FARMING 4R LAND

ECONOMIC ANALYSIS — GEORGE MORRIS CENTRE

4R nutrient stewardship

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CCEMC Climate Change & Emissions Management Corporation

Alberta Innovates Bio Solutions

Canadian Fertilizer Institute
Institut Canadien des Engrais

Executive Summary

The Canadian Fertilizer Institute, in partnership with Alberta Innovates Bio Solutions and financial support from the Climate Change and Emissions Management (CCEMC) Corporation, has initiated Farming 4R Land for Alberta's producers to demonstrate economic, social and environmental returns by implementing 4R Nutrient Stewardship.

Nitrous oxide (N2O) is one of the five greenhouse gases (GHG) that absorb heat, raising the Earth's temperature and contributing to global warming. Although it is estimated that the agricultural sector only contributes about 8% of Canada's total national GHG inventory, it is responsible for 69% of nitrous oxide and 25% of methane emissions. The Quantification Protocol for Agricultural Nitrous Oxide Emissions Reduction Protocol (NERP) developed by Canadian Fertilizer Institute targets decreasing nitrous oxide emissions in cropping systems through applying an integrated set of Best Management Practices (BMPs) for Nitrogen.

The BMPs are integrated into a 4R Nutrient Stewardship plan (Right Source @ the Right Rate, Right Time, and Right Place®). The technology has three performance levels — Basic, Intermediate, and Advanced. Each of the three levels is associated with a different degree of technological sophistication in applying nitrogen fertilizers. Successful implementation, however, is restricted by lack of knowledge on economic effectiveness of NERP when it is applied under alternative cropping scenarios.

The purpose of this study was to provide an economic analysis of the 4R Nutrient Stewardship plan and associated NERP, as implemented in the Alberta context. Through the economic analysis it was discovered that there were material benefits from adopting 4R Nutrient Stewardship on farm. The table below demonstrates potential financial benefits along with the associated GHG reduction potential based on the NERP methodology.

Prospective Individual Farm Benefits of Advanced NERP vs. Baseline

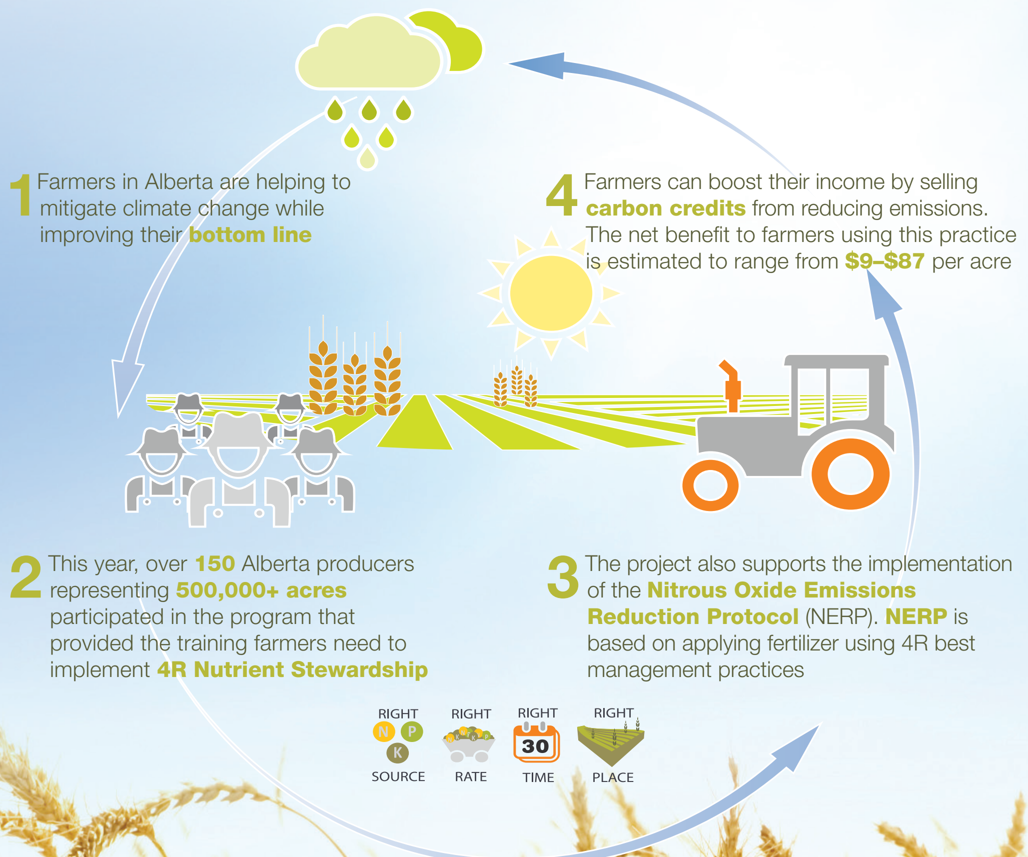
		Advanced NERP-Baseline $CDN/Acre	Acres/ Year	$CDN/ Year	Total $CDN/ Farm	Potential GHG Reduction Baseline — Advanced NERP
Dark Brown	Canola	62.52	320.00	20,005	$46,300	**25%**
	Barley	38.81	320.00	12,420		
	Wheat	43.36	320.00	13,876		
Black	Canola	86.59	320.00	27,709	$67,821	**25%**
	Barley	51.72	320.00	16,550		
	Wheat	73.63	320.00	23,562		
Dark Gray Peace	Canola	56.98	320.00	18,232	$51,397	**25%**
	Barley	40.51	320.00	12,964		
	Wheat	63.13	320.00	20,200		

