Economic Assessment of Pulse Crop Rotations in Western Canada

M. Khakbazan[1], Y. Gan[2], M. Bandara[3], J. Huang[1]

[1]AAFC-Brandon; [2]AAFC-Swift Current; [3]Alberta Agric. & Forest

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Research background

- Pulse crops have become essential to farming practices in the Northern Great Plains, but less known about how rotation systems with different crop mixes affect the economic returns.
- One of the most prominent benefits of pulses is its potential to reduce the use of crop inputs such as fertilizer, pesticide, and irrigation water when included in a crop rotation.
- Pulses are also valuable to crop rotations in that they serve as a disease break.

Research background

- Furthermore, several measures of soil quality can be improved using pulses in a crop rotation. Diversifying cropping systems by introducing pulse crops has been found to improve soil water use and soil nitrogen availability (Gan et al. 2015).
- For new cropping systems including pulse crops to have long-term sustainability, they must be economically efficient in addition to being agronomically feasible and ensuring high soil, water, and air quality (Zentner et al. 2002).

Objectives

- The objectives of this large, multi-location study are to evaluate the effects of rotating a cereal crop with a range of pulse crops at different frequencies and sequences on the annual economic returns of both the entire rotation and individual crop production in western Canada.

Experimental Design

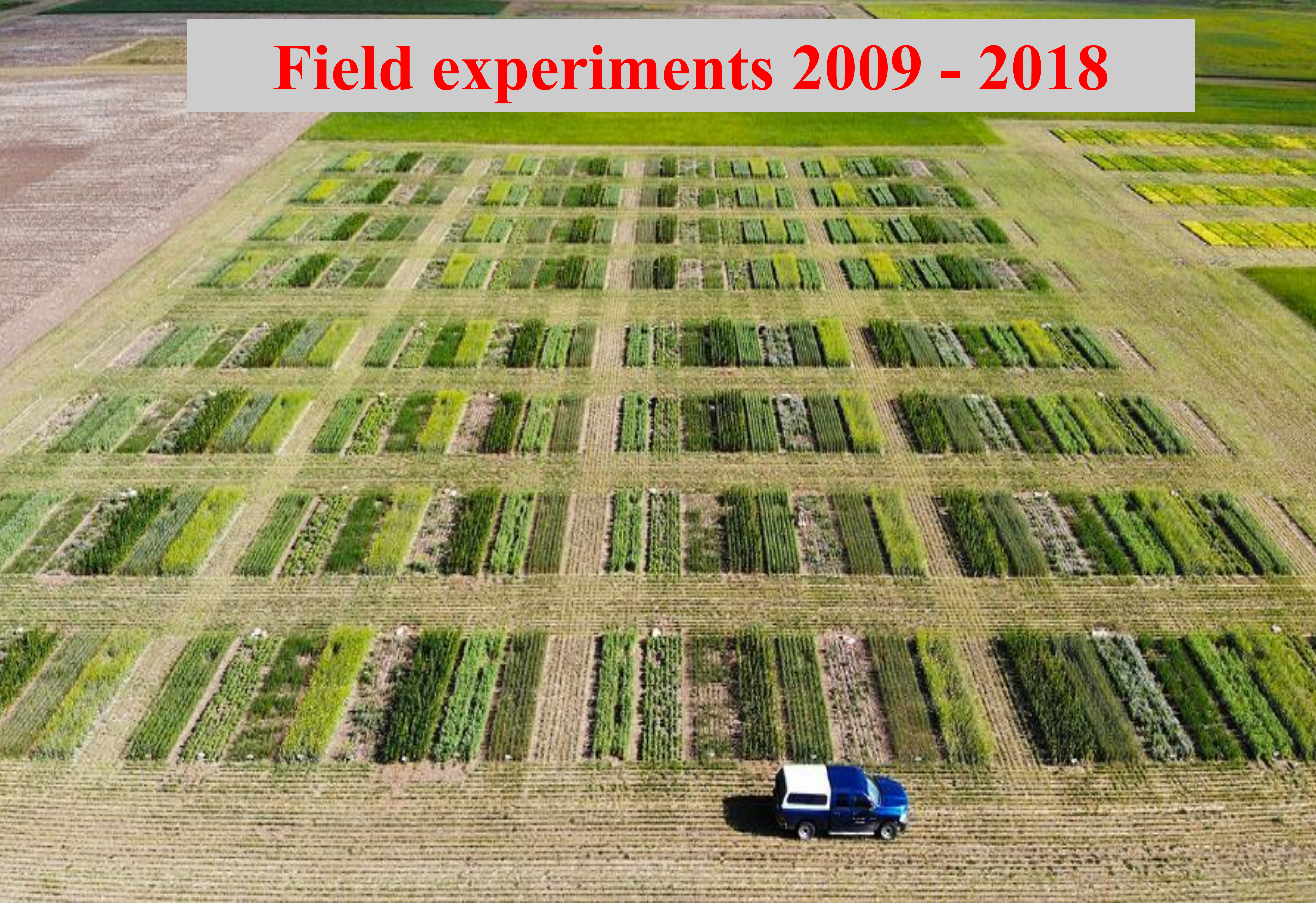
A four-year cycle crop rotation study (cereal crop with a range of pulse and oilseed at different frequency and sequence in rotation) was established at the first site of Swift Current (Swift1), Saskatchewan in 2010 as well as the second site at the Swift Current (Swift2) in 2011. The third site was established in 2011 at the Crop Diversification Centre South in Brooks, Alberta.

