

*Supplementary Material*

**Changes in soil phosphorus pools in long-term wheat-based rotations in  
Saskatchewan, Canada with and without phosphorus fertilization**

**Barbara J. Cade-Menun<sup>1</sup>**

<sup>1</sup>Agriculture & Agri-Food Canada, Swift Current Research and Development Centre, Swift Current,  
SK, Canada

**\* Correspondence:**

Barbara Cade-Menun

[barbara.cade-menun@agr.gc.ca](mailto:barbara.cade-menun@agr.gc.ca)

Figures: 1

Tables: 10

**Table S1:** Bulk densities(g cm<sup>-3</sup>) of plots for each rotation and treatment, determined in 2021. Values are means (std. err); n=9 for FWW, n=6 for FW and LW, and n=3 for CW.

Rotation	Treatment	0-7.5 cm	7-15 cm
FWW	+N+P	1.04 (0.018)	1.36 (0.014)
	-N+P	1.08 (0.032)	1.35 (0.027)
	No P	1.07 (0.026)	1.35 (0.017)
CW	+N+P	0.899 (0.034)	1.38 (0.071)
	-N+P	1.04 (0.033)	1.36 (0.033)
FW	+N+P	1.12 (0.038)	1.33 (0.029)
WL	+N+P	1.04 (0.009)	1.33 (0.018)

**Table S2:** ANOVA results ( $P < F$ ), for soil total phosphorus (P), organic P and Olsen (bicarbonate P), analyzed by Treatment (T), cumulative year (Y) and the T\*Y interaction. Treatments are fallow-wheat-wheat (FWW), continuous wheat (CW), fallow-wheat (FW) and wheat-lentil (WL). For WL, only wheat yields are shown. Values in bold are statistically significant ( $\alpha=0.05$ ).

Parameter	Depth (cm)	FWW			CW			FW			WL		
		T	Y	T*Y	T	Y	T*Y	T	Y	T*Y	T	Y	T*Y
Total P (mg kg <sup>-1</sup> )	0-7.5	<0.001	<0.001	0.794	<0.001	<0.001	0.389	<b>0.023</b>	<b>0.029</b>	0.955	<b>0.001</b>	<b>0.017</b>	0.932
	7.5-15	<0.001	<0.001	0.126	<b>0.001</b>	<0.001	0.058	0.206	0.243	0.721	0.113	0.117	0.741
Total P (kg ha <sup>-1</sup> )	0-15	<0.001	<0.001	0.413	<0.001	<0.001	0.105	<b>0.031</b>	0.796	0.939	<b>0.005</b>	<b>0.014</b>	0.790
Organic P (mg kg <sup>-1</sup> )	0-7.5	0.124	<0.001	0.317	<0.001	<b>0.002</b>	0.956	0.734	0.077	<b>0.039</b>	0.961	0.122	0.715
	7.5-15	0.406	<0.001	0.938	<b>0.001</b>	<b>0.007</b>	0.907	0.990	0.073	0.099	0.959	0.939	0.986
Organic P (kg ha <sup>-1</sup> )	0-15	0.281	<0.001	0.950	<b>0.027</b>	<b>0.002</b>	0.999	0.805	0.301	<b>0.040</b>	0.999	0.473	0.975
Organic P (% TP)	0-7.5	<0.001	<0.001	0.166	<0.001	<0.001	0.601	0.185	0.205	<b>0.018</b>	0.157	0.112	0.949
	7.5-15	0.198	<0.001	0.767	<0.001	<0.001	0.920	0.365	0.046	<b>0.038</b>	0.225	0.098	0.822
Olsen P (mg kg <sup>-1</sup> )	0-7.5	<0.001	<0.001	<b>0.013</b>	<0.001	<0.001	<0.001	<0.001	<0.001	0.238	<b>0.001</b>	0.111	0.265
	7.5-15	<0.001	<0.001	<b>0.022</b>	<0.001	<0.001	0.0517	0.094	<0.001	0.433	0.090	<0.001	0.539
Olsen P (kg ha <sup>-1</sup> )	0-15	<0.001	<0.001	0.064	<0.001	<0.001	<0.001	<0.001	<0.001	0.290	<0.001	<b>0.001</b>	0.189
Olsen P (% TP)	0-7.5	<0.001	<0.001	<b>0.001</b>	<0.001	<0.001	<0.001	<b>0.002</b>	<0.001	0.243	<0.001	<b>0.003</b>	0.328
	7.5-15	<0.001	<0.001	<b>0.001</b>	<0.001	<0.001	0.060	0.124	<0.001	0.420	0.140	<0.001	0.522
Total P Δ <sup>a</sup> (kg ha <sup>-1</sup> )	0-15	<b>0.027</b>	—	—	<b>0.026</b>	—	—	0.646	—	—	0.517	—	—
Organic P Δ <sup>a</sup> (kg ha <sup>-1</sup> )	0-15	0.415	—	—	0.871	—	—	0.461	—	—	0.980	—	—
Olsen P Δ <sup>a</sup> (kg ha <sup>-1</sup> )	0-15	<0.001	—	—	<0.001	—	—	0.105	—	—	<b>0.019</b>	—	—

