. They integrate and look at the overall impact of nutrient management decisions on economic, social and environmental goals.

In fact, 4R Nutrient Stewardship does more than just look at a farm's contribution to sustainability, it links cropping system performance to sustainability goals in a measurable and traceable way.

4R Nutrient Stewardship is based on the principle of adaptive management and continuous improvement. So developing a 4R Nutrient Stewardship Management Plan is more than just a paper exercise, it's a living document that evolves over time and retains its value going forward.

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2 Farm Information

In this section we are asking for general information which may stay consistent between years. However, this information is very important for understanding the conditions and context of the applied practices. Please also include any information that you think is relevant or unique to your operation and include as much detail as possible.

One of the most valuable resources to help guide your decision making are the services of a professional advisor, such as a Certified Crop Adviser or professional agronomy consultant, they can assist in the development of a 4R Nutrient Stewardship Management Plan. If you would like to find out more about the benefits of a Certified Crop Adviser or to find you one in your region, please go to www.prairiecca.ca. To find out about Professional Agrologists or how to contact one, please go to www.mia.mb.ca.

Enterprise Name (Farm or Business name):	
Contact Information – Farmer (Name, Address, Phone, Email):	
Contact Information – Adviser (Certified Crop Adviser, or Consulting Agronomist):	
Dates That This Plan Will be Implemented (Month/Year) :	
Enterprise Description (total number of fields etc):	
Total Crop Area:	
Crops Grown:	
Livestock and/or Poultry (Describe):	
On Farm Nutrient Sources (eg. Manure, Composts, and Other Materials) and volume available annually:	
Quantity of Manure Produced on Site:	

3 Sustainability Goals and Indicators Related to Nutrients

The underlying driver behind 4R Nutrient Stewardship is the goal of sustainable nutrient management. While a number of definitions exist for sustainable agriculture, the most common concepts highlight the need to accommodate growing demands for production without compromising the natural resources upon which agriculture depends.

The first step in 4R Nutrient Stewardship Planning is to set environmental, social and economic goals for nutrient management on the farm. Goals are not really very useful things unless you can tell when you meet them. Part of goal setting is to think about the performance indicators that will help you measure progress towards the goals.

Effective 4R goals need to be relevant to the farming operation, the farmer and the farm family's needs. They also need to be relevant to other stakeholders in the local and global community and require input from those stakeholders. And finally, goals need to be something that the cropping system can influence.

So what do sustainable agriculture goals look like? Starting with economic goals, one example is the goal of keeping farms in an economically viable situation. While there needs to be a balance between economic, social and environmental goals, it's hard to imagine a farm that isn't economically viable being able to contribute significantly to social and environmental goals. One of the main social goals of sustainable agriculture can be the production of nutritionally abundant and affordable food. On the environmental side, there are many ways that agricultural producers can use 4R Nutrient Stewardship Planning to minimize environmental losses. In the Lake Winnipeg Watershed, subsurface nitrate leaching and phosphorus and nitrogen runoff into surface water are all pressing concerns that can cause algal blooms and eutrophication. The decreased water quality of Lake Winnipeg has become increasingly pronounced over the last decade. Sustainable cropping systems help ensure clean water and clean air. You must choose the goals and corresponding performance indicators that are the most appropriate to you under each of the sustainability areas.

	Performance Indicator Examples
Yield	Amount of crop harvested per unit of cropland per unit of time
Quality - Harvest	Protein, minerals, vitamins or other value adding attribute
Quality - Stand	Plant population, tillering, lodging, maturity
Nutrient Use Efficiency	Yield produced or nutrient removed per unit of nutrient applied taking residual nutrient levels into account
Carbon Credits	Nitrous oxide emission estimates, carbon sequestration estimates
Off-field Nutrient Losses	Losses from edge of field, bottom of root zone and top of crop canopy
Value to input cost ratio	Dollars of crop produced per dollar of nutrient input
Soil Productivity	Soil organic matter, and other soil quality indicators

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3 Sustainability Goals and Indicators Related to Nutrients

Once you have chosen some sustainability goals you will want to spend a bit of time thinking about measuring progress towards those goals, and to do that you need some performance indicators. For example, we can measure soil quality in terms of things like soil organic matter, compaction and productivity. We can assess the quality of water that flows off agricultural land by looking at the nutrient and sediment load. In the economic area, farmers measure their profitability and their return on investment.

