IRRIGATED AND RAINFED FIELD TRIALS TO EVALUATE THE LEGACY IMPACTS OF SOYBEAN AND PEA:

First Year Wheat Yields (2025) and Response to Nitrogen Fertilizer

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Background

- Agronomists, growers and extension specialists in Manitoba are interested in examining the legacy impacts that soybean and pea provide to crops that follow these nitrogen fixing grain legumes in the crop rotation.
- Furthermore, with increased pressure for growers to be efficient with applications of synthetic nitrogen fertilizer, alongside reported gains in the yield potential and acreage of modern pea and soybean varieties, there are several merits to further characterize soil nitrogen dynamics and the performance of crops that follow soybean or pea in rotation.
- In the preceding 2024 growing season rainfed and irrigated small plot field trial sites were established at locations near Warren, MB and Carberry, MB to generate a stepwise gradient in the yield potential of multiple pea and soybean varieties.
- For the current growing season (2025) three wheat varieties (Faller, Hockley, Starbuck) were grown at the same locations in Warren and Carberry without any additional fertilizer applied, with separate wheat plots (Starbuck only) receiving incremental additions of fertilizer up to 150 lbs N/acre.
- The objective of this study seeks to characterize the relationship between soybean and pea yields, residual soil nitrogen (N) levels, and the fertilizer replacement value (FRV) of legume residues towards wheat and canola crops that follow pea or soybean in rotation.

Methods

- In the spring of 2025 at two locations in Manitoba (Warren, Carberry) with irrigation capabilities paired rainfed and irrigated small plot field studies were established on sites sown to soybean or pea in 2024 (See Figure 1, Figure 2).
- Each rainfed or irrigated “sub-trial” encompassed a replicated and randomized variety block accommodating three (3) commercial wheat varieties . (n = 8 per variety, n = 24 per crop type, Starbuck/Faller/Hockley) sown into pea or soybean residue. No supplemental nitrogen fertilizer was added to variety blocks.
- Adjacent to each replicated variety block (NO fertilizer added), a replicated fertilizer replacement value (FRV) block was planted to Starbuck wheat, and received incremental rates (0, 25, 50, 100, 150 lbs N/acre) of nitrogen broadcasted as urea.
- During the growing season wheat variety blocks, reference crop strips and only select plots (150 lbs N/acre) in the FRV block were submitted for paired soil (0-6”, 6-24”) and tissue testing at flag leaf emergence.
- Beyond irrigation scheduling, intensively managed ***irrigated*** variety and FRV blocks received supplemental PKS fertility and fungicide applications to maximize yield potential.

TABLE 1. SUMMARY OF FIELD SITE OPERATIONS, PRECIPITATION AND SOIL PROPERTIES AT WARREN AND CARBERRY IN 2025

YEAR	SEEDING DATE	HARVEST DATE(S)	Precipitation (rain)	Historical Mean	Irrigation (+ added)	GDD	CHU	pH	O.M.	SAND	SILT	CLAY
										----------%	----------	
2025 WARREN	May 14, 2025	September 17, 2025	221 mm	341 mm	215 mm	1824	2929	7.8	7.6	27	38	35
2025 CARBERRY	May 23, 2025	September 22, 2025	231 mm	307 mm	254 mm	1629	2617	6.3	2.6	75	14	11

Precipitation, Growing Degree Day (GDD), Crop Heat Unit (CHU) and Historical Mean sourced via MAFRD Ag-Weather Program.
May 01, 2025 to Sept 30, 2025. Woodlands and Carberry Stations

Figure 1. Aerial and ground images of establishment phase (Year 1) of rainfed and irrigated pea and soybean plots at Carberry, MB and Warren, MB field sites. Variety blocks sown to one of three commercial pea varieties (Inca, AC Carver, CDC Lewochko) or soybean varieties (S007-Y4, Akras R2, BY Hector XT) would be transitioned to corresponding wheat varieties (Starbuck, Faller, Hockley) in 2025 (See Figure 2). Fertilizer replacement value (FRV) plots were also sown adjacent variety blocks using AC Carver and Akras R2 as chosen varieties.