<sup>a</sup> Net change, 2015 minus 1995 for FWW and CW; 2016 minus 2010 for FW and WL.

**Table S3:** Phosphorus (P) concentrations in various pools for the fallow-wheat-wheat FWW rotation, analyzed by year, for 1995-2015.

Values are means (std. err); n = 108 for 1997-2006, n = 144 for 2009, and n = 162 for 2012 and 2015.

P pool	Units	Depth (cm)	Cumulative Year					
			1997	2000	2003	2006	2009	2012
Total P	mg kg <sup>-1</sup>	0-7.5	560.8 a (5.43)	518.6 d (5.02)	520.8 cd (5.01)	542.3 abc (5.46)	553.2 ab (5.62)	538.9 bcd (4.56)
	mg kg <sup>-1</sup>	7.5-15	473.4 bcd (6.14)	441.4 e (5.92)	451.5 de (5.26)	466.4 cd (5.46)	478.6 abc (5.31)	489.5 ab (4.08)
	kg ha <sup>-1</sup>	0-15	927.3 a (8.11)	861.8 c (8.90)	873.8 bc (8.05)	905.2 ab (7.94)	929.1 a (9.25)	926.6 a (7.35)
Org. P	mg kg <sup>-1</sup>	0-7.5	276.2 cd (5.11)	303.4 ab (5.22)	290.8 bc (5.02)	297.8 b (3.73)	317.7 a (4.47)	276.6 cd (4.33)
	mg kg <sup>-1</sup>	7.5-15	251.8 b (5.81)	275.3 a (5.99)	280.8 a (5.82)	294.3 a (5.98)	289.4 a (4.87)	276.7 a (4.01)
	kg ha <sup>-1</sup>	0-15	475.9 c (8.38)	521.3 ab (8.63)	517.4 ab (7.26)	535.6 a (7.72)	548.2 a (7.64)	500.7 bc (6.39)
% TP	0-7.5		49.4 b (0.86)	58.7 a (0.93)	56.4 a (1.03)	55.5 ab (0.86)	57.7 a (0.75)	51.8 b (0.85)
	7.5-15		53.6 c (1.16)	62.6 a (1.12)	62.1 a (0.92)	63.4 a (1.20)	60.9 ab (0.99)	57.0 c (0.85)
Olsen P	kg ha <sup>-1</sup>	0-15	20.1 bc (0.79)	17.7 c (0.91)	16.7 c (0.98)	18.5 bc (1.23)	17.0 c (0.84)	22.4 ab (1.11)
								26.4 a (1.33)

**Table S4:** Phosphorus (P) concentrations in various pools for the continuous wheat (CW) rotations, analyzed in 3-year blocks, for 1995-2015. Values are means (std. err); n=36; different letters within each row indicate significantly different means ( $\alpha=0.05$ ).