Choose one goal and performance indicator under each sustainability category, you may write different ones that better reflect your farm:

	Goals (examples)	Sample Performance Indicators (ex. Yield, quality of crop, nutrient use efficiency etc)
Economic	☐ Improve value to input cost ratio for fertilizer by 10% over two years ☐ Produce revenue to sustain farm operations ☐ Other: _____	☐ Value to input cost ratio (Dollars of crop produced per dollar of nutrient input) ☐ Farm Profit
Environmental	☐ Improve nutrient use efficiency by 5% over two years ☐ Reduce washouts/soil erosion ☐ Other: _____	☐ Nutrient use efficiency (amount of crop produced per pound of nitrogen applied) ☐ Measure level of ground cover by cover crops or crop residue during high risk times for soil erosion.
Social	☐ Increase society's awareness of how farmers in the Lake Winnipeg Watershed are responsible stewards of the land. ☐ Help meet global food needs ☐ Other: _____	☐ Become a 4R Advocate or participate in similar programs with Manitoba Conservation and Water Stewardship (MCW) or Manitoba Agriculture Food and Rural Initiatives (MAFRI). ☐ Ecosystem Services

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4 Production Information (for each field or management zone):

The aim of 4R Nutrient Stewardship is to improve nutrient management on the farm. In fact it's designed to improve nutrient management on a field-by-field or even a within-field basis. For this reason Production Information should be filled out for each field or management zone in the operation.
This includes any performance indicators measured and reported (eg. yield, profit, quality etc).

Once sustainability goals have been set, it is time to gather production information for each field or management zone. In some cases, there will be very complete sets of production information based on actual measures. In other cases the information might be a generic value. For example, a producer may not know the nutrient content of their manure sample; however, they can get averaged data based on manure source from MAFRI or other sources. These generalized data points are never as accurate as actually obtaining a representative on farm sample. But by filling out this form you can pinpoint what information you need to gather for the next season and improve your information accuracy over time.

Much of this information may already be recorded through the use of a GPS or you may already input this information into existing programs such as MAFRI's MARC (Manure Application Rate Calculator), Environmental Farm Plans, Nutrient Management Plans, etc.

- Legal Location and/or GPS coordinates: The first piece of information required is the legal location or GPS coordinates. With this information we request you add a map and a description of the field. This can include slopes, proximity to water bodies, presence of manure storage, tile drainage or any other distinguishing features. You can download information using Google Maps, your GPS or a wide range of products online. Aerial photos and MAFRI's Agri-Maps can also be very useful.

- Management System (Conventional or Variable Rate): Identify whether you are applying variable rate on your field. If you are applying variable rate, please fill out all of the following information in the table for each Management Zone.

- Agricultural Capability Ratings (CLI) and Landscape Topography and Soil Drainage Characteristics: Obtaining CLI information that determines agricultural capability can be useful. Both the Nutrient Management Regulation (NMR) and the Livestock Manure and Mortalities Management Regulation (LMMMR) in Manitoba use CLI information for defining and regulating nutrient limits. Topography refers to slopes on the field. Soil drainage can be classified using the CLI system or be described with infiltration rate. It can also be described qualitatively such as a description of which fields have ponding and which infiltrate rapidly.

- Identify environmentally sensitive areas on maps. Buffers regulated under the NMR and LMMMR should be adhered to.

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4 Production Information (for each field or management zone):

Legal location and/or GPS coordinates (please attach a map and description):			
Field or Management Zone Name or Number:		Area (size, acres):	
Management System- are you applying variable rate and for which nutrient?		Number of Management Zones:	
Agricultural Capability Ratings (CLI), Landscape Topography and Soil Drainage Characteristics (e.g. well drained, poorly drained etc., if tile drainage is present, describe design.):			

- Previous Crop: Please list crops planted in the last year including any crop rotation.
- Yield and Quality: Based on location specific history, yield monitors, yield mapping or crop variety, an estimate should be feasible for expected yield and quality.

Previous Crops:		Specific Crop(s) for This Planning Event:	
Previous Yield and Quality:			
Realistic Target Yield and Quality:			

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5 Nutrient Balance

In the next section, we ask that you use the following information to create a nutrient balance for the upcoming season. Please include all sources such as cover crops, crop residue, manure, non-agricultural source materials etc. Include the appropriate unit for each value (Kg/ha, ppm, lb/acre, etc). If you already create a nutrient balance with existing software or online programs you can move ahead to the planning section.

- Soil characteristics based on soil analysis: This is where you assess what is already there and available for your crops. Please use the information from your latest soil test results. Manure and Nutrient Management plans required in Manitoba, have specified procedures for N and P determination. These tests are water soluble nitrate-nitrogen in the top 24" of soil and Olsen extractable phosphorus in the 6" surface depth. A basic soil analyses should include: 1. Water soluble nitrate-nitrogen in the surface and subsurface soil 2. Extractable phosphorus using the Olsen or sodium bicarbonate technique. (The modified Kelowna test used by Exova and ALS also works on our soils and can be approximately converted to Olsen equivalent) 3. Exchangeable potassium using the ammonium acetate extractant or modified Kelowna extractant 4. Water soluble sulphur 5. Soil pH and Salinity or electrical conductivity (E.C.). Additional options include micronutrients, organic matter and cation exchange capacity.

