



FERTILIZER CANADA

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Ontario 4R Nutrient Stewardship Management Plan



1. Introduction: Watershed Management

In 2012, the Great Lakes Water Quality Agreement between the USA and Canada was updated with renewed commitment to reduce nitrate and phosphorous loading into the Great Lakes River Basin. Ontario's 36 watershed Conservation Authorities (CAs) continue to be one of the primary mechanisms for watershed based management programs. These CAs are interested in taking on a more active role in working with the provincial and federal authorities to identify priority watersheds for non-point source pollution control and implement management actions (Conservation Ontario, 2012).

Examples of two watersheds identified as priority watersheds are Lake Simcoe and Grand River. The Lake Simcoe Watershed in Ontario was identified as a priority watershed for nutrient reduction in 2008. Another important watershed is the Grand River watershed which encompasses all the land drained by the Grand River and is the largest watershed in southern Ontario. It is 6,800 square kilometers (2,800 square miles) in size. Sand and gravel aquifers in the middle part of the watershed are drinking water sources for both the urban areas and rural residents, but are vulnerable to contamination by nitrate. Further, phosphorous exports from the Grand watershed enter the eastern basin of Lake Erie, where they contribute to algae growth.

Four R Nutrient planning and management for nitrogen (N) and phosphorous (P), is one of the key tools being examined to reduce N and P loading in the Grand River watershed and ultimately the Great Lake Basin. The key elements of preventing soil erosion, subsurface placement of P, and keeping most of the P applications near planting time help to reduce agriculture's contribution to total P loading will lead to higher P Use Efficiency on-farm. Matching N applications to crop requirements reduces the risk of nitrate moving below the rooting zone, or exiting the farm via run-off, and contaminating aquifers and waterways. Studies have shown that under 4R management, higher N Use Efficiencies can be achieved.

Currently the Grand River Conservation Authority is working with municipal, provincial, federal governments, First Nations and other partners to develop a Water Management Plan for the Grand River watershed. The key issues which are being addressed are to; ensure a sustainable supply of water for communities and ecosystems, reduce potential flood damages, and improve water quality (which includes lowering concentrations of nitrate and phosphate in the River system) and the watershed's resilience to climate change.

Steps to Follow When Developing a 4R Nutrient Stewardship Plan

The 4R Nutrient Stewardship approach is a framework that helps you organize your decisions about nutrients by focusing on what's important; the Right Source @ the Right Rate, Time and 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 off farm impacts at the same time.

The core of successful 4R Nutrient Stewardship is including a plan for managing applied nutrients that is rooted in all 4R's. One of the key principles of the 4R Nutrient Stewardship Plan is site-specific management where nutrient management practices are optimized to match the requirements of the crop and manage environmental risks at the individual field or sub-field level. The result is a series of beneficial management practices or BMPs that allow you to convert principles to practical knowledge that fits local conditions. These BMPs need to be regionally specific and based on scientific studies that are relevant to the local cropping systems.

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. The choice of the 4Rs depends on specific situation (crop, soil type, topography, equipment available, etc.). The R's may be different for each nutrient type, for example, nitrogen 4R's may be different from phosphorous 4R's. 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 Worksheet, 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 does more than just look at a farm's contribution to sustainability, 4R 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 Worksheet is more than just a paper exercise, it's a living document that evolves over time and retains its value going forward.

2. Farm Information

This section asks 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 Agrologist, they can assist in the development of a 4R Nutrient Management Plan. If you don't currently work with an advisor, and 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.canadiancca.com. To find out about

Professional Agrologists or how to contact one, please go to www.oia.on.ca.

3. Sustainability Goals and Indicators Sustainability Goals and Indicators related to Nutrients

The underlying driver behind 4R Nutrient Management is the goal of sustainably managing nutrients. 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. Sustainability applies to the multiple dimensions of social goals, environment and economic simultaneously. All three must be considered in order to approach sustainability.

The first step in 4R Nutrient Stewardship Planning is to set environmental, social and economic goals for managing nutrients 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.

Farm Information	
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:	



Good 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 a large number of ways that agricultural producers can contribute ecological goods and services. Subsurface nitrate leaching and phosphorus runoff into surface water are both pressing concerns in the North and South Saskatchewan watersheds as well as the Milk River watershed. Choosing goals and corresponding performance indicators that are the most appropriate to you and your local conditions under each of the sustainability areas is needed (e.g. an area where nitrate leaching is a concern due to sandy soil typically is not likely to be a concern for P runoff).

Performance Indicators: 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



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.