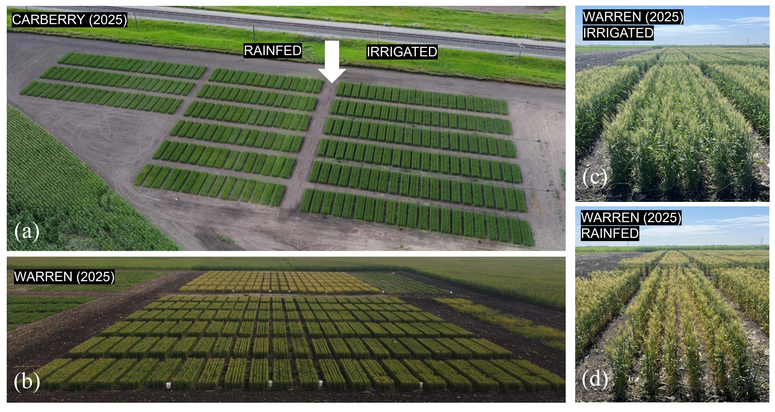

Figure 2. Aerial and ground images of wheat varieties sown in 2025 upon soybean or pea residue at study sites at Warren, MB and Carberry, MB (a) Carberry field site showing visible differences (irrigation right of arrow, rainfed left of arrow) due to irrigation treatments. (b) Warren site displaying differences in maturity due to irrigation (foreground) or rainfed (background) treatments. (c,d) Contrast in maturity and canopy closure of Starbuck wheat in FRV plots receiving no supplemental nitrogen fertilizer.

Season 2: Rainfed & Irrigated Wheat Yields Variety Blocks

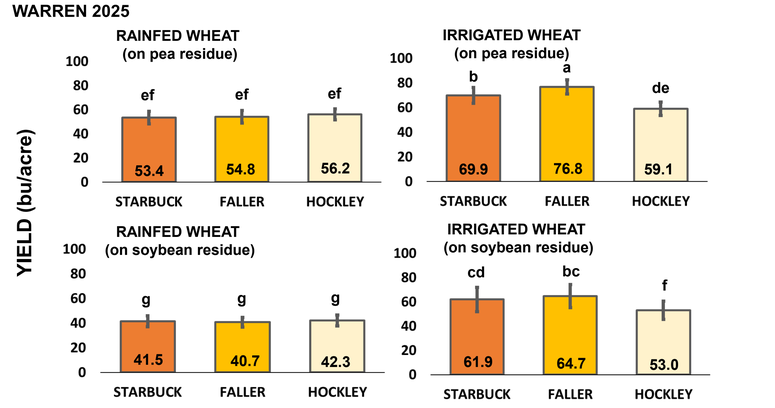

Figure 3. Crop yields (bu/ac) for rainfed and irrigated wheat variety blocks at Warren in 2025. No supplemental nitrogen fertilizer applied. Within location, crop type and past residue treatment (rainfed + irrigated combined) varieties with different letters differ according to LSD (0.05) = 5.4 bu/ac.

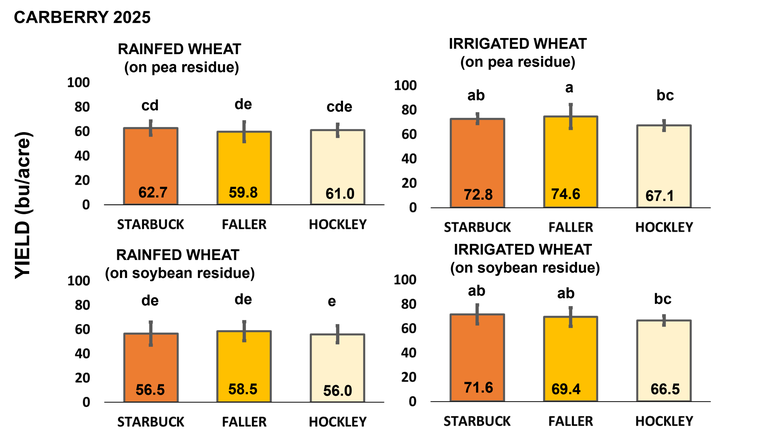

Figure 4. Crop yields (bu/ac) for rainfed and irrigated wheat variety blocks at Carberry in 2025. No supplemental nitrogen fertilizer applied. Within location, crop type and past residue treatment (rainfed and irrigated combined) varieties with different letters differ according to LSD (0.05) = 6.8 bu/ac

Season 2: Rainfed & Irrigated Wheat Yields Fertilizer Replacement Value (FRV) Blocks

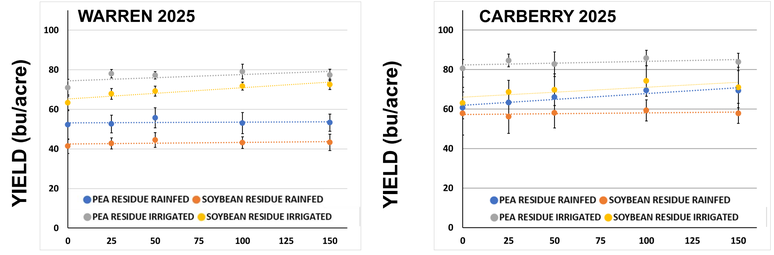

Figure 5. Yields of CWRS wheat (cv. Starbuck) at varying rates of nitrogen fertilizer within fertilizer replacement value (FRV) blocks at Warren and Carberry field trial locations given similar underlying legume residue and irrigation treatments applied to variety blocks receiving no supplemental nitrogen.