P pool	Units	Depth (cm)	Cumulative Year					
			1997	2000	2003	2006	2009	2012
Total P	mg kg <sup>-1</sup>	0-7.5	594.4 ab (9.87)	558.3 b (7.84)	570.6 ab (7.24)	563.0 ab (9.91)	598.0 ab (12.1)	602.5 a (10.8)
	mg kg <sup>-1</sup>	7.5-15	484.5 abc (12.8)	450.6 c (8.85)	468.4 bc (8.97)	468.6 bc (8.59)	502.1 ab (12.7)	521.6 a (9.17)
	kg ha <sup>-1</sup>	0-15	929.8 abc (18.8)	870.3 c (15.4)	898.0 bc (12.7)	891.4 bc (14.1)	952.7 ab (22.1)	972.9 a (15.5)
Organic P	mg kg <sup>-1</sup>	0-7.5	290.8 b (9.77)	332.7 a (8.34)	302.5 ab (6.30)	307.0 ab (8.73)	318.3 ab (10.2)	291.6 b (10.8)
	mg kg <sup>-1</sup>	7.5-15	250.9 b (7.54)	288.7 a (7.79)	286.4 a (6.79)	276.6 ab (8.16)	291.6 a (7.79)	285.2 ab (9.93)
	kg ha <sup>-1</sup>	0-15	468.8 c (12.5)	537.1 a (11.0)	513.5 abc (8.71)	506.7 abc (13.1)	502.1 ab (12.7)	521.6 a (9.17)
% TP	0-7.5		49.2 b (1.75)	60.0 a (1.72)	53.3 ab (1.27)	55.4 ab (2.13)	53.6 ab (1.73)	48.7 b (1.88)
	7.5-15		53.1 c (2.19)	64.6 a (1.76)	61.5 ab (1.38)	59.3 abc (1.69)	58.9 abc (1.81)	54.9 abc (1.79)
Olsen P	mg kg <sup>-1</sup>	7.5-15	6.76 ab (0.54)	5.57 abc (0.73)	5.00 bc (0.83)	6.31 bc (1.27)	4.07 c (0.54)	8.82 ab (1.35)
	% TP	7.5-15	1.46 abc (0.13)	1.20 abc (0.14)	1.06 bc (0.16)	1.28 abc (0.24)	0.83 c (0.11)	1.64 ab (0.23)
								10.6 a (1.52)
								1.93 a (0.25)

**Table S5:** Soil phosphorus (P) concentrations in various pools for the fallow-wheat (FW) wheat-lentil (WL) rotation, analyzed by treatment and cumulative year, for 2008-2016. Values are means (std. err); n=24. For cumulative year, results were averaged over a two-year period, to cover both 1 phases for each plot.