It is important to note that the implementation of NERP is directly linked to the uptake of 4R Nutrient Stewardship thus, providing both economic and environmental returns to participating producers. To that end, these findings set the stage for future emphasis on consistent record keeping and an easy to use data management system for farmers and extension tools for agronomic advisors.

The results showed the following:

- In all cases, the costs of overall fertility management are lowest under the baseline scenario.
- Total fertility costs are the highest for the Advanced NERP, followed by the Basic NERP, and the baseline.
- The effect of reducing the nitrogen applied by 5% under the Advanced NERP scenario was almost exactly offset by the additional cost of treating urea with urease inhibitor;
- Revenue per acre is the highest under the Advanced NERP scenario, clearly due to the yield assumption under this scenario.
- The margin over fertility cost is highest for the Advanced NERP, followed by the Basic NERP, followed by the baseline.
- The implied net benefit of adoption of NERP practices was material, and ranged from $9/acre to about $87/ acre
- The benefits of the Advanced NERP scenario were highly dependent upon the anticipated yield increase; testing showed that a yield increase of just under 7% compared with the Basic NERP was required to make the Advanced NERP pay off.

These results suggest, importantly, that while NERP practices are likely to increase costs, they tend to generate benefits that exceed the additional costs. In no case were the margins over fertility cost higher under the baseline than under the NERP scenarios. The results also indicate that it is critical that improved fertilizer management be leveraged to increase yields in order to create an economic net benefit; the benefits of fertility management under the Advanced NERP were sensitive to yield increases.



1.0 Introduction

Nitrous oxide (N2O) is one of the five greenhouse gases (GHG) that absorb heat raising the Earth's temperature and contribute to global warming. Although it is estimated that the agricultural sector only contributes about 8%[1] of Canada's total national GHG inventory, it is responsible for 69%[2] of nitrous oxide and 25% of methane emissions. The Quantification Protocol for Agricultural Nitrous Oxide Emissions Reduction Protocol (NERP) developed by Canadian Fertilizer Institute targets decreasing nitrous oxide emissions in cropping systems through applying an integrated set of Beneficial Management Practices (BMPs) for Nitrogen. The BMPs are integrated into a 4R plan (Right Source @ the Right Rate, Right Time, and Right Place).[3] The technology has three performance levels – Basic, Intermediate, and Advanced. Each of the three levels is associated with a different degree of technological sophistication in applying nitrogen fertilizers. Successful implementation, however, is restricted by lack of knowledge on economic effectiveness of NERP when it is applied under alternative cropping scenarios.

1.1 Purpose and Objectives

The purpose of this study is to provide an economic analysis of the 4R plan and associated NERP, as implemented in the Alberta context.
The specific objectives are to

- develop an economic baseline for representative Alberta cropping systems,
- develop scenarios for Alberta representing BMP's implemented under the 4R-NERP plan ,
- provide an economic analysis of the 4R-NERP scenarios.

1.2 Organization of the Report

Section 2 below provides an overview of the NERP protocols. Section 3 describes the approach and assumptions applied in evaluating the NERP. Section 4 presents the results of the analysis, and Section 5 concludes the report.

2.0 Protocol for Agricultural Nitrous Oxide Emissions Reduction (NERP)

The Nitrous Oxide Emission Reduction Protocol fits within the framework of the Specified Gas Emitters Regulation administered by Alberta Environment and Sustainable Resource Development. The NERP uses life cycle analysis (LCA) to identify key sources and sinks of nitrous oxide in cropping systems. It also describes beneficial management practices that can form the basis for an on-farm nitrous oxide reduction program and procedures for estimating and validating emission reductions compared with a baseline scenario. The estimation equations used in NERP are derived from Canada's national inventory methods for greenhouse gases. They have been modified for application to a field or management zone within a specified farm enterprise. Nitrous oxide emission reductions quantified through NERP can be converted to carbon dioxide equivalents and traded in within Alberta's carbon trading system. While the NERP is currently only applicable in Alberta, it is being considered for use in other jurisdictions in Canada and the United States.

Table 2.1 below presents a summary of 4R nitrogen management practices taken from the NERP. The reduction modifier is the estimate of nitrous oxide emissions relative to a historic baseline for the farm. The modifier is stated as a decimal fraction of the baseline emissions. The practices are consistent with basic, intermediate, and advanced implementation of a 4R Nitrogen Management Plan under the NERP. As stated explicitly in the protocol, implementation of the 4R Plan requires sign-off by an Accredited Professional Advisor, who assists by recommending practices consistent with alternative NERP levels. Thus, putting in place the practices in Table 2.1 under the guidance of an accredited advisor provides for the implementation of the NERP at the farm enterprise level. The practices outlined below also form the basis for the economic estimates in Section 3 and 4.

[1] — *Environment Canada. Sectoral Greenhouse Gas Emission Summary. 2008.*
[2] — *Environment Canada. Canada's Greenhouse Gas Inventory. 2002.*
[3] — *Quantification Protocol for Agricultural Nitrous Oxide Emissions Reductions. Government of Alberta. October 2010.*

Table 2.1 4R Plan and Consistent Levels for Drier Soils

Performance Level	Right Source	Right Rate	Right Time	Right Place	Reduction Modifier
Basic	» Ammonium-based formulation;	» Apply N according to recommendation of 4R N stewardship plan*, using annual soil testing and/or N balance to determine application rate.	» Apply in spring; or » Split apply; or » Apply after soil cools in fall	» Apply in bands / Injection	0.85
Intermediate	» Ammonium-based formulation; and/or » Use slow / controlled release fertilizers; or Inhibitors; or Stabilized N	» Apply N according to qualitative estimates of field variability (landscape position, soil variability)	» Apply fertilizer in spring; or » Split apply; or » Apply after soil cools in fall if using slow / controlled release fertilizer or inhibitors / stabilized N	» Apply in bands / Injection	0.75
Advanced	» Ammonium-based formulation; and/or » Use slow / controlled release fertilizers; or » Inhibitors; or » Stabilized N	» Apply N according to quantified field variability (e.g. digitized soil maps, grid sampling, satellite imagery, real time crop sensors.) and complemented by in season crop monitoring	» Apply fertilizer in spring; or » Split apply; or » Apply after soil cools in fall if using slow / controlled release fertilizer or inhibitors / stabilized N	» Apply in bands / Injection	0.75

3.0 Economic Analysis Approach and Assumptions

The NERP is a protocol that applies at a site-specific level based on the recommendations of an advisor. At this level, farmer and advisor can customize within limits source, rate, time and place practices to meet the unique nutrient management challenges of each field. However, a provincial level economic analysis must occur at a level beyond the site-specific to allow for observations to be made that reflect a regional level. Thus, an approach that relates observed levels of economic variables to prospective agronomic changes at level beyond the site-specific requires simplifying assumptions. This section outlines the approach, simplifying assumptions, and data applied in the economic analysis.

3.1 Approach

The essential methodology of evaluating an agronomic management change is to define a baseline in which the NERP protocol is not implemented and evaluate its corresponding costs and returns, and then to contrast this with costs and returns in scenarios in which the NERP is implemented. This is appropriate since, as indicated on page 11 of the protocol, "Independent survey data of nutrient management practices across the country show that it is highly unlikely the complete suite of practices associated with the 4R Consistent Plan, applied consistently every year, is a common practice".

There are two potential approaches to establishing a baseline; one is to access existing benchmarks or crop budgets, which reflect actual practice or expert opinion on the fertilizer costs and the associated fertilizer analysis and application practices involved. The alternative is to consult an expert agronomist regarding what typical practices would be for a grower that had not implemented any of the NERP practices, and then estimate the costs of these by construction. This latter approach builds the baseline and scenarios, focusing on what changes between scenarios rather than including the breadth of detail contained in a benchmark or budget.

