

RESILIENT ROTATIONS: NITROGEN USE EFFICIENCY NORTHERN PRAIRIES



Research has shown the benefits of diversifying crop rotations, and yet most Prairie farmers keep their rotations short and simple with cereals and oilseeds being intensively grown. For the past four years, researchers across Western Canada have compared different crop rotations to measure the drawbacks and benefits. This work is designed to help farmers make crop rotation decisions that are the best fit for their operation, based on local research.

Six different crop rotations were studied in Alberta, Saskatchewan and Manitoba to represent growing conditions in the Canadian Prairies. This factsheet looks at the differences between rotations for **nitrogen use efficiency**.

NITROGEN USE EFFICIENCY

Nitrogen use efficiency was calculated as the ratio of grain yield (expressed as canola equivalent yield, CEY) to available nitrogen (soil mineral nitrogen + applied nitrogen fertilizer).

The nitrogen fertilizer rates were determined by soil test recommendations except for the market driven rotation treatment which received 1.2 times the recommended nitrogen fertilizer rate to maximize yield.



**Integrated Crop
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SOIL MINERAL NITROGEN + APPLIED NITROGEN FERTILIZER = AVAILABLE NITROGEN (lbs actual N/ac) for the six crop rotation treatments at the four experimental sites in the Northern Prairies

Rotation Treatment	Beaverlodge, AB		Lacombe, AB		Melfort, SK		Scott, SK	
	Soil Mineral N	Applied N Fertilizer	Soil Mineral N	Applied N Fertilizer	Soil Mineral N	Applied N Fertilizer	Soil Mineral N	Applied N Fertilizer
Control	50	56	88	89	56	89	70	58
Intensified	49	63	70	85	57	102	51	47
Diversified	47	25	81	37	56	59	55	14
Market Driven	53	85	67	140	52	127	55	69
High Risk	49	46	63	66	54	82	53	31
Soil Health	48	34	92	40	62	60	56	16













Averaged across the four sites, the **market driven** rotation had the highest rates of applied nitrogen fertilizer while **diversified** rotation and the **soil health** rotations had the highest proportion of soil mineral nitrogen.






NITROGEN USE EFFICIENCY (NUE) BY CROP ROTATION IN ALBERTA, 2018-2021

Rotation Treatment	Crop Species Used Based on Local Growing Conditions				Nitrogen Use Efficiency Ranking of Various Crop Rotations*	
	Year 1	Year 2	Year 3	Year 4	Beaverlodge	Lacombe
The average NUE of all rotations at Beaverlodge was 13.9 kg CEY/kg available N (0.28 bu CEY/lb available N). The highest NUE at Beaverlodge was for the diversified rotation at 19.4 kg CEY/kg available N (0.39 bu CEY/lb available N). The average NUE of all rotations at Lacombe was 17.1 kg CEY/kg available N (0.34 bu CEY/lb available N). The highest NUE at Lacombe was for the diversified rotation at 23.9 kg CEY/kg available N (0.48 bu CEY/lb available N).						
Control	Wheat	Pea	Wheat	Canola		
Intensified	Wheat	Canola	Wheat	Canola		
Diversified	Pea	Winter Wheat	Faba Bean	Canola		
Market Driven	Canola	Malt Barley	Canola	Canola		
High Risk	Flax	Soybean	Durum	Canola		
Soil Health	Forage Pea Green Manure	Winter Wheat	Faba Bean	Canola		

NITROGEN USE EFFICIENCY (NUE) BY CROP ROTATION IN SASKATCHEWAN, 2018-2021

Rotation Treatment	Crop Species Used Based on Local Growing Conditions				Nitrogen Use Efficiency Ranking of Various Crop Rotations*	
	Year 1	Year 2	Year 3	Year 4	Melfort	Scott
The average NUE of all rotations at Melfort was 10.8 kg CEY/kg available N (0.22 bu CEY/lb available N). The highest NUE at Melfort was for the diversified rotation at 13.2 kg CEY/kg available N (0.26 bu CEY/lb available N). The average NUE of all rotations at Scott was 14.5 kg CEY/kg available N (0.29 bu CEY/lb available N). The highest NUE at Scott was for the market driven rotation at 16.5 kg CEY/kg available N (0.33 bu CEY/lb available N).						
Control	Canola	Wheat	Pea	Wheat		
Intensified	Canola	Wheat	Canola	Wheat		
Diversified	Pea	Winter Wheat	Faba Bean	Canola		
Market Driven	Oat (Melfort) Canola (Scott)	Canola	Wheat (Melfort) Green Pea (Scott)	Canola		
High Risk	Flax	Soybean	Durum	Canola		
Soil Health	Forage Pea Green Manure	Winter Wheat	Faba Bean	Canola		

Nitrogen Use Efficiency Ranking*

 = good nitrogen use efficiency  = statistically lower nitrogen use efficiency  = statistically lowest nitrogen use efficiency

*Nitrogen use efficiency ranking is calculated by location

THE BOTTOM LINE

- The **diversified rotation** consistently had some of the highest nitrogen use efficiencies in the northern Prairies. This is likely attributed to having pulse crops in the rotation for two of four years and winter wheat which is able to make use of available nitrogen late in the fall and early in the spring.
- The **soil health** rotation significantly reduced the amount of nitrogen fertilizer (by approximately 1/3 to 2/3, depending on the location) applied compared with the control rotation; however, the **soil health** rotation did not have a high nitrogen use efficiency because of its low yield.

FOR MORE INFORMATION

More information on how these crop rotations stack up in terms of yield and yield stability, precipitation use efficiency and net returns have been covered in separate factsheets as part of this series.

These results are based on the first four years of the study. More robust results are expected if a second four-year cycle of the study is completed.

This factsheet is part of a series by Resilient Rotations – a project of the Integrated Crop Agronomy Cluster – led by Kui Liu, AAFC Swift Current – the project examines the benefits and drawbacks of different crop rotation options for farmers across Western Canada.

To find out more visit

wgrf.ca/resilient-rotations-factsheet/