Phosphorus pool	Depth cm)	Cumulative Year			
		2010	2012	2014	2016
<b>FW Total P</b> mg kg <sup>-1</sup>	0-7.5	595.8 y (9.79)	561.0 z (7.19)	566.7 yz (9.59)	573.8 yz (7.76)
	mg kg <sup>-1</sup>	7.5-15	481.9 (9.29)	506.5 (13.4)	504.9 (13.1)
	kg ha <sup>-1</sup>	0-15	980.3 (17.7)	973.8 (12.5)	976.7 (14.5)
<b>FW Org P</b> mg kg <sup>-1</sup>	7.5-15	263.4 (11.8)	307.3 (14.7)	273.5 (12.4)	278.4 (9.71)
<b>FW Olsen P</b> mg kg <sup>-1</sup>	0-7.5	24.6 z (0.70)	27.0 yz (1.43)	30.1 xy (1.25)	32.3 x (1.28)
	mg kg <sup>-1</sup>	7.5-15	7.09 z (0.73)	13.8 y (1.38)	16.2 y (1.27)
	kg ha <sup>-1</sup>	0-15	27.6 z (1.09)	36.2 y (1.93)	41.3 xy (1.68)
% TP	0-7.5	4.15 z (0.13)	4.79 yz (0.23)	5.31 xy (0.20)	5.61 x (0.18)
	7.5-15	1.48 z (0.14)	2.66 y (0.23)	3.15 y (0.22)	3.22 y (0.2)
<b>WL Total P</b> mg kg <sup>-1</sup>	0-7.5	669.0 y (12.5)	635.5 yz (7.63)	611.5 z (18.8)	635.4 yz (10.6)
	mg kg <sup>-1</sup>	7.5-15	538.2 (12.5)	527.5 (13.2)	494.6 (15.4)
	kg ha <sup>-1</sup>	0-15	1057.3 y (23.1)	1018.8 yz (14.9)	967.2 z (22.5)
<b>WL Org P</b> mg kg <sup>-1</sup>	0-7.5	348.7 (10.5)	312.5 (7.55)	336.8 (13.4)	318.7 (13.8)
mg kg <sup>-1</sup>	7.5-15	308.8 (12.4)	306.9 (10.3)	310.4 (8.64)	301.4 (10.2)
	kg ha <sup>-1</sup>	0-15	578.1 (18.2)	548.0 (14.5)	570.3 (16.8)
	% TP	0-7.5	52.4 (1.72)	49.3 (1.24)	57.0 (3.81)
% TP	7.5-15	57.6 (2.22)	58.5 (1.94)	64.0 (2.56)	57.6 (1.45)
	0-7.5	27.6 (1.55)	35.4 (1.75)	32.8 (2.69)	32.5 (2.79)
<b>WL Olsen P</b> mg kg <sup>-1</sup>	mg kg <sup>-1</sup>	7.5-15	5.19 z (0.43)	10.3 y (0.90)	9.25 y (0.96)
	kg ha <sup>-1</sup>	0-15	31.4 z (1.48)	37.8 y (1.92)	34.6 yz (2.42)
	% TP	0-7.5	4.11 z (0.21)	5.54 y (0.24)	5.39 y (0.40)
% TP	7.5-15	0.97 z (0.08)	1.94 y (0.16)	1.85 y (0.16)	2.25 y (0.24)

**Table S6:** Statistically significant differences in means (Tukey HSD,  $\alpha=0.05$ ), for results for the fallow-wheat-wheat FWW rotation shown in Fig. 1 .

P pool	Treatment	Cumulative Year						
		1997	2000	2003	2006	2009	2012	2015
Olsen P, mg kg <sup>-1</sup> , 0-7.5 cm	+N+P	abcdefg	bcdedghi	bcdedghi	abcdefg	bcdedghi	abcde	ab
	+N-P	bcdedghij	efghijkl	ghijklmn	ijklmno	jklmno	hijkkm	ghijk
	-N+P	abcdef	abcd	abcd	abcde	abc	ab	a
	-N-P	abcdefg	bcdedghi	bcdedghi	cdefghij	fghijk	defghij	bcdefg
	N only	klmnopq	pq	q	pq	nopq	klmnopq	klmnopq
	None	klmnopq	opq	pq	pq	pq	mnopq	lmnopq
Olsen P, mg kg <sup>-1</sup> , 7.5-15 cm	+N+P	cdefghi	defghijkl	efghijkl	defghijkl	efghijkl	abcd	a
	+N-P	cdefghijk	efghijklm	efghijklmn	efghijklmn	ghijklmn	defghijk	cdefgh
	-N+P	abcdef	bcdedgh	bcdedfg	abcde	defghijkl	ab	a
	-N-P	bcdefg	cdefghij	defghijkl	cdefghijk	cdefghijk	bcdef	abcd
	N only	efghijklm	klmn	mn	lmn	lmn	ijklmn	ghijklmn
	None	efghijklm	jklnm	n	lmn	lmn	hjklmn	fghijklm
Olsen P, % TP, 0-7.5 cm	+N+P	abcdefg	bcdedgh	bcdedgh	abcdefg	cdefgh	abcde	ab
	+N-P	bcdefghi	efghijk	fgijklm	hijklmn	ijklmo	ghijk	fghijk
	-N+P	abcdef	abcd	abcde	abcde	defgh	abc	a
	-N-P	abcdefg	bcdedgh	bcdedgh	defghij	klmno	defghi	abcdef
	N only	klmno	no	no	no	lmno	klmno	jklmno
	None	klmno	mno	no	o	no	klmno	klmno
Olsen P, % TP, 7.5-15 cm	+N+P	defghijklm	defghijklmn	efghijklmno	defghijklmn	ghijklmno	abcd	ab
	+N-P	defghijklm	efghijklmno	ghijklmno	ghijklmno	jklmno	efghijklm	defghijkl
	-N+P	abcdefgh	bcdedghi	bcdefghi	abcdef	ijklmno	abc	a
	-N-P	cdefghij	defghijk	defghijklmn	defghijklm	hijklmno	bcdefg	abcde
	N only	ghijklmno	lmno	o	mno	no	klmno	ijklmno
	None	fghijklmno	jklnmno	o	mno	no	klmno	ijklmno