- Manure Analysis: This reflects nutrients available from existing sources found on farm or commonly used. It is best to obtain a representative nutrient sample and then compare this value to an on farm manure analysis database or a published manure database to ensure accuracy. You can also use published databases if you do not have a manure sample yet. MAFRI's manure data is found at: www.gov.mb.ca/agriculture/soilwater/nutrient/pdf/mmf_calcmanureapprates_factsheet.pdf.

- Cover Crops, Crop Residue or Non-agricultural Source Materials: Please describe all sources of nutrients that are planned for this cropping season.

- Recommended Crop Nutrient Levels: Here we ask you to list the crop to be grown and what nutrient quantities are typically required for that crop. This information can come from a variety of places including crop consultants, seed companies or MAFRI 's Soil Fertility Guide at www.gov.mb.ca/agriculture/soilwater/nutrient/pdf/soil_fertility_guide.pdf. Please indicate your source of information. Using the crop requirements and soil test results you can better estimate what amount of additional nutrients need to be applied and whether your rate is sufficient, appropriate or excessive. Make recommendations of nutrient source, rate, timing and placement. Review and modify the plan as needed.

- Balance Calculation: Add up all the sources for each nutrient and then subtract Recommended Crop Nutrient Levels in order to determine what amount of nutrients are required in addition to current supply. E.g. (Soil analysis + manure + crop residue etc.) – Recommended Crop Nutrient Levels = Balance. You should maintain records and complete a nutrient budget if possible.

5 Nutrient Balance

	Nitrate - Nitrogen (List Units)	P_2O_5 (List Units)	K_2O (List Units)	Micronutrients (list all that are available) (List Units)	Any other notes
Soil Analysis Date of Analysis: ______					
Manure Analysis Date of Analysis: ______					
Previous Cover Crops					
Crop Residue					
Non-agricultural Source Materials					
Recommended Crop Nutrient Levels					
Balance Calculation					

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6 Planned Nutrient Application

In this final table you are able to consider all of the information you have provided above to describe your planned nutrient application. All of the 4Rs must be considered and accounted for. You have the opportunity to list your previous choices in source, rate, time and place and along with results in terms of measured and estimated performance indicators (e.g. yield, nutrient use efficiency, etc.). Below that, is a section where you are encouraged to list potential alternative 4R combinations that might improve performance and list the barriers to adopting such 4R combinations. Not all BMPs will have measurable benefits in one year, but may need a more long term period to be effective. This can then be directly linked to one of the chosen performance indicators where you can indicate when you expect to see an improvement (ex. 10% improvement in nutrient use efficiency over 2 years).

4R Recommendations: The goal is for incremental change over time and to track what changed in previous years. By indicating in this worksheet a planned improvement in the combination of application practices, you can keep records of changes in crop performance. BMP combinations should consider:

- Account for all P fertilizer sources and P fertilizers including manures and composts. P applications should be banded/injected whenever possible. Prompt incorporation of broadcast applications should occur when banding or injection is not possible.

- Chose a plant available nutrient source that could have enhanced efficiency, account for N from all sources (including residue, manure and irrigation water) and determine rate based on the difference between the amount of nutrients your crop needs and the amount of nutrients the soil can provide. Try to avoid surface applying urea under conditions that would encourage volatilization losses of N. Consider banding over broadcasting. For fall applications, band fertilizer late in the fall to minimize nutrient loses from run-off, leaching, denitrification, mineralization, etc.

- Ensure compliance with existing Manitoba regulations. Manitoba has legislation to protect water quality. Current legislations impacting nutrient application on agricultural land include:

  1. Livestock Manure and Mortalities Management Regulation, under the Environment Act
     www.gov.mb.ca/conservation/envprograms/livestock/pdf/w065-062.08.pdf

  2. Nutrient Management Regulation under the Water Protection Act
     www.gov.mb.ca/waterstewardship/wqmz/

  3. Save Lake Winnipeg Act
     http://web2.gov.mb.ca/bills/39-5/b046e.php

Consultant Recommendations/Comments: If you work with a CCA, Professional Agrologist or agri-retailer you can ask them to include any comments based on your planned nutrient application decisions. It can be useful to have a 4R certified professional review your decisions.

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6 Planned Nutrient Application

Field		Source (List all that apply) analysis N, P_2O_5, K_2O-S)	Rate (include units)	Time (date, crop growth stage)	Place (depth, method)	Performance Results: (yield bu/A, grain quality %CP, P index, nitrate leaching index) or barriers to adoption
1	Current Application					
	Alternate future application					
2	Current Application					
	Alternate future application					

Recommendations or Comments: