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Development of a Soil Management Information System for Horticulture Dr Rob Simmons [on behalf of the SMIS project team] r.w.simmons@cranfield.ac.uk



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Outline

- Review key soil management issues
- Aims of SMIS
- Metrics of soil health: Examples of metrics that growers collect
- What useful data relating to soil management are growers collecting?
- SMIS System: Structural Overview
- Current extent of the grower data set
- SMIS: Case study examples
- Missing metrics and next steps

Key soil management challenges: Crop specific and cross-rotational





1. Aim of the SMIS project

Apply the principles of 'big data' to the diverse sources of soil management data, knowledge and information to provide best practice guidelines for sustainable soil management in horticulture

The SMIS can:

- hold, represent, manipulate and manage available sources of data, knowledge and information
 - specific effects of soil management practices on horticultural crop productivity and environmental protection
 - Seasonal and rotational context
 - use novel informatics techniques to create and then interrogate a 'rule base' of soil management practices (and their outcomes) in different scenarios (soil type, crop, rotation, location, etc.)
 - provide users with a set of robust, empirically-based, best-practice soil management guidelines (and the likely consequences of applying them)
 - An interactive platform will be created, giving AHDB-Horticulture, and its growers, agronomists and land managers access to guidance on contextual, effective soil management practices





"The pivotal 5" (after Professor Karl Ritz, pers.comm)

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What useful data relating to soil management are growers collecting?

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37 Adjuvants Potatoes Maincro Pesticides TF3930 0634 Ranman Twinpack 0.15 2010 30-Jun-10 Hcct 51/2/3 Ha 38 Adjuvants Potatoes Maincro Pesticides TF3930 0634 Ranman Twinpack 0.15 2010 08-Jul-10 Hcct 51/2/3 Ha 39 Adjuvants Potatoes Maincro Pesticides TF4025 4811 Ranman Twinpack 0.147 2011 29-Jun-11 F725 Marfona/04 Ha 40 Adjuvants Potatoes Maincro Pesticides TF4025 4811 Ranman Twinpack 0.147 2011 29-Jun-11 F725 Marfona/04 Ha 41 Adjuvants Potatoes Maincro Pesticides TF4026 7585 Activator 90 0.2 2011 01-Jun-11 F72.5 Wahole/03.DO NOT BLIGHT SPRAY TRIAL AREA Ha 42 Adjuvants Potatoes Maincro Pesticides TF4026 7585 Activator 90 0.2 2011 01-Jun-11 F9.Ossablanca/04 L 43 Adjuvants Potatoes Maincro Pesticides TF4026 7585 Activator 90 0.2 2011 01-Jun-11 F9.Nectar/03 <t< td=""><td>36 Adjuvants</td><td>Potat</td><td>toes Ma</td><td>incro F</td><td>Pesticides</td><td>TF3929</td><td>9517</td><td>Ranman Twinpack</td><td>0.147</td><td>2011</td><td>29-Jun-11 F56</td><td>Ha</td></t<>	36 Adjuvants	Potat	toes Ma	incro F	Pesticides	TF3929	9517	Ranman Twinpack	0.147	2011	29-Jun-11 F56	Ha
38 Adjuvants Potatoes Maincro Pesticides TF3930 0634 Ranman Twinpack 0.15 2010 08-Jul-10 Hcct 51/2/3 Ha 39 Adjuvants Potatoes Maincro Pesticides TF4025 4811 Ranman Twinpack 0.147 2011 29-Jun-11 F725 Mafona/04 Ha 40 Adjuvants Potatoes Maincro Pesticides TF4026 7685 Activator 90 0.2 2011 01-Jun-11 F92.Mashona/04 L 41 Adjuvants Potatoes Maincro Pesticides TF4026 7585 Activator 90 0.2 2011 01-Jun-11 F92.Mashona/04 L 42 Adjuvants Potatoes Maincro Pesticides TF4026 7585 Activator 90 0.2 2011 01-Jun-11 F92.Mashona/04 L 43 Adjuvants Potatoes Maincro Pesticides TF4026 7585 Activator 90 0.2 2011 01-Jun-11 F92.Mashona/04 L 43 Adjuvants Potatoes Maincro Pesticides TF4026 7585 Activator 90 0.2	37 Adjuvants	Potat	toes Ma	incro F	Pesticides	TF3930	0634	Ranman Twinpack	0.15	2010	30-Jun-10 Hcct 51/2/3	Ha
39 Adjuvants Potatoes Maincro Pesticides TF4025 4811 Ranman Twinpack 0.147 2011 29-Jun-11 F72/5 Marfona/04 Ha 40 Adjuvants Potatoes Maincro Pesticides TF4025 4811 Ranman Twinpack 0.147 2011 29-Jun-11 F72/5 Marfona/04 Ha 41 Adjuvants Potatoes Maincro Pesticides TF4026 7585 Activator 90 0.2 2011 01-Jun-11 F9.Cassablanca/04 L 42 Adjuvants Potatoes Maincro Pesticides TF4026 7585 Activator 90 0.2 2011 01-Jun-11 F9.Cassablanca/04 L 43 Adjuvants Potatoes Maincro Pesticides TF4026 7585 Activator 90 0.2 2011 01-Jun-11 F9.Meta/045 L 43 Adjuvants Potatoes Maincro Pesticides TF4026 7585 Activator 90 0.2 2011 01-Jun-11 F9.Meta/03 L Image: Figure	38 Adjuvants	Potat	toes Ma	incro F	Pesticides	TF3930	0634	Ranman Twinpack	0.15	2010	08-Jul-10 Hcct 51/2/3	Ha
40 Adjuvants Potatoes Maincro Pesticides TF4025 '4811 Ranman Twinpack 0.147 2011 29-Jun-11 F72/5 Whole/03.DO NOT BLIGHT SPRAY TRAL AREA Ha 41 Adjuvants Potatoes Maincro Pesticides TF4026 '7585 Activator 90 0.2 2011 01-Jun-11 F9.Cassablanca/04 L 42 Adjuvants Potatoes Maincro Pesticides TF4026 '7585 Activator 90 0.2 2011 01-Jun-11 F9.Marfona/05 L 43 Adjuvants Potatoes Maincro Pesticides TF4026 '7585 Activator 90 0.2 2011 01-Jun-11 F9.Marfona/05 L 43 Adjuvants Potatoes Maincro Pesticides TF4026 '7585 Activator 90 0.2 2011 01-Jun-11 F9.Marfona/05 L 4 Adjuvants Potatoes Maincro Pesticides TF4026 '7585 Activator 90 0.2 2011 01-Jun-11 F9.Marfona/05 L L 4 Adjuvants Ha Ha Ha Ha Ha Ha </td <td>39 Adjuvants</td> <td>Potat</td> <td>toes Ma</td> <td>incro F</td> <td>Pesticides</td> <td>TF4025</td> <td>4811</td> <td>Ranman Twinpack</td> <td>0.147</td> <td>2011</td> <td>29-Jun-11 F72\5.Marfona/04</td> <td>Ha</td>	39 Adjuvants	Potat	toes Ma	incro F	Pesticides	TF4025	4811	Ranman Twinpack	0.147	2011	29-Jun-11 F72\5.Marfona/04	Ha
41 Adjuvants Potatoes Maincro Pesticides TF4026 7585 Activator 90 0.2 2011 01-Jun-11 F9.Cassablanca/04 L 42 Adjuvants Potatoes Maincro Pesticides TF4026 7585 Activator 90 0.2 2011 01-Jun-11 F9.Cassablanca/04 L 43 Adjuvants Potatoes Maincro Pesticides TF4026 7585 Activator 90 0.2 2011 01-Jun-11 F9.Marfona/05 L 43 Adjuvants Potatoes Maincro Pesticides TF4026 7585 Activator 90 0.2 2011 01-Jun-11 F9.Nectar/03 L + Sheet1 • <td>40 Adjuvants</td> <td>Potat</td> <td>toes Ma</td> <td>incro F</td> <td>Pesticides</td> <td>TF4025</td> <td>4811</td> <td>Ranman Twinpack</td> <td>0.147</td> <td>2011</td> <td>29-Jun-11 F72\5.Whole/03.DO NOT BLIGHT SPRAY TRIAL AREA</td> <td>Ha</td>	40 Adjuvants	Potat	toes Ma	incro F	Pesticides	TF4025	4811	Ranman Twinpack	0.147	2011	29-Jun-11 F72\5.Whole/03.DO NOT BLIGHT SPRAY TRIAL AREA	Ha
42 Adjuvants Potatoes Maincro Pesticides TF4026 7585 Activator 90 0.2 2011 01-Jun-11 F9.Marfona/05 L 43 Adjuvants Potatoes Maincro Pesticides TF4026 7585 Activator 90 0.2 2011 01-Jun-11 F9.Marfona/05 L + → Sheet1 • <td>41 Adjuvants</td> <td>Potat</td> <td>toes Ma</td> <td>incro F</td> <td>Pesticides</td> <td>TF4026</td> <td>7585</td> <td>Activator 90</td> <td>0.2</td> <td>2011</td> <td>01-Jun-11 F9.Cassablanca/04</td> <td>L</td>	41 Adjuvants	Potat	toes Ma	incro F	Pesticides	TF4026	7585	Activator 90	0.2	2011	01-Jun-11 F9.Cassablanca/04	L
43 Adjuvants Potatoes Maincro Pesticides IF4026 7585 Activator 90 0.2 2011 01-Jun-11 F9.Nectar/03 L 4 → Sheet1 ⊕ :	42 Adjuvants	Potat	toes Ma	incro F	esticides	TF4026	7585	Activator 90	0.2	2011	01-Jun-11 F9.Marfona/05	L
↓ Sheet1 ↓ READY □ ↓	43 Adjuvants	Potat	toes Ma	incro F	'esticides	IF4026	/585	Activator 90	0.2	2011	01-Jun-11 F9.Nectar/03	L 🗸
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Tillage operations during establishment

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3198	Establishment	Calabrese	Machinery Costs	TF3925	4633 A	↓ <u>S</u> ort A to Z		2011	23-Jul-10	Ellis Halgarth	ha	2.91	2.91	3.17	
3199	Establishment	Calabrese	Machinery Costs	TF3925	4633 z	↓ Sort Z to A		2011	23-Sep-10	Ellis Halgarth	ha	2.91	2.91	3.17	
3200	Establishment	Calabrese	Machinery Costs	TF3925	4633	Sort by Color	•	2011	09-Sep-10	Ellis Halgarth	ha	2.91	2.91	3.17	
3201	Establishment	Calabrese	Machinery Costs	TF4025	4811			2011	24-Sep-10	F//.A	ha	9.65	9.65	0	
3202	Establishment	Calabrese	Machinery Costs	TF4025	4811	Clear Filter From "Product Na View Product Na	me"	2011	24-Sep-10	F/7.A	na	9.65	9.65	11.70	
203	Establishment	Calabrase	Machinery Costs	TE4020	4605	Filter by Color	Þ	2011	21-Jdll-11 10. Jon 11	Fod.A Ellic Bank	ha	1.22	1.22	11.79	
3204	Establishment	Calabrese	Machinery Costs	TF4020	5823	Text <u>Filters</u>	Þ	2011	20_ Jan_11	F13 Δ	ha	14.01	14.01	14.65	
3206	Establishment	Calabrese	Machinery Costs	TF4027	8129	Search	Q	2011	11-Nov-10	F12.A	ha	11.82	11.82	13.35	
3207	Establishment	Calabrese	Machinery Costs	TF4228	8295	(Select All)		2011	24-Sep-10	Jep 66	ha	6.95	6.95	7.13	
3208	Establishment	Calabrese	Machinery Costs	TF4228	8295	- I Leg Buster		2011	15-Nov-10	Jep 66	ha	6.95	6.95	7.13	
3209	Establishment	Calabrese	Machinery Costs	TF4427	2697	AHW Combi Drill(4m)		2011	15-Oct-10	Jep 59	ha	12.37	12.37	12.96	
3210	Establishment	Calabrese	Machinery Costs	TF4530	8063	AHW Fert Application	=	2011	25-Jan-11	Jep 40	ha	16.27	16.39	16.84	
3211	Establishment	Cauliflowers	 Machinery Costs 	TF 3825	9862	Combination Drill		2010	05-Nov-09	Ellis-Chapmans	ha	2.99	2.99	3.16	
3212	Establishment	Cauliflowers	 Machinery Costs 	TF3531	8257	- Cultivate		2012	06-Sep-11	Hcct Johnsons	ha	13.05	13.05	13.42	
3213	Establishment	Cauliflowers	Machinery Costs	TF3631	8154	Disc & Press		2012	06-Sep-11	Hcct 6/10	ha	13.36	13.36	14.32	
3214	Establishment	Cauliflowers	 Machinery Costs 	TF3826	3806	Fill in Furrows		2011	15-Feb-11	Ellis Muntons	ha	11.33	11.33	11.26	
3215	Establishment	Cauliflowers	Machinery Costs	TF3925	4283	Flatlifting		2010	04-Nov-09	Yard Field	ha	3.36	3.36	3.56	
3216	Establishment	Cauliflowers	Machinery Costs	TF3925	4633	- HCCT Fert Appliction		2010	03-Nov-09	Ellis Halgarth	ha	2.91	2.91	3.17	
3217	Establishment	Cauliflowers	Machinery Costs	TE2025	4825	Interrow Cultivate Pota	toes	2011	23-Jul-10	Ellis A17	ha	2.22	2.22	2.51	
210	Establishment	Cauliflowers	Machinery Costs	TE2025	4020	LFP Beet Drill	-	2010	20-001-09	Ellis A17	ha	2.22	2.22	2.51	
3218	Establishment	Cauliflowers	Machinery Costs	TF3925	4825	•	+	2011	09-Sep-10	Ellis A17	ha	2.22	2.22	2.51	
3221	Establishment	Cauliflowers	Machinery Costs	TE3925	8779		Canad	2010	23-Oct-09	F1\2	ha	11.95	11.95	13.05	
3222	Establishment	Cauliflowers	Machinery Costs	TF3928	0176	UK	Cancel	2010	08-Dec-09	E63 A	ha	38 73	38 73	58.2	
3223	Establishment	Cauliflowers	Machinery Costs	TF3928	6634	Plough		2010	20-Nov-09	F67	ha	5.08	5.08	5.49	
3224	Establishment	Cauliflowers	Machinery Costs	TF3928	7583	Plough		2011	11-Oct-10	F54.A	ha	10	10	11.17	
3225	Establishment	Cauliflowers	Machinery Costs	TF3928	7583	Plough		2015	11-Oct-14	F54.A/02	ha	10	10	11.17	
3226	Establishment	Cauliflowers	Machinery Costs	TF3929	2107	Plough		2010	24-Nov-09	F61.A	ha	9.15	9.15	11.47	
3227	Establishment	Cauliflowers	Machinery Costs	TF3929	5201	Plough		2011	11-Oct-10	F59.A	ha	12.21	12.21	13.5	
3228	Establishment	Cauliflowers	Machinery Costs	TF4025	4245	Plough		2010	13-Nov-09	F71	ha	10.41	10.41	10.87	
3229	Establishment	Cauliflowers	Machinery Costs	TF4025	4287	Plough		2010	06-Nov-09	Ellis House	ha	5.98	5.98	6.64	
3230	Establishment	Cauliflowers	Machinery Costs	TF4025	7174	Plough		2014	28-Nov-13	F68\9.ELU/04	ha	8.82	8.82	10.29	
3231	Establishment	Cauliflowers	Machinery Costs	TF4026	0350	Plough		2010	04-Dec-09	F5	ha	3.94	3.94	4.24	
3232	Establishment	Cauliflowers	Machinery Costs	TF4026	2342	Plougn Flail Tappin		2010	19-Feb-10	F7	na	12.84	12.84	14	
233	Establishment	Cauliflowers	Machinery Costs	TE4026	7585	Plaur Plaur		2014	20-Feb-14	F9/02	ha	23.00	23.00	23.50	
3235	Establishment	Cauliflowers	Machinery Costs	TE4026	7585	Plough		2014	25-Feb-14	F9/02	ha	23.50	23.56	23.56	
3236	Establishment	Cauliflowers	Machinery Costs	TF4027	8182	Plough		2014	09-Dec-09	F21	ha	10.1	10.1	11.02	
3237	Establishment	Cauliflowers	Machinery Costs	TF4028	3385	Plough		2011	04-Nov-10	F43\4 A	ha	20.64	20.64	22.04	
3238	Establishment	Cauliflowers	Machinery Costs	TF4028	6463	Plough		2011	12-Nov-10	F41a	ha	8.44	8.44	15.16	
3239	Establishment	Cauliflowers	Machinery Costs	TF4029	1101	Flatlifting		2013	20-Feb-13	F52	ha	17.84	17.84	18.44	
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Source: Grower G dataset

Cross rotational tillage operations for a specific field

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8250	Establishment	Cauliflowers	Machinery Costs	TF4328	9868	Plough	2014	23-Jan-14	Jep 23	ha	13.62	13.62	0	
8906	Establishment	Peas Vining	Machinery Costs	TF4328	9868	Plough	2010	18-Nov-09	Jep 23	ha	13.18	13.18	0	
8907	Establishment	Peas Vining	Machinery Costs	TF4328	9868	Roll	2010	21-May-10	Jep 23	ha	13.18	13.18	0	
8908	Establishment	Peas Vining	Machinery Costs	TF4328	9868	Simba Culti Press	2010	21-Apr-10	Jep 23	ha	13.18	13.18	0	
8909	Establishment	Peas Vining	Machinery Costs	TF4328	9868	WFL Pea Drill+Cult	2010	21-May-10	Jep 23	ha	13.18	13.18	0	
9702	Establishment	Potatoes Maincro	Machinery Costs	TF4328	9868	Disc & Press	2011	11-Aug-10	Jep 23	ha	13.62	13.62	0	
9703	Establishment	Potatoes Maincro	Machinery Costs	TF4328	9868	Flatlifting	2011	11-Aug-10	Jep 23	ha	13.62	13.62	0	
9704	Establishment	Potatoes Maincro	Machinery Costs	TF4328	9868	Plough	2011	04-Nov-10	Jep 23	ha	13.62	13.62	0	
9705	Establishment	Potatoes Maincro	Machinery Costs	TF4328	9868	Potato Cultivator GForce 6m	2011	02-Apr-11	Jep 23	ha	13.62	13.62	0	
9706	Establishment	Potatoes Maincro	Machinery Costs	TF4328	9868	Potato Planter AVR 4 Row	2011	02-Apr-11	Jep 23	ha	13.62	13.62	0	
9707	Establishment	Potatoes Maincro	Machinery Costs	TF4328	9868	WFL Fert Application	2011	21-Sep-10	Jep 23	ha	13.62	13.62	0	
10191	Establishment	Sugar Beet	Machinery Costs	TF4328	9868	Flatlifting	2013	27-Aug-12	Jep 23	ha	13.62	13.62	0	
10192	Establishment	Sugar Beet	Machinery Costs	TF4328	9868	LFP Beet Drill	2013	05-Apr-13	Jep 23	ha	13.62	13.62	0	
10193	Establishment	Sugar Beet	Machinery Costs	TF4328	9868	Plough	2013	29-Oct-12	Jep 23	ha	13.62	13.62	0	
10194	Establishment	Sugar Beet	Machinery Costs	TF4328	9868	Preperator	2013	05-Apr-13	Jep 23	ha	13.62	13.62	0	
10931	Establishment	Wheat Winter	Machinery Costs	TF4328	9868	Top Down	2012	21-Sep-11	Jep 23	ha	13.62	13.62	0	
10932	Establishment	Wheat Winter	Machinery Costs	TF4328	9868	Vardestadt Drill 6m	2012	21-Sep-11	Jep 23	ha	13.62	13.62	0	
19349	Harvest	Peas Vining	Machinery Costs	TF4328	9868	Pea Vining	2010	26-Jul-10	Jep 23	ha	13.18	13.18	0	
19471	Harvest	Potatoes Maincro	Machinery Costs	TF4328	9868	WFL Potato Harvesting	2011	16-Sep-11	Jep 23	ha	13.62	13.62	0	
19576	Harvest	Sugar Beet	Machinery Costs	TF4328	9868	LFP Beet Harvest	2013	23-Jan-14	Jep 23	ha	13.62	13.62	0	
19795	Harvest	Wheat Winter	Machinery Costs	TF4328	9868	WFL Combine	2012	23-Aug-12	Jep 23	ha	13.62	13.62	0	
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- Grower data can provide information on the type, timing and frequency and intensity of tillage operations on a crop specific and rotational context.
- Grower data can also provide useful information on a wide range of soil management practices
 - effect of bio-fumigants (and other Brassica crops) on PCN/BCN in a rotational context.
 - influence of organic amendments on soils.....tillage operations/yield/fertiliser use
 - influence of cover crops on soils.....tillage operations/yield/fertiliser use
 - effect of late harvested crops (sugar beet, maize) on subsequent crop yields....

Specific tillage operations can be further classified and incorporated into machine learning queries

Product Name	Technical Description	Tillage classification
WEL Digestate Application		
Tramsproad Digostate Application	/	/
2 Log Pustor	/ Sub soiler	
	Sub soller	
Bust I ramines	Sub soller	
Flatlifting	Sub soller	Deep Tillage
Sumo Trio	Sub soiler w discs and roller	Progressive tillage (Shallow to Deep)
Sumo Trio + Seeding	Sub soiler w discs and roller + drill	Progressive tillage (Shallow to Deep) + Drill
AHW Combi Drill (4m)	Power harrow + seed drill	Rotational Tillage
Combination Drill	Power harrow + seed drill	Rotational Tillage
Disc & Press	Discs and roller	Shallow Tillage
Sneath Beet Drill + Cultivate [18 row Monocem drill,		-
Lemkin Terratilth cultivator + challenger 55 crawler	/	Shallow Tillage
LFP Beet Drill	Beet Drill	Shallow Tillage
Maize Drilling	Maize Drill	Shallow Tillage
Plough	Mouldboard plough	Inversion tillage
Potato Cultivator GForce 6m	Power harrow bed former	Rotational Tillage
Potato Planter AVR 4 Row	Potato Planter	/
Interrow Cultivate Potatoes	Shallow tines and bed-forming	Shallow Tillage
Power Harrow	Power Harrow	Rotational Tillage
Preperator	Shallow tines	Shallow Tillage
Roll	Cambridge roller	/
Rotovating	Power harrow	Rotational Tillage
Simba Culti Press	Tines and packer roll	Shallow Tillage
Top Down	discs/tines/levelling and packer	Shallow Tillage
Vardestadt Drill 6m	Likely to have shallow tillage	Shallow Tillage

Temporal & spatial extent of the grower data set







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Field vegetables included within grower datasets

Crop	2010	2011	2012	2013	2014	2015	Crop specific total (ha)
Celeriac	58	60	78	59	87	99	441
Chicory	13	24	9	/	/	/	46
Fennel	22	17	16	22	13	19	109
Onions _(Set)	31	14	32	31	33	33	174
Onions (Drilled)	66	153	71	113	120	141	664
Daffodils	/	/	6.6	10	/	/	16.6
Beans Dried Spring	/	/	60	126	76	337	599
Beans French	/	/	69	/	79	/	148
Salads	/	/	/	/	19	/	19
Total annual area (ha)	189	268	340	361	426	633	2,220



• Total 6-year cultivated area of horticultural crops = 6,016 (ha)



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Grower specific crop diversity and rotational contexts cont....

Grower C 970 (ha)		Grow 327 (rer D ha)	Grow 2607			
Soil Textural Class	% of cropped area	Soil Textural Class	% of cropped area	Soil Textural Class	% of cropped area		
SL	94%	ZCL	99%	CL	34%		
CL	6%	ZC	1%	ZCL	23%		
				SL	23%		
							Barley Spring Barley Winter Peas Vining WOSR Potatoes (Main Sugar Beet Celeriac
Horticultu	Iral Crops	Horticultu	ral Crops	Horticult	ural Crops		Fennel
(175	5 ha)	(196	ha)	(68	(68 ha)		Squashes
,	,	`	-	,	-		Onions (Sets)
							Quinoa

Grower specific crop diversity and rotational contexts cont...