**Table S7:** Statistically significant differences in means (Tukey HSD,  $\alpha=0.05$ ), for results for the continuous wheat (CW) rotation shown in Fig. 1.

P pool	Treatment	Cumulative Year						
		1997	2000	2003	2006	2009	2012	2015
Olsen P, mg kg <sup>-1</sup> , 0-7.5 cm	+N+P	abcdefgh	defghij	efghijk	defghijk	efghijk	abcde	ab
	+N-P	cdefghij	ghijk	hijk	k	ijk	jk	ijk
	-N+P	abcde	abcd	abc	ab	abcdef	abcdefg	a
	-N-P	bcdefghi	bcdefghij	efghijk	fghijk	ijk	defghijk	bcdefghij
Olsen P, kg kg <sup>-1</sup> , 0-15 cm	+N+P	bcdefghi	efghijkl	fghijkl	fghijkl	hijkl	abcdefg	abcd
	+N-P	cdefghijk	ijkl	ijkl	l	JKL	kl	ijkl
	-N+P	abcdef	abc	abcd	ab	abcdefg	abcde	a
	-N-P	bcdefghij	defghijkl	defghijkl	ghijkl	JKL	defghijkl	bcdefghijk
Olsen P, % TP, 0-7.5 cm	+N+P	abcde	bcd	defg	cdefg	defg	abcd	abc
	+N-P	bcdefg	defg	efg	g	fg	fg	fg
	-N+P	abcd	ab	ab	a	abcd	abcde	a
	-N-P	bcdef	bcd	defg	defg	fg	defg	bcdef

**Table S8:** ANOVA results ( $P < F$ ), for grain and straw yield, grain and straw nitrogen (N) and grain and straw phosphorus (P), analyzed by Treatment (T), cumulative year (Y) and the T\*Y interaction. Treatments are fallow-wheat-wheat (FWW), continuous wheat (CW), fallow-wheat (FW) and wheat-lentil (WL). Values in bold are statistically significant ( $\alpha=0.05$ ).