Crop rotation and pulse crop frequency in rotation at Swift1, Swift2 and Brooks

Crop rotation[a]	Crop sequence				# of pulse phase	# of oilseed phase
	Year 1	Year 2	Year 3	Year 4		
1: W-W-W-W	wheat	wheat	wheat	wheat	0	0
2: P-W-W-W	field pea	wheat	wheat	wheat	1	0
3: C-W-W-W	chickpea	wheat	wheat	wheat	1	0
4: P-W-P-W	field pea	wheat	field pea	wheat	2	0
5: P-W-L-W	field pea	wheat	lentil	wheat	2	0
6: L-W-C-W	lentil	wheat	chickpea	wheat	2	0
7: L-W-L-W	lentil	wheat	lentil	wheat	2	0
8: C-W-C-W	chickpea	wheat	chickpea	wheat	2	0
9: P-M-C-W	field pea	mustard	chickpea	wheat	2	1
10: P-M-L-W	field pea	mustard	lentil	wheat	2	1
11: P-P-P-W	field pea	field pea	field pea	wheat	3	0
12: L-L-L-W	lentil	lentil	lentil	wheat	3	0
13: C-C-C-W	chickpea	chickpea	chickpea	wheat	3	0
14: L-C-P-W	lentil	chickpea	field pea	wheat	3	0

[a]W=wheat, C=chickpea, P=pea, L=lentil and M=mustard.

Field experiments 2009 - 2018



Field plots in Swift Current, 2018

Crop seed and fertilizer application rates

Product	Swift1	Swift2	Brooks
	---------------- Kg ha^{-1}	-------------	
Seed			
Wheat (AC Lillian)	78	84	65
Durum wheat (Brigade)	150	149	200
Chickpea (CDC Frontier)	207	243	200
Field pea (CDC Meadow)	200	204	162
Lentil (CDC Maxim CL)	56	56	56
Mustard (Cutlass)	6	6	6
Fertilizer			
yr1 N for wheat plots	80	80	80
yr1 N for non-wheat (pules) plots	0	0	0
yr1 P_2O_5 all plots	17	17	17
yr2-yr4 N for wheat plots	55	55	50
yr2-yr4 N for non-wheat (pules) plots	0	0	0
yr2-yr4 P_2O_5 all plots	22	22	20

Methodology

- A combination of budgeting techniques and economic modelling based on returns and risk of returns trade-offs, and life cycle assessment (LCA) was used to determine the economic and input use efficiency of crop rotations.
- Annual net revenue (NR) was calculated for each crop and crop rotation by subtracting production and input expenses from gross income as described by Zentner et al. (2002) and Khakbazan et al. (2014).

Methodology

- Average 8 years (2010-2017) input and crop prices was used to calculate NR.
- Sensitivity analysis was also conducted where average of 17 years (2001-2017) of crop prices was used.
- Input and crop price distributions were used in Risk analysis but the results are not presented here.

