Nutrient Management Strategy Evaluation

VR Validation

The Olds College Centre for Innovation (OCCI) evaluated whether the current variable rate (VR) fertilization strategy at the Smart Farm provides agronomic and economic benefits compared to a fixed-rate fertilization program. This discussion has been ongoing for many years, seeking to uncover new insights that could justify the more informed use of variable rate in both environmental and economic terms.

The project focused on two production environments: Field 1516, an area that has long been managed using VR, and Delong East, an area recently converted from pasture to annual cropping. Management zones were defined using multi-year NDVI data, and side-by-side strip trials were used to compare variable rate and fixed-rate fertilization within each zone.

INTRODUCTION

Variable rate (VR) fertilization is a key precision agriculture practice that supports sustainable nutrient management by applying the right nutrient source at the right rate, time, and place (the 4Rs). Rather than treating every acre uniformly, VR uses spatial data (such as NDVI, yield, and field history) to target nutrients where crop response is expected to be greatest.

At the Olds College Smart Farm, this project was designed to validate whether existing management zones are robust enough to justify the continued use of VR and to quantify its practical return compared to a fixed-rate approach.

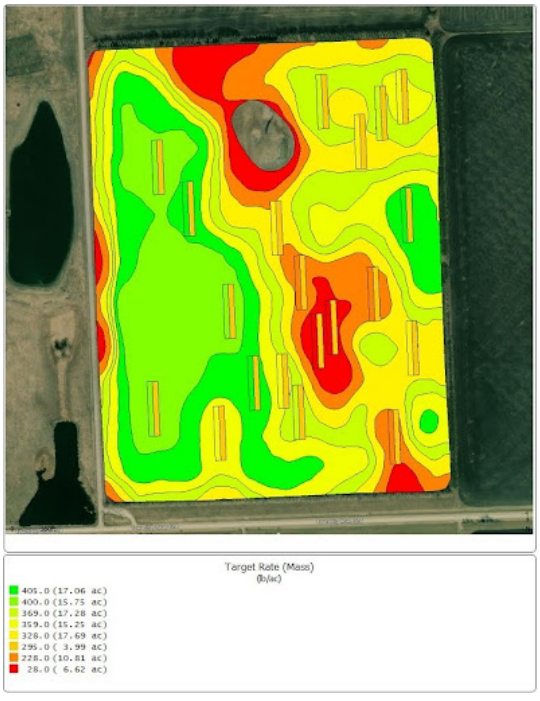
OBJECTIVES

The trials evaluate yield and financial implications of the current nutrient management strategy used on the Olds College Smart Farm. Additionally, a small case study compared the cost of fertilizer inputs in Field 1516 to determine how VR impacts producers financially.

STUDY DETAILS

Two fields were selected for the 2025 validation trial. Field 1516 had seven management zones originally developed in 2019, while Delong East had more recent zones derived from historical NDVI imagery following its transition from pasture to cropping in 2024. Within each field, treatment strips measuring 91.4 m × 11.9 m were placed within management zones using a paired split-plot experimental design, with a 15.2 m harvest buffer zone to reduce transition effects.

Two fertilization strategies were compared: (1) Variable Rate Fertilizer Application and (2) Fixed Rate (Control). Prescription files and guidance lines were developed in SMS and uploaded to equipment monitors. Field 1516 was seeded to wheat in early May 2025, and Delong East was seeded to canola in late May 2025. Both fields were harvested in fall 2025, and yield data were analyzed using linear mixed-effects models to account for treatment pairing and zone structure.



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SMART Farm

OLDS COLLEGE OF AGRICULTURE & TECHNOLOGY

RESULTS

Among the key findings from the 2025 season, the following stand out:

Field 1516: The VR treatment outperformed the fixed-rate treatment in zones 4, 5, 6 and 7, with gains of approximately 4.4 to 7.2 bushels per acre. In zone 2, the fixed-rate treatment performed better.

Field 1516: When treatment yields were projected across the entire field, VR would have produced 367.73 more bushels than the fixed rate and approximately $462.22 in additional total revenue, despite requiring 5,992.90 more pounds of fertilizer.

Delong East: VRF outperformed in most zones, with the strongest response observed in zone 2. Across the 62.87-acre field, VR was estimated to provide 223.22 more bushels and an additional $3,393.61 in profit.

Delong East: Implementing VR across the entire cropped area would have also reduced fertilizer use by 1,085.64 pounds compared to the fixed rate.

Field 1516 Yield

Zone ID	Acres	Variable Rate Average Yield (bu/ac)	Control Average Yield (bu/ac)	Variable Rate Average Yield (bu) Applied to entire field	Control Average Yield (bu) Applied to entire field
2	11.86	79.32	84.53	940.79	1,002.58
3	19.28	82.82	79.61	1,596.67	1,534.88
4	18.39	93.02	88.81	1,710.55	1,633.28
5	16.33	88.63	81.47	1,447.36	1,330.46
6	18.38	95.96	90.47	1,763.65	1,662.87
7	16.73	97.81	93.46	1,636.32	1,563.55
Total				9,095.35	8,727.61

Field 1516 Gross Margins

Zone ID	Acres	Variable Rate Average Gross Margins ($/ac)	Control Average Gross Margins ($/ac)	Variable Rate Gross Margins Applied to entire field ($)	Control Gross Margins Applied to entire field ($)
2	11.86	$485.87	$499.50	$5,762.38	5,924.07
3	19.28	$474.29	$463.09	9,144.31	8,928.28
4	18.39	$538.34	$531.18	9,899.98	9,768.31
5	16.33	$502.06	$476.71	8,198.69	7,784.67
6	18.38	$542.73	$543.55	9,975.38	9,990.45
7	16.73	$558.27	$565.61	9,339.91	9,462.66
Total				52,320.66	51,858.44

Field Delong East Yield

Zone ID	Acres	Variable Rate Average Yield (bu/ac)	Control Average Yield (bu/ac)	Variable Rate Average Yield (bu) Applied to entire field	Control Average Yield (bu) Applied to entire field
2	6.31	$41.37	$31.27	$261.04	197.32
3	14.35	$44.41	$47.11	637.27	675.96
4	23.49	$52.76	$47.82	1,239.31	1,123.34
5	18.14	$53.77	$49.24	975.37	893.13

Field Delong East Yield

Zone ID	Acres	Variable Rate Average Gross Margins ($/ac)	Control Average Gross Margins ($/ac)	Variable Rate Gross Margins Applied to entire field ($)	Control Gross Margins Applied to entire field ($)
2	6.31	$457.53	$265.22	$2,886.98	1,673.54
3	14.35	$464.50	$483.32	6,665.58	6,935.64
4	23.49	$558.89	$494.55	13,128.33	11,616.90
5	18.14	$563.46	$511.71	10,221.16	9,282.36

NEXT STEPS/FUTURE RESEARCH

The 2025 results support the value of VR fertilization but also demonstrate that performance depends on accurate zone delineation, reliable application data and robust equipment calibration. Future studies should repeat these comparisons across different years, weather conditions and crop types to determine the stability of responses over time. Additional research using the same format and conducted in the same fields could provide long-term answers to this question. The possibility of rotating fields and crops across different years could also offer a broader understanding of responses and variable interactions.