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**Effects of long-term rotation and tillage practice on grain yield and protein of wheat and soil fertility on a Vertosol in a medium-rainfall temperate environment**

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**Supplementary Table 1: Crop cultivars used in SCRIME (2001 to 2017) and sowing dates**

Year	Treatment	Crop	Variety	Sowing date	Notes
2001	1-10	Wheat	Goldmark	14-6-2001	Snail damage at 2 to 3 leaf stage
	3, 4, 9	Barley	Gairdner	1-6-2001	
	2, 6-9	Canola	Rainbow	13-6-2001	
	10	Chickpea	ICCV96836	15-6-2001	
	2,3,5-9	Fieldpea	Dundale	15-6-2001	
2002	1-10	Wheat	Goldmark	17-6-2002	
	3, 4, 9	Barley	Gairdner	28-5-2002	
	2, 6-9	Canola	Rainbow	4-6-2002	
	10	Chickpea	ICCV96836	16-6-2002	
	2,3,5-9	Fieldpea	Dundale	17-6-2002	
2003	1-10	Wheat	Goldmark	19-6-2003	
	3, 4, 9	Barley	Gairdner	26-5-2003	
	2, 6-9	Canola	Beacon	27-5-2003	
	10	Chickpea	ICCV96836	11-6-2002	
	2,3,5-9	Fieldpea	Dundale	24-6-2003	
2004	1-10	Wheat	Goldmark	24-6-2004	ZT treatment commenced; chickpeas resown due to mice
	3, 4, 9	Barley	Gairdner	30-5-2004	
	2, 6-9	Canola	Beacon	30-5-2004	
	10	Chickpea	ICCV96836	3-8-2004	
	2,3,5-9	Fieldpea	Dundale	24-6-2004	
2005	1-10	Wheat	Goldmark	12-6-2005	
	3, 4, 9	Barley	Gairdner	3-6-2005	
	2, 6-9	Canola	Beacon	7-6-2005	
	10	Chickpea	ICCV96836	12-6-2005	
	2,3,5-9	Fieldpea	Parafield	10-6-2005	
2006	1-10	Wheat	Goldmark	19-6-2006	
	3, 4, 9	Barley	Gairdner	10-5-2006	
	2, 6-9	Canola	Beacon	12-5-2006	

	10	Chickpea	ICCV96836	20-6-2006	
	2,3,5-9	Fieldpea	Parafield	20-6-2006	
2007	1-10	Wheat	Clearfield JNZ	7-6-2007	
	3, 4, 9	Barley	Gairdner	7-5-2007	
	2, 6-9	Canola	Beacon	7-5-2007	
	10	Chickpea	ICCV96836	6-6-2007	
	2,3,5-9	Fieldpea	Parafield	6-6-2007	
2008	1-10	Wheat	Clearfield JNZ	7-6-2008	
	3, 4, 9	Barley	Gairdner	15-5-2008	
	2, 6-9	Canola	Beacon	13-5-2008	
	10	Chickpea	Genesis 90	22-8-2008	
	2,3,5-9	Fieldpea	Parafield	16-6-2008	
2009	1-10	Wheat	Clearfield JNZ	5-6-2009	
	3, 4, 9	Barley	Gairdner	21-5-2009	
	2, 6-9	Canola	Beacon	15-5-2009	
	10	Chickpea	Genesis 90	4-6-2009	
	2,3,5-9	Fieldpea	Kaspa	29-5-2009	
2010	1-10	Wheat	Clearfield JNZ	28-5-2010	Wheat resown 4 <sup>th</sup> June due to mice ; wheat following fallow not determined
	3, 4, 9	Barley	Gairdner	9-5-2010	
	2, 6-9	Canola	Beacon	10-5-2010	
	10	Chickpea	Slasher	26-5-2010	
	2,3,5-9	Fieldpea	Kaspa	26-5-2010	
2011	1-10	Wheat	Clearfield JNZ	9-5-2011	Rust outbreak; wheat following fallow not determined
	3, 4, 9	Barley	Gairdner	4-5-2011	
	2, 6-9	Canola	Beacon	9-5-2011	
	10	Chickpea	Slasher	20-5-2011	
	2,3,5-9	Fieldpea	Kaspa	20-5-2011	
2012	1-10	Wheat	Clearfield JNZ	22-5-2012	
	3, 4, 9	Barley	Gairdner	27-4-2012	