Rotation	Factor	Grain yield	Straw Yield	Grain N	Grain P	Straw N	Straw P	P Depl. Mean	P Dep. Tot.
FWW	T	<b>&lt;0.001</b>							
	Y	<b>&lt;0.001</b>	<b>&lt;0.001</b>	<b>&lt;0.001</b>	<b>&lt;0.001</b>	<b>&lt;0.001</b>	<b>&lt;0.001</b>	—	—
	T*Y	0.579	0.866	0.887	0.052	0.816	0.153	—	—
CW	T	<b>&lt;0.001</b>							
	Y	<b>&lt;0.001</b>	<b>&lt;0.001</b>	<b>&lt;0.001</b>	<b>&lt;0.001</b>	<b>&lt;0.001</b>	<b>&lt;0.001</b>	—	—
	T*Y	0.963	0.384	0.937	0.135	0.130	0.201	—	—
FW	T	0.131	0.055	0.263	0.280	0.091	0.135	<b>0.008</b>	<b>&lt;0.001</b>
	Y	<b>0.010</b>	<b>&lt;0.001</b>	<b>0.015</b>	<b>0.009</b>	<b>0.023</b>	<b>0.021</b>	—	—
	T*Y	0.319	0.416	0.387	0.388	0.716	0.935	—	—
WL Wheat	T	0.367	<b>0.045</b>	0.203	0.319	0.204	0.168	<b>&lt;0.001</b>	—
	Y	<b>0.001</b>	<b>&lt;0.001</b>	<b>&lt;0.001</b>	<b>&lt;0.001</b>	<b>0.001</b>	<b>&lt;0.001</b>	—	—
	T*Y	0.705	0.311	0.635	0.682	0.952	0.978	—	—
WL Lentils	T	0.268	0.523	0.279	0.514	0.582	0.322	<b>&lt;0.001</b>	—
	Y	<b>&lt;0.001</b>	<b>&lt;0.001</b>	<b>&lt;0.001</b>	<b>&lt;0.001</b>	<b>0.008</b>	0.249	—	—
	T*Y	0.901	0.380	0.920	0.951	0.244	0.261	—	—
WL all	T	—	—	—	—	—	—	—	<b>&lt;0.001</b>

**Table S9:** Grain and straw yield, grain and straw nitrogen (N) and grain and straw phosphorus (P), analyzed by cumulative year (average of 3-year period), 1995-2015. Rotations are fallow-wheat-wheat (FWW) and continuous wheat (CW). Different letters within each rotation indicate significant differences ( $\alpha=0.05$ ).

Rotation	Cumulative Year	Grain yield Mg ha <sup>-1</sup>	Straw Yield Mg ha <sup>-1</sup>	Grain N kg ha <sup>-1</sup>	Grain P kg ha <sup>-1</sup>	Straw N kg ha <sup>-1</sup>	Straw P kg ha <sup>-1</sup>
FWW	1997	2.59 ab (0.07)	3.71 a (0.14)	61.5 ab (2.24)	8.91 b (0.26)	10.5 c (0.57)	0.70 d (0.04)
	2000	2.24 bc (0.11)	3.76 a (0.17)	55.5 bc (2.69)	9.24 a (0.42)	15.2 b (0.86)	1.95 b (0.10)
	2003	2.00 cd (0.07)	2.74 b (0.12)	52.2 bc (1.90)	7.61 c (0.28)	14.6 b (0.73)	1.17 c (0.06)
	2006	2.47 ab (0.08)	4.31 a (0.16)	55.8 bc (2.19)	10.7 a (0.31)	19.7 a (1.03)	2.58 a (0.13)
	2009	1.82 d (0.06)	2.68 b (0.10)	47.5 c (1.69)	6.64 c (0.19)	11.5 c (0.75)	0.88 cd (0.04)
	2012	2.75 a (0.10)	4.41 a (0.18)	65.9 a (2.64)	11.7 a (0.40)	15.3 b (0.63)	1.86 b (0.08)
	2015	2.36 bc (0.11)	4.02 a (0.27)	54.0 bc (2.59)	9.32 b (0.42)	13.2 bc (0.91)	1.83 b (0.16)
CW	1997	2.20 a (0.12)	3.06 ab (0.17)	49.4 a (3.86)	8.93 abc (0.41)	9.03 b (0.94)	0.89 c (0.06)
	2000	1.76 bc (0.16)	2.98 abc (0.15)	43.0 ab (3.77)	8.25 bc (0.37)	13.4 ab (1.71)	2.96 a (0.27)
	2003	1.63 bc (0.09)	2.15 cd (0.08)	41.2ab (2.63)	7.07cd (0.30)	11.9 ab (1.41)	1.32 c (0.10)
	2006	2.12 ab (0.11)	3.69 a (0.17)	44.1 ab (3.14)	10.6 a (0.30)	16.4 a (1.85)	3.39 a (0.22)
	2009	1.33 c (0.10)	1.93 d (0.17)	35.6 b (2.99)	5.76 d (0.30)	10.0 b (1.35)	1.16 c (0.10)
	2012	2.24 a (0.12)	3.42 ab (0.17)	51.9 a (3.38)	10.2 ab (0.30)	12.3 ab (0.86)	1.88 b (0.14)
	2015	1.91 ab (0.11)	2.66 bcd (0.17)	42.3 ab (3.01)	7.83 c (0.30)	8.43 b (0.73)	1.33 c (0.11)