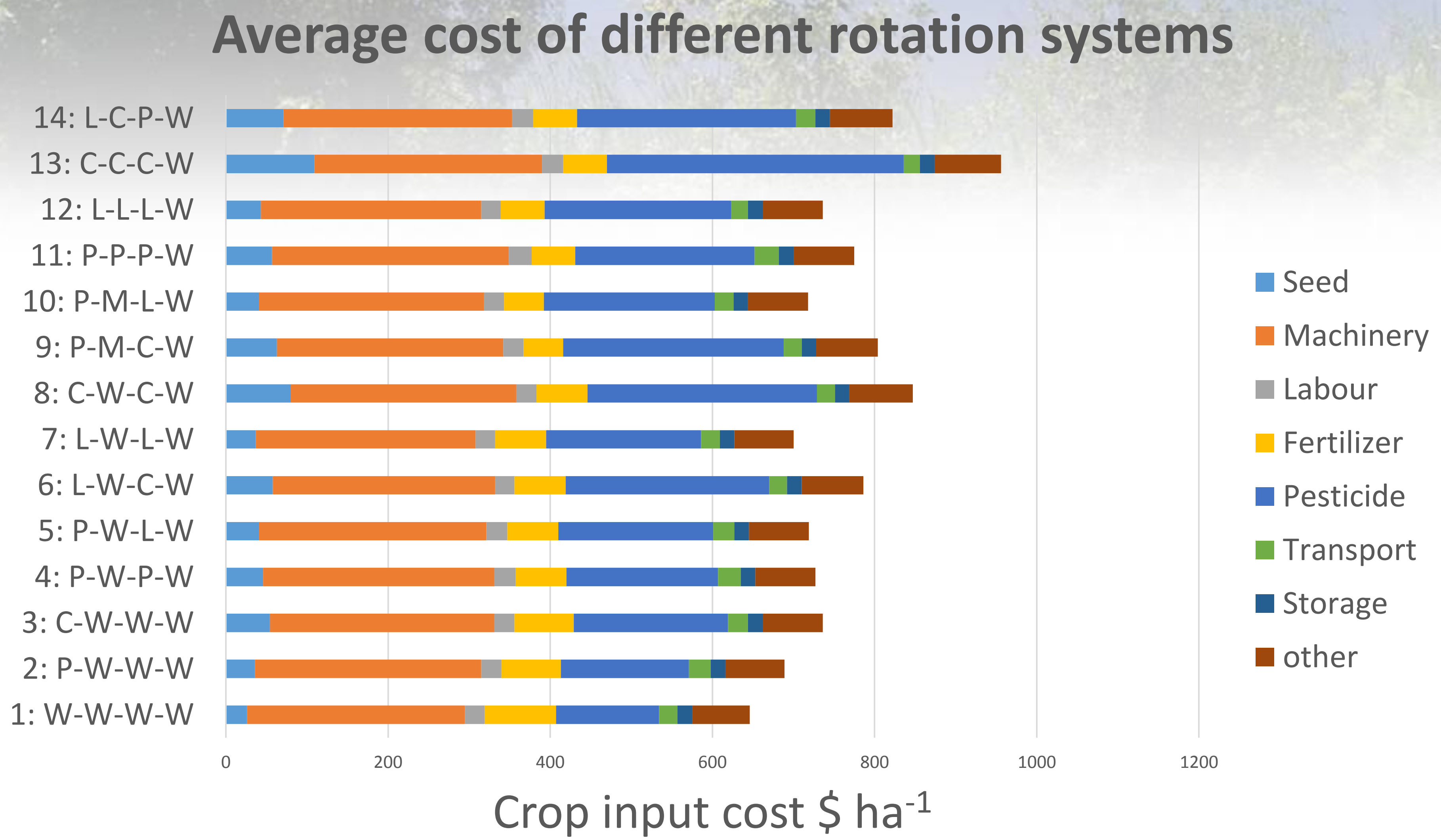
Unit price for crops

Year	Seed price ($ Kg^{-1})						Fertilizer price ($ Kg^{-1})	
	Spring wheat	Durum wheat	Pea	Lentil	Chick-pea	Mustard	N	P_2O_5
Mean	0.347	0.411	0.369	0.842	0.657	4.252	1.147	1.068
SD	0.086	0.103	0.085	0.230	0.164	2.150	0.197	0.175

