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Diversifying crop rotation boosts system's productivity by 35%

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Introduction

In many rainfed areas, summerfallowing practices are used to conserve rainwater and promote the release of N through the mineralization of soil organic matter. However, summerfallowing leaves land without any crops planted for one entire growing season. Also, summerfallowing carries significant, negative impacts on the environment. Producers in the northern Great Plains of North America have been using diversified cropping systems (**Fig. 1**) to retain the beneficial features of summerfallowing. However, quantitative data are lacking in terms of how a pulse-based diverse cropping system may enhance soil water conservation, improve soil N availability, and increase systems' productivity compared to traditional cereal-based monoculture.

Fig. 1 Cereal-pulse-oilseed diversified cropping systems, Swift Current, Saskatchewan, Canada

Materials & Methods

A 3-yr cropping sequence study was conducted in southwestern Saskatchewan in which various rotational sequences were evaluated for five cycles between 2005 and 2011. In the 3-yr cropping sequences, spring wheat (*Triticum aestivum* L.) was grown in Year-1, followed by various pulses, a cereal [spring wheat or barley (*Hordeum vulgare*)], and a summerfallow control in Year-2. In Year-3, durum wheat (*Triticum turgidum subsp. durum*) was planted on the different stubble generated from the Year-2 crops and on the summerfallow.

Results & Discussion

- Total amount of water in the depth of 1.2 m at planting varied largely from year to year and is a reflection of the quantity of water remaining at the harvest of the previous crops and the postharvest water recharge to the soil profile (data not shown).
- Pulse- and summerfallow-based systems enhanced soil N availability compared with other systems by enhancing the soil N distributions across the rooting zones (**Fig. 2**).

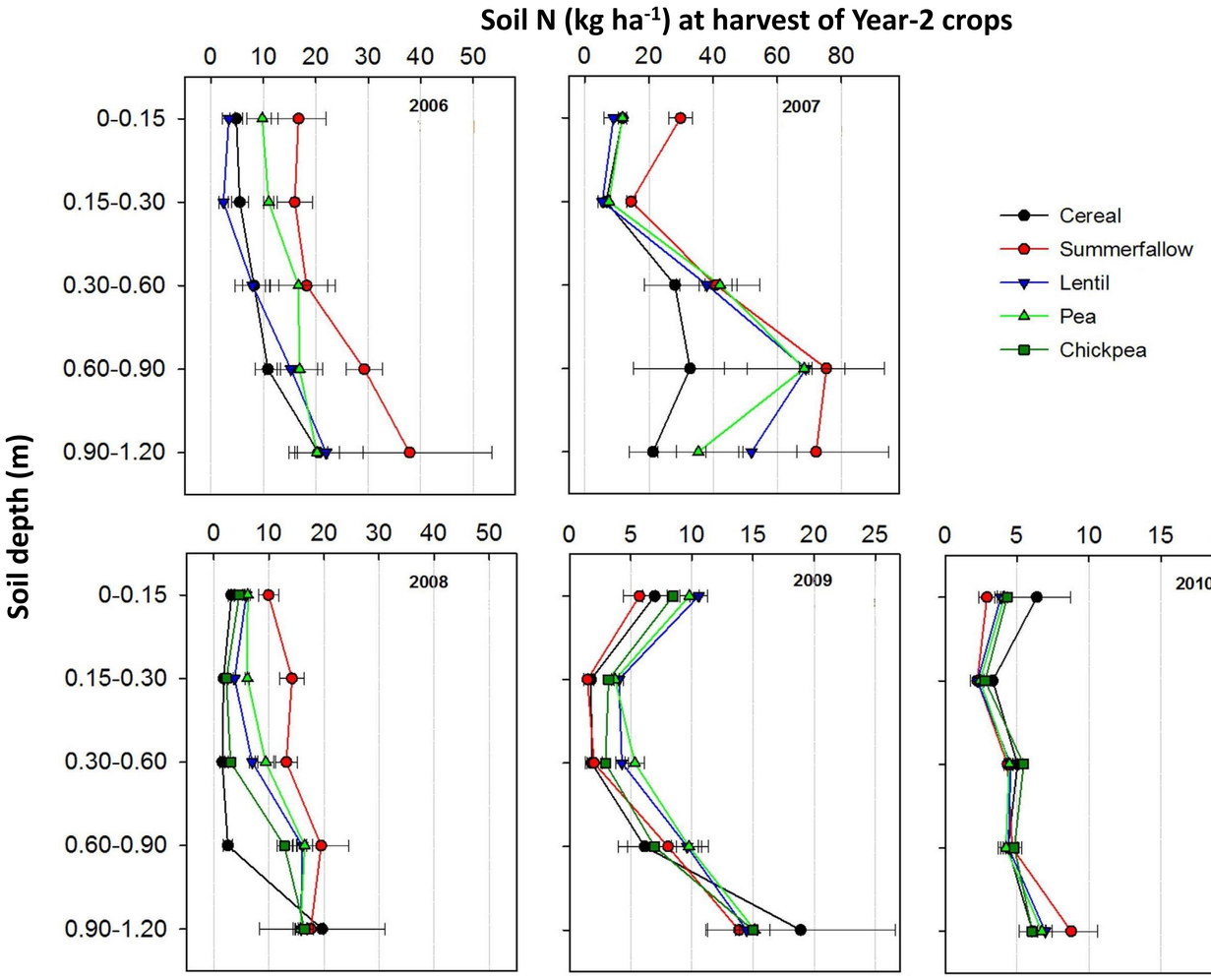

Fig. 2 Soil N distribution across the 0-1.2 m depth under different cropping systems

- Averaged across the five cycles of the 3-yr crop sequences, the pulse system increased total grain production by 35.5%, improved protein yield by 50.9%, and enhanced fertilizer-N use efficiency by 33.0% compared with summerfallowing system (**Table 1**).

Table 1 Productivity and N use efficiency (NUE) of different cropping systems under dry and normal to wet conditions

Cropping system	Grain	Protein	N applied	NUE (kg ha^{-1} of N)	
	kg ha^{-1}			Grain	Protein
Dry					
wheat-fallow-durum	4312.9	624.2	59.7	74.9	10.8
wheat-pulse-durum	5895.9	1004.9	58.2	102.4	17.5
wheat-cereal-durum	5561.2	664.4	116.3	51.5	6.1
Normal to wet					
wheat-fallow-durum	4720.4	654.3	64.9	74.8	10.3
wheat-pulse-durum	6341.2	921.0	66.8	96.7	14.0
wheat-cereal-durum	6302.7	709.4	122.4	51.8	5.9

Conclusions

Diversifying cropping systems with pulses improved soil water use, crop production and fertilizer N use efficiency compared to cereal monoculture. Both pulse- and summerfallow-based systems enhanced soil N availability, but the pulse systems did so through biological N-fixation, whereas the summerfallow system did so through 'mining' soil N by depleting soil organic matter.

Key references

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