In this study, the first approach was explored and found to be unworkable. Alberta Agriculture, Food, and Rural Development produces budgets and surveys costs and returns for major field crops which includes a line item for fertilizer costs. However, it proved impossible to determine or attribute the method of application or timing associated with the fertilizer costs. Thus, the second method in which the baseline was developed based on "typical practice" exclusive of the NERP was employed.

To reflect the diversity of Alberta agronomic conditions, three soil zones were considered- Dark Brown, Black, and Dark Gray (Peace River). Within each of these soil zones, three crops were considered- canola, wheat, and barley. In each case, it was assumed that these crops were sown into stubble following an appropriate rotational crop and adequate moisture

3.2 Modeling Assumptions

The starting point for the baseline, as well as the NERP scenarios, was the Alberta AFFIRM model[4]. AFFIRM is a simulation model that relates soil and crop management, agro-climatic region, and soil test results to yields and fertility requirements for specified crops. The model also contains nitrogen-yield response functions that can be used to relate nitrogen applications to predicted yield response, crop prices, and fertilizer prices.

AFFIRM was used initially to solve for optimum nitrogen rates based on recent fertilizer and sample crop prices for each of the three agronomic regions, using soil test values that would be typical of stubble fields fall sampled after a good crop year and average moisture conditions. The results provided an index combination of yields and associated fertilizer recommendations (Table 3.1). These index values were then used in formulating baseline, Basic NERP, and Advanced NERP scenarios.

Nitrogen fertilizer sources used in the scenarios included monoammonium phosphate (MAP), ammonium sulfate (AS), and urea. Only NPS use is covered under the assumptions that potassium (K) and micronutrient deficiencies, while not uncommon in certain regions, are not typical of Alberta soils. Soil test values were set in AFFIRM to reflect that K and the micronutrients were not limiting so that AFFIRM would generate a zero rate for these nutrients. Soil test sulfur values were also set as non-limiting in AFFIRM, but a 15 lb S/acre recommendation was added to all canola scenarios as this reflects common practice among canola growers. The assumption in all scenarios is that the crop is seeded into a low disturbance system using an air drill. Fertilizer sources

[4] — http://www1.agric.gov.ab.ca/$department/softdown.nsf/main?openform&type=AFFIRM&page=information

Table 3.1 Yield and Fertilizer Results Obtained from AFFIRM

		Sample Price ($/tonne)	Predicted Yields	N Rate	P2O5 Rate	K2O Rate	S Rate
				Lbs/acre			
Dark Brown	Canola	650	30.8	90	20	0	**15**
	Wheat	325	39.8	80	20	0	**0**
	Barley	275	62	70	20	0	**0**
Black	Canola	650	41.1	100	25	0	**15**
	Wheat	325	59.9	115	25	0	**0**
	Barley	275	89.9	100	25	0	**0**
Dark Gray Peace	Canola	650	30	80	25	0	**15**
	Wheat	325	51	100	25	0	**0**
	Barley	275	80.2	90	25	0	**0**

Table 3.2 Scenario Assumptions

	Scenario		
	Baseline	**Basic NERP**	**Advanced NERP**
Yield	Index minus 10%	Index	Index plus 10%
Fertilizer Application Time and Place	Spring, Surface Broadcast	Spring Banded	Spring Banded
Soil Testing	None	Composite sampling, Two depths, Complete nutrient analysis	VRT recommendations, Sampling by management zone, two depths, complete nutrient, analysis.
N Source	Urea	Urea	Urea treated with urease inhibitor
N Rate	Index	Index	Index minus 5%

are urea and MAP with the addition of AS when canola is the crop. Urea is assumed as the primary nitrogen source. The rates of urea application are adjusted in each scenario to account for N applied in MAP and AS.

In the baseline scenario, fertilizer rates followed the AFFIRM recommendations, although no soil tests were assumed. Application practice is broadcast (place) of all fertilizer as a blend prior to seeding in the spring (time). Baseline yield is assumed to be 10% below the predicted index level obtained from AFFIRM. The reduced yield assumption is based on the low nitrogen use efficiency obtained from surface applied urea and falls within the range of performance differences between spring broadcast and spring banded nitrogen found by various researchers in Western Canada.

[5]Under the Basic NERP scenario fertilizer rates and crop yields are at the index level. Annual soil testing on a composite field basis has been added as a supporting practice for developing fertilizer recommendations. Fertilizer is applied in a narrow band in the spring at time of seeding.