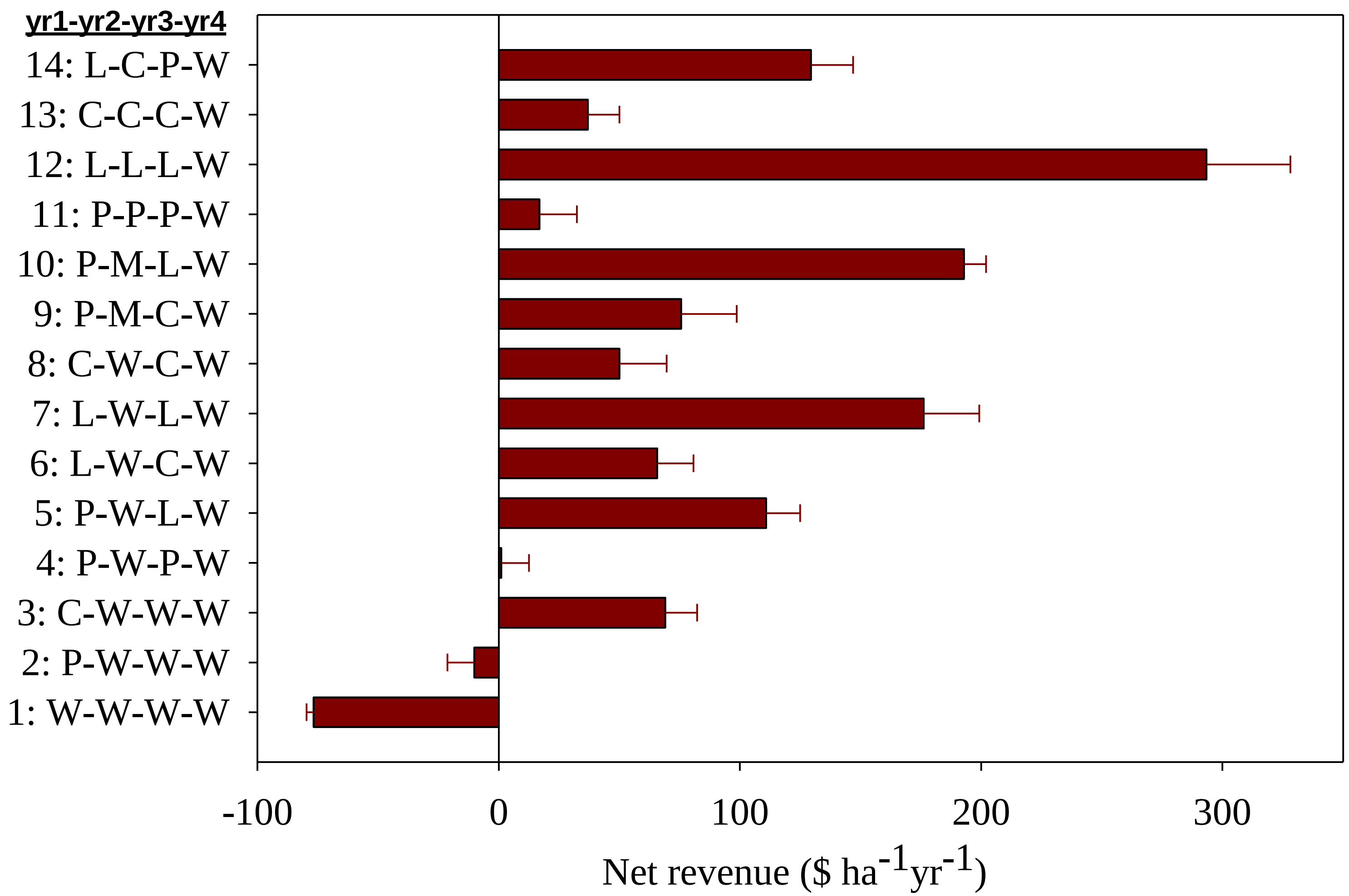
	Crop on-farm market price($ Kg^{-1})					
	Spring wheat	Durum wheat	Pea	Lentil	Chick-pea	Mustard
Mean ± SD (2001-2017)						
	0.196 ± 0.04	0.208 ± 0.05	0.210 ± 0.06	0.458 ± 0.13	0.489 ± 0.12	0.507 ± 0.16
Mean ± SD (2010-2017)						
	0.223 ± 0.03	0.236 ± 0.03	0.251 ± 0.05	0.546 ± 0.12	0.543 ± 0.13	0.612 ± 0.10