	2, 6-9	Canola	Beacon	30-4-2012	
	10	Chickpea	Slasher	22-5-2012	
	2,3,5-9	Fieldpea	Kaspa	22-5-2012	
2013	1-10	Wheat	Grenade CL Plus	19-5-2013	
	3, 4, 9	Barley	Gairdner	21-5-2013	
	2, 6-9	Canola	Gem TT	10-5-2013	
	10	Chickpea	Slasher	24-5-2013	
	2,3,5-9	Lentil	Hurricane	24-5-2013	
2014	1-10	Wheat	Grenade CL Plus	15-5-2014	
	3, 4, 9	Barley	Gairdner	1-5-2014	
	2, 6-9	Canola	Gem TT	1-5-2014	
	2,3,5-10	Lentil	Hurricane	19-5-2014	
2015	1-10	Wheat	Grenade CL Plus	18-5-2015	
	3, 4, 9	Barley	Gairdner	30-4-2015	
	2, 6-9	Canola	Gem TT	30-4-2015	
	2,3,5-10	Lentil	Hurricane	18-5-2015	
2016	1-10	Wheat	Grenade CL Plus	2-5-2016	Late frost
	3, 4, 9	Barley	Gairdner	4-5-2016	
	2, 6-9	Canola	Gem TT	4-5-2016	
	2,3,5-10	Fieldpea	Kaspa	16-5-2016	
2017	1-10	Wheat	Grenade CL	15-5-2017	
	3, 4, 9	Barley	Gairdner	9-5-2017	
	2, 6-9	Canola	Gem TT	2-5-2017	
	2,3,5-10	Fieldpea	Kaspa	18-5-2017	

**Supplementary Table 2: Monthly, pre-sowing (January-March), growing season (GSR: April-November) and annual rainfall (mm) compared to the long-term (1860-2017) average.**

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Pre sowing(mm)	GSR (mm)	Annual (mm)
1998	17	20	3	62	18	44	43	16	42	63	29	14	54	317	370
1999	5	17	30	0	44	21	25	56	15	39	35	72	66	235	359
2000	2	67	7	37	25	17	48	24	51	32	23	20	148	257	354
2001	19	14	28	5	13	45	33	46	74	39	28	11	81	283	355
2002	11	9	15	17	20	22	25	16	31	14	33	21	46	178	234
2003	4	56	5	8	36	67	29	52	24	60	9	23	86	285	371
2004	9	2	13	6	23	51	35	39	36	8	52	38	33	250	314
2005	65	28	3	11	12	59	24	38	24	73	50	18	134	291	407
2006	23	2	6	41	23	18	23	16	31	2	7	6	49	161	197
2007	72	22	5	63	60	6	38	13	18	7	45	22	105	250	372
2008	48	1	7	8	37	30	47	32	22	7	10	73	78	193	322
2009	0	1	13	20	60	60	55	47	72	22	62	33	87	398	446
2010	16	48	67	46	31	21	53	76	46	49	45	126	164	367	624
2011	160	69	20	14	23	19	53	45	13	35	54	50	375	256	555
2012	7	4	36	12	41	60	52	30	35	13	11	16	97	254	315
2013	0	22	4	15	25	64	64	50	35	34	13	9	42	300	335
2014	14	6	16	55	39	40	40	9	14	5	13	15	45	215	266
2015	77	9	2	17	17	43	18	11	31	5	15	8	103	157	253
2016	19	26	24	7	62	40	66	47	108	43	17	48	77	390	507
2017	31	20	5	70	60	5	42	57	29	39	50	23	104	352	431
mean	22	15	26	33	37	41	36	38	29	30	32	99	269	369	369
Long term average	25	23	23	29	43	44	43	43	41	41	31	28	100	314	416

**Supplementary Table 3: Effect of rotation and tillage practice treatments on Harvest Index of wheat Phase from 20001 to 2017.**

In 2014 there was a significant interaction between rotation/tillage treatment and Nfert and *lsd* value represents interaction value. Values in parentheses represent mean of +Nfert treatments assessed from 2008 onwards if Nfert treatment effect was significant (P <0.05). n.d., not determined