Season 2: In-Season Soil Nitrogen

TABLE 2. SOIL NITROGEN VALUES (IN-SEASON FLAG LEAF) FROM IRRIGATED AND RAINFED WHEAT BLOCKS GROWN ON PEA OR SOYBEAN RESIDUE - WARREN, MB

	WHEAT (ON PEA RESIDUE)						WHEAT (ON SOYBEAN RESIDUE)					
	RAINFED			IRRIGATED			RAINFED			IRRIGATED		
	(lbs N /ac)			(lbs N /ac)			(lbs N /ac)			(lbs N /ac)		
Soil Sample Depth	NO_3^--N	NH_4^+-N	TOTAL N	NO_3^--N	NH_4^+-N	TOTAL N	NO_3^--N	NH_4^+-N	TOTAL N	NO_3^--N	NH_4^+-N	TOTAL N
0-6"	16	4	20	34	2	36	14	3	17	15	2	17
6-24"	68	10	78	56	9	65	42	10	52	22	6	28
TOTAL (0-24")	84a	14a	98a	90a	11ab	101a	56b	13a	69b	37c	8b	45c

In season soil sampling Warren site. Composite soil samples (n=3) for each pea or soybean variety. n=9 per crop x residue system. Total depth (0-24") LSD (0.05) for NO_3^--N, NH_4^+-N, and Total N of 18.7, 3.6 and 19.0 lbs N/acre, respectively.

TABLE 3. SOIL NITROGEN VALUES (IN-SEASON FLAG LEAF) FROM IRRIGATED AND RAINFED WHEAT BLOCKS GROWN ON PEA OR SOYBEAN RESIDUE - CARBERRY, MB

	WHEAT (ON PEA RESIDUE)						WHEAT (ON SOYBEAN RESIDUE)					
	RAINFED			IRRIGATED			RAINFED			IRRIGATED		
	(lbs N /ac)			(lbs N /ac)			(lbs N /ac)			(lbs N /ac)		
Soil Sample Depth	NO_3^--N	NH_4^+-N	TOTAL N	NO_3^--N	NH_4^+-N	TOTAL N	NO_3^--N	NH_4^+-N	TOTAL N	NO_3^--N	NH_4^+-N	TOTAL N
0-6"	7	1	8	8	1	9	12	1	13	9	1	10
6-24"	21	6	27	8	3	11	24	4	28	8	6	14
TOTAL (0-24")	28ab	7a	35a	16b	4a	20a	36a	5a	41a	17b	7a	24a

In season soil sampling Carberry site. Composite soil samples (n=3) for each pea or soybean variety. n=9 per crop x residue system. Total depth (0-24") LSD (0.05) for NO_3^--N, NH_4^+-N, and Total N of 15.7, 5.4 and 11.9 lbs N/acre, respectively.

Highlights and Future Steps

- The 2025 growing season for wheat (May-Sept) was moisture limited at both field sites with respect to rainfed yields and historical precipitation patterns **(Table 1).** As a consequence, with irrigation treatments, the yield of both unfertilized wheat variety blocks and FRV plots was significantly greater than corresponding rainfed subtrials (**see Figure 3; Figure 4**).
- Fertilizer replacement value (FRV) plots demonstrated Starbuck wheat was responsive to supplemental nitrogen fertilizer. However, positive response(s) were more apparent for irrigated subtrials, or rainfed subtrials where soil test N levels (e.g. soybean residue) were low relative to wheat growing on pea residue.
- In season soil testing (2025) at the Warren location revealed significantly higher nitrate (NO_3^--N) and total soil N levels (NO_3^--N, NH_4^+-N) when wheat was grown on pea residue **(Table 2)** compared to soybean residue. Similar patterns were observed from fall soil sampling in 2024.
- Several facets of the current study indicate that crop water usage patterns, higher residual soil water contents following peas (or even irrigation treatments) may be altering soil nitrogen dynamics or potentially contribute to rotational effects unrelated to nitrogen credits.
- For the 2026 season variety blocks and fertilizer replacement value (FRV) plots at both locations will be sown to canola and managed under comparable irrigated and rainfed systems. Plots will be taken harvest and monitored for changes in soil nitrogen levels.

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