The Advanced NERP scenario assumes variable rate technology (VRT) with the field divided into several management zones. Soil testing was assumed to be for two depths by management zone. Yield is assumed to be on aggregate for the field 10% higher than the index level. Finally, the nitrogen source is urea treated with a urease inhibitor and the rate is assumed to be on aggregate for all zones in the field 5% less than the index recommendation from AFFIRM. Fertilizer recommendations are based on soil testing ranges from none under the baseline, up to advanced soil testing under Advanced NERP scenario.

3.3 Data

In order to estimate costs and returns under the baseline and alternative NERP scenarios, data on fertilizer prices were obtained from Alberta Agriculture, Food and Rural Development (AFRD)[6]. These were the following:

- Mono-Ammonium Phosphate (11-52-0), 2010-2012 monthly average price ($723/tonne),
- Urea (46-0-0), 2010-2012 monthly average price ($596/tonne).

Other values were assumed based on industry information:

- Ammonium Sulphate (21-0-0-24) assumed at recent price of $425/tonne,
- Agrotain (urease inhibitor) treatment assumed at $45/tonne of urea.

Data on custom rates were also obtained from AAFRD[7]. These were generally presented as a range, and the approximate midpoint of the range was used.

- Granular fertilizer spreading, floater truck $6.25-$8.75/acre
- Air seeder $20-$27/acre
- Double depth soil testing, complete nutrient analysis $160/field (interpreted as $1/acre)

Advanced soil testing with VRT map building was assumed at $8/acre based on industry information.

Alberta prices for canola, wheat, and barley were obtained from AAFRD[8]. For canola and barley, price quotes from mid-year 2011 and 2012, along with early May 2013 were used to develop a price reference. For canola, the price quote delivered to a crusher was used. Barley prices were basis Lethbridge, feed mill bids. Alberta-basis wheat price quotes were not available for the same period. Instead, #1/2 Canada Western Red Spring Wheat quotes were obtained from AAFRD for the first week of the months of February, March, April, and May 2013 and averaged.

[5] — *For a relevant comparison of broadcast versus banded performance see Grant* et al *(2002) and Malhi* et al *(2001)*
[6] — *http://www.agric.gov.ab.ca/app21/rtw/surveyprices/graph.jsp?groupId=5&dataId=39*
[7] — *http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/inf14269*
[8] — *http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/sdd6248*

4.0 Results

To evaluate the NERP scenarios relative to the baseline, the fertilizer costs associated with the alternative fertilizer management scenarios were computed and compared with the associated revenue. Based upon this, the margin over fertility cost (fertilizer ingredients plus application/agronomy cost) was calculated. The level of this margin under the baseline, basic NERP, and advanced NERP serves as the criterion for an economic ranking of the fertility management alternatives.

First the basic nutrient requirements were obtained from the information in Table 3.1 above, and then interpreted according to scenarios using the assumptions contained in Table 3.2. The fertilizer costs were calculated by balancing the requirements for P2O5 with mono-ammonium phosphate (MAP) and requirements for sulfur with Ammonium Sulfate. The nitrogen content of these ingredients were credited against nitrogen requirements, and the remaining nitrogen requirements provided by urea. Based on the per acre requirements of these fertilizer ingredients and the prices of fertilizer ingredients, the implied costs of fertilizer per acre were calculated.

These are presented in Table 4.1 below. Each row in the table represents a crop; the three crops are categorized according to NERP scenario, and these in turn are categorized by soil zone. The first set of columns presents the per acre requirements of MAP, ammonium sulphate, and urea; the second set of columns gives the per acre cost of the ingredients. The final column totals these fertilizer costs into total per acre fertilizer costs. As can be seen from the table, the fertilizer ingredient costs per acre for the baseline and Basic NERP scenarios are identical. The total fertilizer costs are slightly lower under the advanced NERP scenario under the combined effect of a 5% lower nitrogen application rate and the additional cost of urease treatment of urea.

Table 4.2 combines the fertility costs with other agronomic costs and revenues to provide an estimate of margin over fertility costs. The rows in the table are laid out as in Table 4.1. The columns in Table 4.2 report total fertilizer ingredient costs, costs associated with soil testing and agronomy planning, fertilizer application costs, total costs of fertility management (fertilizer, agronomy planning/analysis, and application), anticipated crop yields, prices, and revenue, and margin over fertility cost. The rows in the final column are colour coded so that, within a soil zone, a given crop can be compared across fertility management scenarios.