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

The aim of 4R is to improve management of nutrients on the farm. In fact it's designed to improve management of nutrients 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 with some farmers, 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 Provincial Agriculture Min-

Sustainability Goals and Indicators Related to Nutrients		
	Goals (examples)	Performance Indicators (ex. Yield, quality of crop, nutrient use efficiency etc)
Economic	<input type="checkbox"/> Improve value to input cost ratio for fertilizer by 10% over two years <input type="checkbox"/> Produce revenue to sustain farm operations <input type="checkbox"/> Other:	<input type="checkbox"/> Value to input cost ratio (Dollars of crop produced per dollar of nutrient input)
		<input type="checkbox"/> Farm Profit
Environmental	<input type="checkbox"/> Improve nutrient use efficiency by 5% over two years <input type="checkbox"/> Reduce washouts/soil erosion <input type="checkbox"/> Other:	<input type="checkbox"/> Nutrient use efficiency (amount of crop produced per pound of nitrogen applied)
		<input type="checkbox"/> Measure level of ground cover by cover crops or crop residue during high risk times for soil erosion.
Social	<input type="checkbox"/> Increase society's awareness of how farmers in Ontario's priority watersheds (e.g. Grand River) are responsible stewards of the land <input type="checkbox"/> Produce revenue to sustain farm operations <input type="checkbox"/> Other:	<input type="checkbox"/> Become a 4R Advocate or participate in similar programs with Conservation Ontario, or the Environmental Farm Plan Program (EFP), or another regional group.
		<input type="checkbox"/> Ecosystem Services



istries or other advisors. These generalized data points can never be as representative as actually measuring a 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 AFFIRM, FCC's AgExpert etc.

- **Spatial Information:** The first piece of information required is the spatial location and size of the field or management zone. 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 the information using Google Maps, your GPS or a wide range of free products online. Aerial photos and Agri-Maps can also be very useful. The Ontario Ministry of Agriculture and Rural Affairs (OMAFRA) hosts a useful mapping tool called AgMAP to assist in this area (see <http://www.omafra.gov.on.ca/english/landuse/gis/portal.htm>).

- **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 for each Management Zone.

- **Soil Information, Landscape Topography and Soil Drainage Characteristics:** OMAFRA has integrated CLI (agricultural capability ratings) and soils information into the AgMap portal (see link above). This information can be useful assessing various parameters such as soil texture, topography (slope of the field), drainage characteristics and other soil limitations on land use capability. Soil drainage can be classified using the Hydrologic Soil Group, which has been determined for each soil series in the province.

- **Identify Environmentally Sensitive Areas on Maps:** Buffers and setbacks regulated under OMAFRA and the 2002 Nutrient Management Act (when applying manure or biosolids) should be adhered to. See <http://www.omafra.gov.on.ca/english/agops/>.

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:	
Soil Texture, 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.

Production Information (for each field or management zone):			
Previous Crops		Specific Crop(s) for This Planning Event:	
Field or Management Zone Name or Number:			
Management System-are you applying variable rate and for which nutrient?			

5. Planned Nutrient Application

When determining your planned nutrient application, it's important to set a realistic yield target for the crop you are planning on growing in the upcoming season. When submitting your soil samples for analysis to an accredited lab, you will need to identify your realistic yield target along with the above information. The soils lab will take into account the available soil nutrient levels, the yield target for the planned crop, and provide you with a recommendation on nutrient rates for N, P2O5, K2O and S application to achieve the targeted yield.

In order to meet the crop nutrient demands and not over-apply nutrients, it's important to consider additional potential nutrient sources that may have been or are being applied to the field, for the upcoming season such as cover crops (forage plow-down), crop residues, manure, and any non-agricultural source materials (e.g. biosolids).

- **Soil Nutrient Levels 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. For most nutrients collect samples to a depth of approximately 15 centimeters (6 inches). This depth is appropriate even where no tillage is used, as it represents the part of the soil where most roots are present and most nutrient absorption occurs. The exception to this are the soil nitrate samples, which are

collected at a depth of 30 cm (12 inches) to include nitrate which may have been leached from the surface soil to the lower part of the rooting zone. To collect sub-samples at the proper depth, the easiest equipment to use is a sampling tube or auger, which is simply inserted to the proper depth and then removed, bringing the sample with it. A shovel or spade can be used instead, but it is more labor intensive than a sampling tube or auger, and it is much more difficult to keep each sub-sample of uniform size. Send your samples to an OMAFRA accredited soil test laboratory. More detail can be found in the 2012 Sampling and Analysis Protocol for Ontario Regulation 264/03 under the 2012 Nutrient Management Act, where the collection of soil samples is described. This information can be accessed at: <http://www.omafra.gov.on.ca/english/nm/regs/sampro/sampro02-12.htm>.