Treat	Harvest Index																		
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012*	2013	2014a	2014b	2015	2016c	2017	Mean
1	0.28	0.020	0.276	0.15	0.207	n.d.	0.23	0.06	0.32	0.39	0.36	0.41	0.39	0.29	0.32	0.38	0.36	0.38	0.28
2	0.31	0.023	0.292	0.09	0.223	n.d.	0.23	0.10	0.33	0.39	0.36	0.40	0.37	0.29	0.25	0.13	0.36	0.33	0.26
3	0.37	0.194	0.312	0.18	0.212	n.d.	0.22	0.05	0.31	0.40	0.39	0.42	0.36	0.26	0.24	0.15	0.31	0.37	0.27
4	n.d.	n.d.	n.d.	0.00	0.220	n.d.	0.14	0.04	0.30	0.36	0.35	0.41	0.41	0.24	0.28	0.18	0.30	0.33	0.25
5	0.33	0.011	0.279	0.12	0.221	n.d.	0.15	0.06	0.35	0.43	0.35	0.38	0.34	0.28	0.29	0.21	0.32	0.34	0.26
6	0.34	0.011	0.33	0.15	0.214	n.d.	0.16	0.05	0.33	0.39	0.36	0.39	0.34	0.25	0.29	0.21	0.27	0.34	0.25
7	0.34	0.204	0.37	0.25	0.232	n.d.	0.20	0.22	0.33	n.d.	n.d.	0.42	0.35	0.32	0.33	0.35	0.36	0.37	0.31
8	0.35	0.008	0.285	0.00	0.225	n.d.	0.15	0.01	0.28	0.40	0.33	0.40	0.37	0.25	0.16	0.06	0.31	0.34	0.22
9	0.32	0.003	0.241	0.12	0.206	n.d.	0.07	0.01	0.26	0.36	0.34	0.36	0.36	0.22	0.07	0.06	0.29	0.30	0.21
<b>Mean</b>	<b>0.326</b>	<b>0.039</b>	<b>0.292</b>	<b>0.11</b>	<b>0.214</b>	<b>n.d.</b>	<b>0.17</b>	<b>0.07</b>	<b>0.31</b>	<b>0.39</b>	<b>0.36</b>	<b>0.40</b>	<b>0.36</b>	<b>0.27</b>	<b>0.25</b>	<b>0.19</b>	<b>0.32</b>	<b>0.34</b>	<b>0.26</b>
<i>lsd</i> (5%)	0.041	0.079	0.03	0.05	0.014	n.d.	0.06	0.03	0.30	0.04	0.03	0.03	0.06	0.05	0.09	0.05	0.03	0.0124	

**Supplementary Table 4: Effect of rotation and tillage practice treatment on grain protein concentration (%) of wheat phase from 2001 to 2017.**

Values in parentheses represent mean of +Nfert treatments where effect was significant ( $P < 0.05$ ). In 2001, 2013 and 2014 there was a significant interaction between treatment and Nfert. n.d., not determined; n.s., not significant ( $P < 0.05$ )

Treat	Grain protein (%)																				Mean (t/ha)
	2001a	2001b	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013a	2013b	2014a	2014b	2015	2016	2017	
1	9.4	10.25	14.1	10.3	17.6	7.9	n.d.	15.5	16.6	13.0	10.0	9.8	9.9	7.2	7.1	9.0	9.0	12.1	10.3	9.0	10.9
2	11.5	12.25	14.2	9.1	19.2	10.2	n.d.	15.9	17.2	13.3	10.4	9.5	9.8	7.4	7.7	10.7	13.4	15.3	9.5	10.6	11.9
3	13.4	13.92	13.6	9.8	17.3	12.6	n.d.	15.5	17.8	13.2	12.5	11.9	12.6	10.8	11.2	12.6	15.9	16.3	11.2	12.6	13.4
4	n.d.	n.d.	n.d.	21.0	13.1	n.d.	18.0	18.9	14.4	13.1	11.6	11.3	11.3	8.0	7.3	9.7	11.5	15.0	11.5	9.2	12.9
5	10.0	10.71	13.1	11.2	18.7	12.0	n.d.	16.3	17.1	13.3	11.9	10.7	9.4	7.3	7.4	9.9	11.2	15.2	10.0	8.9	11.8
6	10.1	11.78	13.9	13.0	19.8	13.1	n.d.	17.9	18.2	14.4	13.3	11.5	12.4	7.9	7.4	9.5	10.9	12.7	10.9	9.4	12.5
7	11.5	12.23	12.0	11.5	16.3	11.8	15.9	16.0	16.7	14.4	n.d.	n.d.	11.6	9.3	8.4	11.8	13.6	14.2	10.3	12.0	12.8
8	13.3	13.69	13.3	11.9	19.6	12.8	n.d.	16.3	16.8	16.5	11.2	9.7	12.0	9.1	9.9	13.6	19.2	13.5	11.7	12.7	13.5
9	12.0	13.07	13.9	14.5	19.1	13.7	n.d.	16.3	16.4	18.3	11.4	11.1	16.2	10.1	12.3	12.8	19.5	17.2	12.0	11.0	14.2
mean	11.6	12.6	13.9	12.5 (12.3)	18.7	11.9	15.9	16.4	17.3	14.6 (16.2)	11.7 11.2	10.7	11.7 (12.3)	8.6	8.7	11.1	13.8	14.6 (15.4)	10.8 (11.4)	10.6 (11.3)	13.2
<i>Isd</i> (5%)	0.8	0.8	0.7	0.9	1.1	n.s.	0.7	0.6	0.3	0.77	1.4	0.9	1.0	2.1	1.5	0.9	1.4	1.5	0.9	1.3	0.29