These results show the following:

- The effect of reducing the nitrogen applied by 5% under the Advanced NERP scenario is almost exactly offset by the additional cost of treating urea with urease inhibitor; thus, the total fertilizer ingredient cost under the Advanced NERP scenario is only slightly lower than under the other scenarios.
- In all cases, the costs of overall fertility management are lowest under the baseline scenario. This is to be expected, as the fertilizer ingredient costs are as low as the Basic NERP scenario and almost as low as the Advanced NERP, there are no soil testing costs, and fertilizer application costs are the lowest among scenarios.
- Total fertility costs are the highest for the Advanced NERP, followed by the Basic NERP, and the baseline.
- Revenue per acre is the highest under the Advanced NERP scenario, clearly due to the yield assumption under this scenario.
- The above leads naturally to the observation that the margin over fertility cost is highest for the Advanced NERP, followed by the Basic NERP, followed by the baseline.

Table 4.3 below shows the value of the spread in margin over fertility cost from Table 4.2 above. The economic advantage of the Advanced NERP is generally the highest for canola, followed by barley. The apparent benefit of adoption of NERP practices based on this table is quite material; comparing the Advanced NERP with the Baseline, additional returns of up to $87/acre are envisioned. There are also material benefits associated with adopting the advanced NERP compared with the Basic NERP; these range from about $9/acre to over $20/acre. These relate to the use of VRT and field mapping along with urease inhibitors. These technologies, in turn, allow for a 5% decrease in nitrogen application and an anticipated 10% increase in yield.

The results above appear heavily dependent on the anticipated benefits of increased yield under the Advanced NERP. To test this, the sensitivity of the margin over fertility costs to anticipated yield increase relative to index from AFFIRM (and Basic NERP) was tested. Table 4.4 below reports the results. The first column of the table essentially reports the margin spread between the Advanced and Basic NERP scenarios presented in Table

Table 4.1 Basic Fertilizer Requirements and Costs

			11-52-0 amount (Lbs/acre)	21-0-0-24 amount (Lbs/acre)	46-0-0 amount (Lbs/acre)	11-52-0 Cost ($/acre)	21-0-0-21 Cost ($/acre)	46-0-0 Cost ($/acre)	Total Fertilizer Cost ($/acre)
Dark Brown	Baseline	Canola	38.46	62.50	157.92	12.61	12.05	67.88	92.53
		Wheat	38.46	0.00	164.72	12.61	0.00	70.80	83.40
		Barley	38.46	0.00	142.98	12.61	0.00	61.45	74.06
	Basic NERP	Canola	38.46	62.50	157.92	12.61	12.05	67.88	92.53
		Wheat	38.46	0.00	164.72	12.61	0.00	70.80	83.40
		Barley	38.46	0.00	142.98	12.61	0.00	61.45	74.06
	Advanced NERP	Canola	38.46	62.50	148.14	12.61	12.05	66.70	91.35
		Wheat	38.46	0.00	156.02	12.61	0.00	70.24	82.85
		Barley	38.46	0.00	135.37	12.61	0.00	60.95	73.55
Black	Baseline	Canola	48.08	62.50	177.36	15.76	12.05	76.23	104.04
		Wheat	48.08	0.00	238.50	15.76	0.00	102.51	118.27
		Barley	48.08	0.00	205.89	15.76	0.00	88.50	104.25
	Basic NERP	Canola	48.08	62.50	177.36	15.76	12.05	76.23	104.04
		Wheat	48.08	0.00	238.50	15.76	0.00	102.51	118.27
		Barley	48.08	0.00	205.89	15.76	0.00	88.50	104.25
	Advanced NERP	Canola	48.08	62.50	166.49	15.76	12.05	74.96	102.76
		Wheat	48.08	0.00	226.00	15.76	0.00	101.75	117.51
		Barley	48.08	0.00	195.03	15.76	0.00	87.81	103.56
Dark Grey Peace	Baseline	Canola	48.08	62.50	133.88	15.76	12.05	57.55	85.35
		Wheat	48.08	0.00	205.89	15.76	0.00	88.50	104.25
		Barley	48.08	0.00	184.16	15.76	0.00	79.15	94.91
	Basic NERP	Canola	48.08	62.50	133.88	15.76	12.05	57.55	85.35
		Wheat	48.08	0.00	205.89	15.76	0.00	88.50	104.25
		Barley	48.08	0.00	184.16	15.76	0.00	79.15	94.91
	Advanced NERP	Canola	48.08	62.50	228.45	15.76	12.05	102.85	130.66
		Wheat	48.08	0.00	195.03	15.76	0.00	87.81	103.56
		Barley	48.08	0.00	174.37	15.76	0.00	78.51	94.26

