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DIGGING INTO RESEARCH

Diversified cropping systems with pulses had high, stable yields

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A long term rotation study at Swift Current, Saskatchewan found that a diversified crop rotation with wheat-canola-wheat-pulse produced more grain and protein yield than traditional cereal or fallow systems. The rotation was more stable over the years, and had high nitrogen use efficiency (NUE).

To meet the growing world population, cropping systems in the future will not only have to be more productive, but also have yield stability and use resources efficiently. On the semi-arid Prairies of western Canada, cropping systems are moving from a wheat-fallow rotation, to longer rotations that may include pulse crops.

A long term research study was initiated at Agriculture and Agri-Food Canada Swift Current in 1987 to look at crop rotation diversity. The objective of this study was to examine the effect of summer fallow frequency, summer fallow replacement with annual green manure (GM), cereal monoculture, and diversified cropping with cereals, oilseeds, and pulses on total grain and protein yield, stability, adaptability, and NUE over a 12 year period.

Nine crop rotations were initially established, but two were dropped in 2003. This research study focused on five crop rotations in place since 2003. These include fallow-wheat-wheat (F-W-W), lentil green manure-wheat-wheat (GM-W-W), fallow-wheat-wheat-wheat (F-W-W-W), continuous wheat (ContW) and wheat-canola-wheat-field pea (W-C-W-P). Wheat grown was a Canada Western Hard Red Spring wheat. Each crop rotation phase was present each year.

The plots were managed using zero-tillage practices. Green manure was incorporated with a V-blade cultivator or a tandem disc plow at full bloom from 1987 to 1992. Afterwards it was done at the preferred termination timing around 20% flowering in early- to mid-July.

Plots were managed with normal agronomic practices.

Nitrogen fertilizer (urea, 46–0–0) was mid-row banded at seeding to non-pulse plots based on soil test recommendations. For wheat on fallow, total N (soil plus fertilizer) was 80 lbs/ac (90 kg/ha), and was (65 lbs/ac (73 kg/ha) for wheat on stubble, and 90 lbs/ac (101 kg N/ha) for canola. A "N credit" of 20% of the N in above-ground legume biomass was applied to soil test values for wheat on green manure.

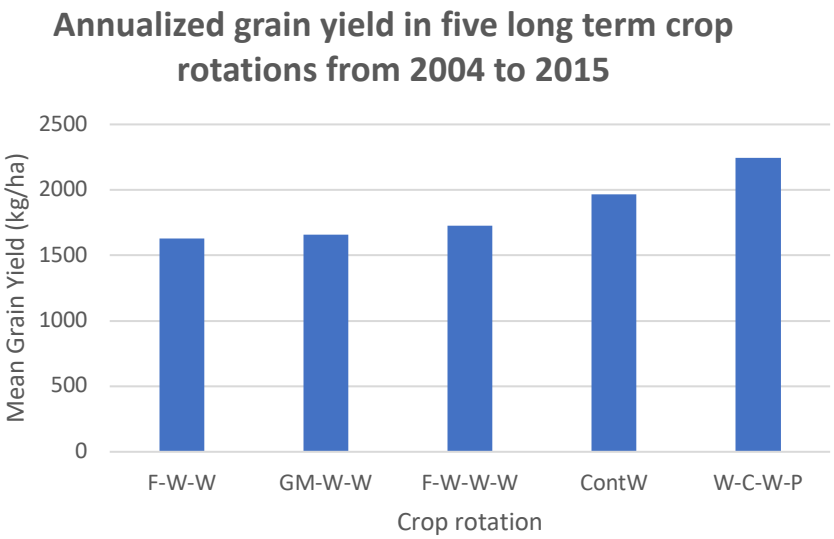
Wheat, canola, and field pea also received 20 lbs/ac (22 kg P_2O_5/ha) at seeding in the form of monoammonium phosphate. Canola also received sulfur at an average rate of 14 lbs/ac (16.1 kg SO_4/ha).

This study used a fertilizer strategy that was based on crop needs and residual nutrients. While it takes more management, the strategy is consistent with farmer approaches to fertilization, and differs from other research where fertilizer is applied at a fixed rate regardless of residual nutrients.

The stubble of all crops was cut to a height of about 30 cm to enhance snow trapping and soil moisture conservation.

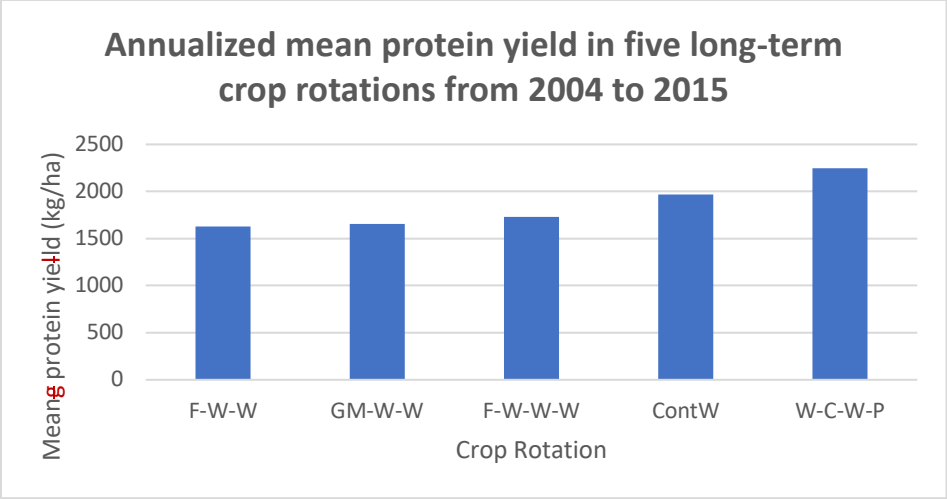
Diversified rotations were higher yielding

Annualized grain yield for the W-C-W-P rotation was highest at 2000 lbs/ac (2244 kg/ha), which was 14% to 38% higher than ContW, F-W-W-W, F-W-W, and GM-W-W.



Source: St. Luce et al. 2020

Similarly, grain protein yield was 331 lbs/ac (372 kg/ha) in the W-C-W-P rotation, and was 33% to 66% higher than the other rotations.



Source: St. Luce et al. 2020

The most stable systems included fallow in the rotation, but were least productive overall. Fallow-based systems were best adapted to low-yielding conditions, particularly in years of low rainfall.

The most diverse system of W-C-W-P consistently produced above-average yields at Swift Current, and performed best in years of higher moisture conditions. The ContW had below-average stability, while the GM-W-W was the least stable and poorly adapted.

Looking at NUE, ContW had the highest efficiency for grain yield, followed by W-C-W-P, while W-C-W-P had the highest NUE for protein yield.

In summary, the diversified crop rotation with pulses in rotation consistently produced high grain and protein yield with high N use efficiency. This rotation can help to minimize potential negative environmental impacts associated with N fertilizer use.

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St. Luce M, Lemke R, Gan Y, et al. Diversifying cropping systems enhances productivity, stability and nitrogen use efficiency. *Agronomy Journal.* 2020;112:1517–1536. https://doi.org/10.1002/agj2.20162

Photo courtesy Mervin St. Luce