**Supplementary Table 5: Effect of rotation and tillage practice treatments on N uptake of wheat (phase 2) from 2004 to 2016.**

N content was also determined in +Nfert subplots from 2008 onwards. Values presented represent N content of plots without the supplementary N fertiliser treatment. Values in parentheses represent mean of +Nfert treatments when the effect was significant ( $P < 0.05$ ). n.s., not significant ( $P > 0.05$ ); n.d., not determined.

Treat.	Crop N content (kg/ha)														Mean
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	
1	26.2	29.7	0.0	140.3	56.8	102.8	89.7	87.1	61.8	37.9	25.0	18.7	54.5	45.8	56.7
2	40.6	93.5	0.0	191.3	68.9	110.5	114.0	100.8	98.9	58.2	42.4	21.4	73.6	95.9	78.0
3	80.8	108.9	24.0	118.9	89.7	123.1	148.1	148.2	134.1	114.8	66.6	38.3	105.8	141.0	100.1
4	2.1	98.9	0.0	114.9	59.0	120.9	139.6	129.7	99.4	58.9	31.3	26.6	78.5	55.6	73.8
5	39.7	113.6	0.0	103.2	59.9	113.8	123.1	132.3	89.9	52.3	34.5	25.5	70.6	62.4	73.7
6	12.9	105.2	0.0	85.4	58.2	113.6	142.8	147.2	91.9	51.7	32.9	28.8	95.5	69.1	74.3
7	85.3	106.1	30.8	135.3	114.7	140.4	n.d.	n.d.	164.3	110.2	105.4	39.2	98.4	134.4	102.7
8	3.4	123.2	0.0	112.1	75.1	134.4	131.8	97.3	120.5	88.4	71.5	25.6	105.4	102.3	83.7
9	43.8	105.2	0.0	77.0	61.5	147.4	126.0	93.7	128.8	116.7	45.5	36.9	111.4	59.9	84.1
Mean	34.0	96.0	4.2	123.4	69.6 (58.5)	125.0	124.5	125.1	110.5	76.5	50.6 (62.2)	29.0	88.2 (112.6)	85.2 (100.4)	81.7
lsd (5%)	8.4	12.3	n.s.	43.3	7.5	19.9	18.6	27.4	15.6	14.1	17.2	6.2	19.5	24.0	5.53



**Supplementary Table 6: Regression coefficients describing relationship between grain (%) and grain yield (t/ha).**

Treatment	Equation	R <sup>2</sup>
1	$y = -1.507x + 14.062$	0.39
2	$y = -1.5081x + 16.036$	0.59
3	$y = -1.0021x + 16.381$	0.62
4	$y = -1.4459x + 16.707$	0.42
5	$y = -1.1764x + 15.227$	0.43
6	$y = -1.0612x + 15.704$	0.35
7	$y = -1.078x + 16.4$	0.66
8	$y = -1.115x + 16.29$	0.54
9	$y = -0.836x + 16.13$	0.29
All data	$y = -1.0898x + 15.649$	0.37