Table 4.2 Scenario Costs and Returns

			Total Ingredient Cost ($/acre)	Soil Testing, VRT, and GPS ($/acre)	Fertilizer Application ($/acre)	Total Fertility Cost ($/acre)	Crop Yield (bu/acre)	Crop Price ($/tonne)	Crop Revenue ($/acre)	Margin over Fertility cost ($/acre)
Dark Brown	Baseline	Canola	92.53	0.00	8.00	100.53	27.72	610.92	384.00	283.47
		Wheat	83.40	0.00	8.00	91.40	35.82	287.43	280.16	188.76
		Barley	74.06	0.00	8.00	82.06	55.80	247.67	300.84	218.78
	Basic NERP	Canola	92.53	1.00	24.00	117.53	32.34	610.92	448.01	330.48
		Wheat	83.40	1.00	24.00	108.40	41.79	287.43	326.85	218.45
		Barley	74.06	1.00	24.00	99.06	65.10	247.67	350.98	251.92
	Advanced NERP	Canola	91.35	8.00	24.00	123.35	33.88	610.92	469.34	345.99
		Wheat	82.85	8.00	24.00	114.85	43.78	287.43	342.42	227.57
		Barley	73.55	8.00	24.00	105.55	68.20	247.67	367.70	262.15
Black	Baseline	Canola	104.04	0.00	8.00	112.04	36.99	610.92	491.93	379.89
		Wheat	118.27	0.00	8.00	126.27	53.91	287.43	337.32	211.05
		Barley	104.25	0.00	8.00	112.25	80.91	247.67	436.22	323.97
	Basic NERP	Canola	104.04	1.00	24.00	129.04	43.16	610.92	573.91	444.88
		Wheat	118.27	1.00	24.00	143.27	62.90	287.43	393.54	250.27
		Barley	104.25	1.00	24.00	129.25	94.40	247.67	508.93	379.67
	Advanced NERP	Canola	102.76	8.00	24.00	134.76	45.21	610.92	601.24	466.48
		Wheat	117.51	8.00	24.00	149.51	65.89	287.43	412.28	262.77
		Barley	103.56	8.00	24.00	135.56	98.89	247.67	533.16	397.60
Dark Grey Peace	Baseline	Canola	85.35	0.00	8.00	93.35	27.00	610.92	359.07	265.72
		Wheat	104.25	0.00	8.00	112.25	45.90	287.43	287.20	174.94
		Barley	94.91	0.00	8.00	102.91	72.18	247.67	389.16	286.25
	Basic NERP	Canola	85.35	1.00	24.00	110.35	31.50	610.92	418.91	308.57
		Wheat	104.25	1.00	24.00	129.25	53.55	287.43	335.06	205.81
		Barley	94.91	1.00	24.00	119.91	84.21	247.67	454.01	334.10
	Advanced NERP	Canola	84.17	8.00	24.00	116.17	33.00	610.92	438.86	322.70
		Wheat	103.56	8.00	24.00	135.56	56.10	287.43	351.02	215.46
		Barley	94.26	8.00	24.00	126.26	88.22	247.67	475.63	349.37

4.2 above. When the anticipated yield advantage to the Advanced NERP is reduced to 7.5% from 10%, the net benefit of the Advanced NERP is correspondingly reduced. This essentially nullifies the net benefit of Advanced NERP for wheat in the Dark Brown and Dark Gray soil zones. If only a 5% yield increase were obtained under the Advanced NERP vs. Basic NERP, it would generate a negative net benefit for Advanced NERP in all of the crops in all soil zones. Thus, in order to be beneficial, it appears that the efforts in improved fertility management under the advanced NERP need to generate a yield improvement of just under 7%.

Table 4.3 Spreads in Margin over Fertility Cost per Acre

		Advanced NERP-Basic NERP ($/acre)	Advanced NERP-Baseline ($/acre)
Dark Brown	Canola	15.52	62.52
	Wheat	9.12	38.81
	Barley	10.22	43.36
Black	Canola	21.60	86.59
	Wheat	12.50	51.72
	Barley	17.93	73.63
Dark Grey Peace	Canola	14.13	56.98
	Wheat	9.65	40.51
	Barley	15.27	63.13

Table 4.4 Impact of Margin Over Fertility Cost Due to Yield Advantage Under Advanced NERP Scenario, $/acre

		Yield Advantage to Advanced NERP vs Basic NERP		
Soil Zone		10%	7.50%	5%
Dark Brown	Canola	15.52	4.85	-5.82
	Wheat	9.12	1.34	-6.45
	Barley	10.22	1.86	-6.49
Black	Canola	21.60	7.94	-5.73
	Wheat	12.50	3.13	-6.24
	Barley	17.93	5.81	-6.31
Dark Grey Peace	Canola	14.13	4.16	-5.82
	Wheat	9.65	1.67	-6.31
	Barley	15.27	4.46	-6.35