- **Note:** phased-in farms applying manure under the Nutrient Management regulation must follow these protocols; for all other farms applying commercial fertilizers it's a good source of information.
- **OMAFRA gives general nutrient and soil sampling information for farms in Ontario:** (<http://www.omafra.gov.on.ca/english/crops/pub611/p611order.html>).
- **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 published manure database to ensure ac-



curacy. Manure and other forms of organic amendments release nutrients over time and over successive growing seasons. If applying these forms of nutrient sources, work with your crop advisor to determine release rates over time, or refer to the link above. You can use generic values of available nutrients based on livestock type. This can be found here: http://www.omafra.gov.on.ca/english/crops/field/news/croptalk/2005/ct_1105a6.htm.

- **Cover Crops, Crop Residue or Non-agricultural Source Materials:** Please describe all sources of nutrients that are planned for this cropping season. Take into account whether any of these have been applied in previous years for this field, and work with your advisor to determine nutrient contents and release rates for the upcoming season.

- **Adjusted Nutrient Application Rates:** Using the crop nutrient recommendations from the soil test analysis, and taking into account any nutrient sources listed above, you can better estimate the planned fertilizer application to make sure the rates are sufficient and not excessive. Make recommendations of nutrient source, rate, timing and placement. Review and modify the plan as needed.

In the table below, you are able to consider all of the information you have provided above to describe your planned nutrient application. All of the 4R's 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:

- **Phosphorous:** 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. Surface applications where incorporation is not possible (e.g. to forages) should be made in the spring or before seeding to allow time for the P to bind to the soil.

- **Nitrogen:** Choose a source which is soluble, and/or enhanced efficiency, account for N from manure and irrigation water; determine rate based on crop advisor's recommendations, provincial charts, pre-sidedress soil nitrate test (PSNT) and/or other nutrient management programs. Time can include preplant, at seeding, postemergence such as sidedress and/or split application, but should be as close as practical to the time when the crop will be up-taking the nitrogen. For place avoid leaving urea on the soil surface. Example: For spring planted annual crop (corn, spring wheat, soy bean) apply some starter fertilizer in furrow and side- band or mid-row band the majority of nitrogen, and the balance of nitrogen as a sidedress or top-dress in-crop application. For more information on PSNT sampling and recommendations in Ontario go to <http://www.omafra.gov.on.ca/english/crops/field/news/croptalk/2016/ct-0616a1.html>

- **Ensure Compliance with Existing Ontario Regulations:** Current legislations impacting nutrient application from non-commercial fertilizers (e.g. manure and biosolids) on agricultural land include:

1. 2002 Nutrient Management Act
2. 2012 Nutrient Management protocol
 - a. 2012 Nutrient Management Tables
3. 2012 Sampling and Analysis Protocol

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

(Chart on next page)



Planned Nutrient Application and Performance Results						
Feild		Source (List all that apply) analysis N, P2O5, K2O-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					



6. Nutrient Balance – A Check on the System

One of the ways of assessing the performance of your 4R Nutrient Stewardship Plan is by conducting a post-harvest nutrient balance. This ‘check on the system’ can be used to influence the next cycle of planning decisions and determine whether the nutrient status of the soil is increasing or decreasing over time. Nutrient balancing is a way to reflect environmental performance monitoring on the farm. This information focuses performance information on economic, social and (in this context) environmental priorities, distinguishing a 4R plan from typical nutrient management planning. Use the table below to assess the nutrient balance for your farm to determine how well the 4R Plan performed.

If you haven’t sent in your crops for analysis to determine crop uptake of nutrients, you can use standard crop removal tables to determine how much nutrient was removed based on the measured yield for that crop. Standard tables can be found at <http://www.ipni.net/article/IPNI-3296> or from your crop advisor.

Other Performance Indicators

Consider using this final table to track other indicators to assess economic, social and environmental performance over time. Others may include soil fertility levels, nutrient use efficiencies, balances, actual yields vs targeted yields, etc):

Other Performance Indicators				
	Past Year	Past Year	Past Year	Current Year
Yeild				
Economic Return				
Net Soil Nutrient Status - N				
Net Soil Nutrient Status - P				
Net Soil Nutrient Status - K				

Nutrient Balance – A Check on the System

	N	P ₂ O ₅	K ₂ O	Any other notes
Applied Nutrients (from Section 5; ensure common units)				
Crop Uptake (based on crop analysis) OR				
Crop Removal (based on standard values for crop removal and crop yield)				
Net Nutrient Status of the Soil				