**Table S10:** Grain and straw yield, grain and straw nitrogen (N) and grain and straw phosphorus (P), analyzed by cumulative year (average of 3-year period), 1995-2015. Rotations are fallow-wheat (FW) and wheat-lentil (WL), with results for both wheat and lentil shown for WL. Different letters within each rotation indicate significant differences ( $\alpha=0.05$ ).

Rotation	Cumulative Year	Grain yield Mg ha <sup>-1</sup>	Straw Yield Mg ha <sup>-1</sup>	Grain N kg ha <sup>-1</sup>	Grain P kg ha <sup>-1</sup>	Straw N kg ha <sup>-1</sup>	Straw P kg ha <sup>-1</sup>
FW	2010	2.85 ab (0.22)	3.76 b (0.14)	68.9 ab (4.77)	10.9 ab (1.21)	13.2 b (1.42)	1.26 b (0.22)
	2012	3.59 a (0.22)	6.60 a (0.17)	80.6 a (5.45)	14.5 a (1.07)	18.7 ab (1.56)	2.14 ab (0.30)
	2014	3.46 ab (0.09)	6.64 a (0.12)	75.2 ab (2.57)	13.2 ab (0.54)	20.6 a (2.09)	2.51 a (0.35)
	2016	2.88 b (0.23)	4.08 b (0.16)	62.9 b (3.24)	10.4 b (0.79)	16.8 ab (2.53)	1.76 ab (0.39)
WL wheat	2010	2.48 b (0.39)	2.79 b (0.49)	66.6 b (1.69)	11.4 b (1.94)	12.5 b (1.62)	1.51 b (0.27)
	2012	4.08 a (0.31)	7.22 a (0.54)	106.4 a (2.64)	18.8 a (1.51)	30.2 a (6.42)	4.37 a (0.77)
	2014	4.08 a (0.12)	6.72 a (0.34)	102.5 a (2.59)	17.1 a (0.40)	21.7 a (1.24)	3.17 a (0.33)
	2016	2.87 b (0.30)	3.66 b (0.52)	66.1 b (3.86)	11.3 b (1.17)	17.1 b (2.06)	1.76 b (0.33)
WL lentils	2010	1.81 bc (0.17)	3.45 bc (0.46)	69.9 b (3.77)	6.83 bc (0.80)	47.6 ab (10.5)	3.76 (0.89)
	2012	4.00 a (0.23)	5.20 a (0.32)	155.9 a (2.63)	15.2 a (0.74)	52.6 a (5.79)	4.59 (0.70)
	2014	2.34 b (0.18)	4.59 ab (0.39)	90.3 bc (3.14)	8.85 b (0.63)	48.6 a (5.21)	4.42 (0.75)
	2016	1.17 c (0.19)	2.43 c (0.31)	40.9 c (3.01)	4.45 c (0.74)	26.6 b (3.53)	3.08 (0.45)

**Figure SM1:** Mean annual precipitation (in mm) at the Swift Current Research and Development Centre, 1995-2016.