5.0 Conclusions

The purpose of this this study was to provide an economic analysis of relevant NERP scenarios implemented under the 4R Plan. To do so, a baseline scenario was constructed to represent agronomic management practices exclusive of NERP practices. Two NERP scenarios were formulated; one represented the Basic NERP and the other represented the Advanced NERP. These were compared against this baseline for canola, wheat, and barley for the Dark Brown, Black, and Dark Gray/ Peace River soil zones.

The baseline scenario reflected spring fertilizer application by surface broadcast without soil testing. The NERP scenarios reflected soil testing and spring banded fertilizer application; the advanced scenario envisioned advanced soil testing and variable rate technology for application, the use of urease inhibitor with nitrogen fertilizers, and both a fertilizer application rate decrease and a yield increase.

The results showed the following:

» In all cases, the costs of overall fertility management are lowest under the baseline scenario.
» Total fertility costs are the highest for the Advanced NERP, followed by the Basic NERP, and the baseline.
» The effect of reducing the nitrogen applied by 5% under the Advanced NERP scenario was almost exactly offset by the additional cost of treating urea with urease inhibitor;
» Revenue per acre is the highest under the Advanced NERP scenario, clearly due to the yield assumption under this scenario.
» The margin over fertility cost is highest for the Advanced NERP, followed by the Basic NERP, followed by the baseline.
» The implied net benefit of adoption of NERP practices was material, and ranged from $9/acre to about $87/ acre
» The benefits of the Advanced NERP scenario were highly dependent upon the anticipated yield increase; testing showed that a yield increase of just under 7% compared with the Basic NERP was required to make the Advanced NERP pay off.

These results suggest, importantly, that while NERP practices are likely to increase costs, they tend to generate benefits that exceed the additional costs. In no case were the margins over fertility cost higher under the baseline than under the NERP scenarios. The results also indicate that it is critical that improved fertilizer management be leveraged to increase yields in order to create an economic net benefit; the benefits of fertility management under the Advanced NERP were sensitive to yield increases.

The magnitude of the results estimated here regarding NERP benefits need to be placed in context to be appreciated. For these crops, the estimated contribution margin from Alberta Agriculture and Rural Development budgets for these crops ranges from $120-154/acre for the Dark Brown soil zone, $209-$264/acre for the Black soil zone, and $187-$231/acre for Grey/Peace River soils[9]. It is unclear the extent to which these budgets may incorporate some of the NERP BMP's. It is clear, however, that the magnitude of margin increase envisioned under the adoption of NERP scenarios for these crops is large in comparison with the budgeted contribution margin estimates. For example, the above results for canola in the dark brown soil zone envision benefits of about $63/acre from adopting the Advanced NERP vs. baseline; this compares with an estimated overall contribution margin of about $120/acre in Alberta budgets.

The results would also be quite significant for an individual farm that adopted the Advanced NERP scenario from the baseline scenario. Table 5.1 below extrapolated the prospective benefits out to a farm of six quarters (960 acres) in a continuous rotation of the three crops. It is acknowledged that, at the margin, the additional yields envisioned under the Advanced NERP vs Baseline would create additional costs such as transportation, storage, cleaning/ drying, etc.; these are excluded from the results in the table. The table shows that, for an Alberta farm of six quarters, the benefit of adopting advanced NERP from a baseline situation could range from about $46,000 up to almost $68,000. Thus, the prospective gains from improved nitrogen fertilizer management under the Advanced NERP scenario are quite material for an individual farm.

[9] — http://www1.agric.gov.ab.ca/$Department/deptdocs.nsf/all/econ10238/$FILE/2013%20Cropping%20Alternatives.pdf

Table 4.3 Spreads in Margin over Fertility Cost per Acre

		Advanced NERP-Baseline	Acres/Year	$/Year	Total $/Farm
Dark Brown	Canola	62.52	320.00	20,005	46,300
	Wheat	38.81	320.00	12,420	
	Barley	43.36	320.00	13,876	
Black	Canola	86.59	320.00	27,709	67,821
	Wheat	51.72	320.00	16,550	
	Barley	73.63	320.00	23,562	
Dark Grey Peace	Canola	56.98	320.00	18,232	51,397
	Wheat	40.51	320.00	12,964	
	Barley	63.13	320.00	20,200	

References

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