Note: Prices for crops were adopted from crop planning Guild published at http://www.publications.gov.sk.ca/details.cfm?p=83871

Average cost of different rotation systems

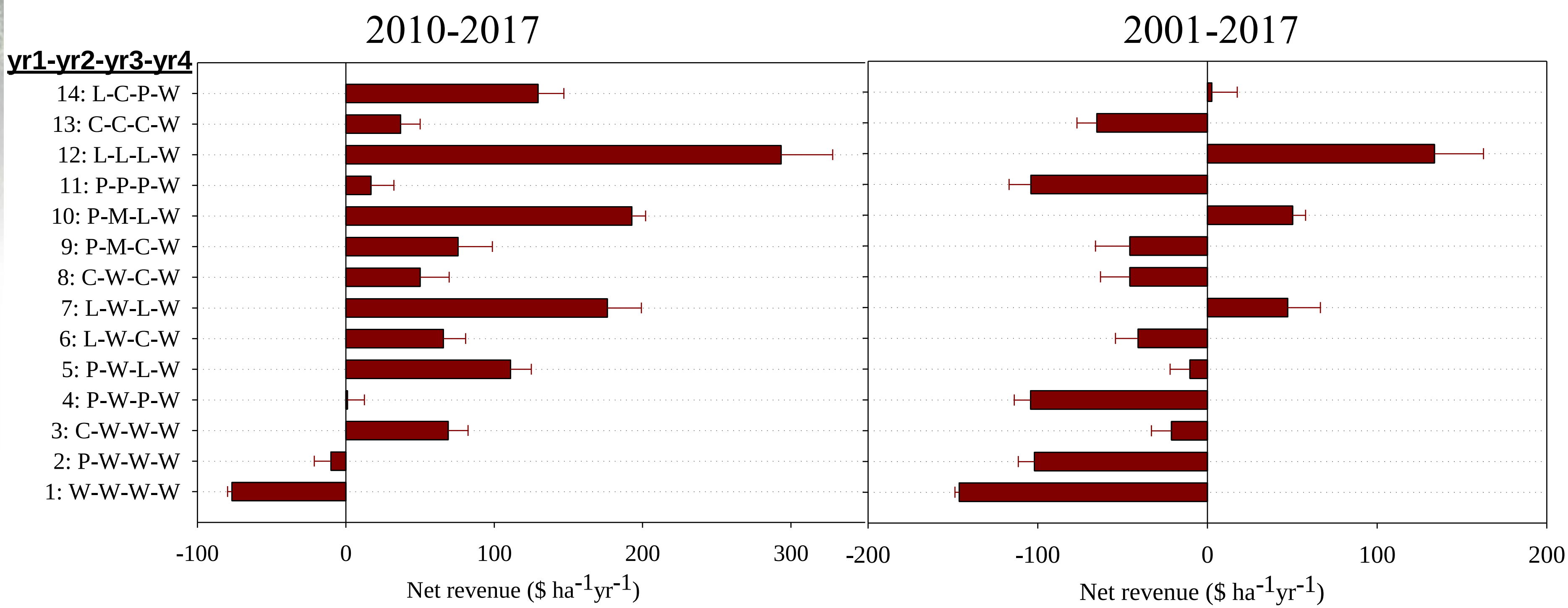


Average net revenue ($ ha^{-1} yr^{-1}) of crop rotations with 8 years average prices (2010-2017)



Note: W=wheat, C=chickpea, P=pea, L=lentil and M=mustard.

Average net revenue ($ ha^{-1} yr^{-1}) of crop rotations with 8 and 18 years average prices (2010-2017, left and 2001-2017, right)



Note: W=wheat, C=chickpea, P=pea, L=lentil and M=mustard.

Research conclusions

- Wheat monoculture generated the worst farm net revenues
- Peas did not do so well when rotated with wheat
- More frequencies of chickpeas in wheat rotations resulted lower net revenues.

Research conclusions

- Crop rotations with more frequencies of lentil provided higher net revenues compared to other rotations
- More diversified rotations including various pulse crops and mustard provided net revenues comparable to rotations with more frequencies of lentil
- Change in ranking of rotations among sites was negligible

Research funding

Growing Forward

SASKATCHEWAN pulse Growers

Saskatchewan GOVERNMENT OF SASKATCHEWAN

ALBERTA PULSE

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