LAN -		337	348 354			SP	(I)		~
		•	Wor	king Area	(ha)				
Сгор	2010	2011	2012	2013	2014	2015	2016	Total Working Area (ha)	326 349
Barley Spring	28.1	13.3						41.4	328 388 303
Beetroot						1.2	9.0	10.1	•278
Broccoli						15.4	20.1	35.5	
Cabbage Head	4.0	19.5						23.5	
Carrots	106.8	85.4	66.1	64.5	64.0	70.6	75.1	533	
Collards	41.0	40.3						81.2	
Green Cover Crop						15.8	38.3	54.1	
Leeks	133.7	109.3	79.9	82.1	71.6	64.5	60.4	601	¥
Maize Forage		18.5	19.2	42.0	16.7	44.8	70.4	212	
Mustard Seed	23.1	15.6			2.4			41.1	18/
Organic Carrots		10.0	8.6					18.6	
Organic Parsnips			3.1	4.0	5.2			12.3	1. 1. 1. 1. 1.
Parsnips	67.2	72.7	58.7	81.1	97.0	80.3	88.4	545	
Peas Vining		25.0						25.0	·/
Point Cabbage						8.8	10.0	18.8	Noth Hyliothan
Potatoes Earlies	7.8	9.3						17.1	1
Potatoes Maincrop	122.6	125.4	143.9	150.6	152.1	128.7	103.6	927	
Pumpkins						14.3	16.0	30.3	
Rented Barley Winter	16.4	10.0						26.4	
Rented out Maize			35.4	14.4	84.7	31.0	102.5	268	
Rented out Pigs							24.7	24.7	
Rented out Vining Peas	45.2		36.9	36.6	23.3	35.8	11.4	189	
Rhubarb	26.0	24.2	23.2	27.3	33.2	40.2	39.9	214	
Savoy Cabbage	47.6	38.1						85.7	
Savoy/Green			7.5	8.0	6.3	5.8	12.9	40.5	
Spring Barley	77.7	89.6	107.8	115.0	62.6	85.2	21.2	559	
Spring Beans					92.5	64.3	37.7	194	
Spring Green	9.6		22.9	23.1	24.5	23.1	26.0	129	
Sugar Beet	109.8	108.7	111.8	131.6	113.0	49.1		624	
White Cabbage	46.4	45.1	53.7					145	
Winter Greens		13.7		15.8	16.8	21.5	10.9	78.6	
Winter OSR	126.4	166.0	126.4	78.8	82.2	85.6	97.1	762	
Winter Savoy / Green Cab			43.2	24.4	27.8	40.5	22.5	158	
Winter Wheat	271.6	300.7	300.2	370.6	367.7	388.5	383.7	2383	
Grand Total	1311	1340	1248	1270	1344	1315	1282	9110	ontains O.S. data @ 4

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Summary of total number of field operations undertaken during crop establishment of Parsnips across the SP (I) landbank

Parsnips	2010	2011	2012	2013	2014	2015	2016	Total
2 Bed Ridger		5						5
3 Bed Ridger	2	1	1	10	12	8	8	42
Bed Former	2	1	9	15	16	16	15	74
Bedform	16	12						28
CARROT/SNIP Drilling		1		9	20	15	10	55
Dam Dyke Installation			4		1		2	7
Dam Dyke Removal			1					1
Destone	13	5	2					20
De-Stoning	2	1	2	5	12	7	8	37
Disc		1		3	2	1	3	10
Disc and Mow							3	3
Drill - Precision	4	12	10	7			5	38
Dutch Harrow	2	1				13	15	31
Fertiliser App	10	5	9	10	13	8	14	69
Lay / Remove Cabbage Netting						1		1
Lilleston Wheeling					12		1	13
Plough	18	10	9	14	17	9	15	92
Plough Press					1			1
Ridge 3 Bed			4					4
Roll						2		2
Rotavate		5	1	1	3	4	5	19
Spread Straw		2		1	2	1		6
Spread Straw +Poly		1		1	2	1	1	6
Steerage Hoe			9		1			10
Subsoil	2	12	10	15	18	17	16	90 <
Sumo		1		1				2
Superflow		2				7	9	18
Superflow Drag			1	1	5	6		13
Top and Rotavate							1	1
Topping		3			1	2	2	8
Vaderstad Carrier 925 Demo						1		1
Vaderstad Carrier L 625						3		3
Vaderstad RDA400S(Drill)						2		2
Total	75	88	73	93	143	127	135	734

LandIS derived Workability Days for Grower G

• Timing of tillage/harvesting operations can be linked to 'Workability Days' in order to identify those operations undertaken at 'Field Capacity' and thus likely to cause compaction.

			Dry Year				Median Year				Wet Year				
SITE	Soil Series	Name of Soil Series	FROM	то	WA_CODE	Wetness Class	FROM	то	WA_CODE	Wetness Class	FROM	то	WA_CODE	Wetness Class	
TF56000200	4	ADVENTURERS'	31-Jan	20-Mar	а	I.	09-Jan	04-Apr	а	I	18-Dec	25-Apr	а	I	
TF56000200	5	AGNEY	31-Jan	20-Mar	а	Ш	09-Jan	04-Apr	а	Ш	08-Nov	25-Apr	с	П	
TF56000200	112	BECCLES	22-Dec	05-Mar	с	Ш	30-Nov	20-Mar	с	Ш	08-Nov	10-Apr	с	Ш	
TF56000200	124	BLACKWOOD	10-Feb	30-Mar	аа	I	19-Jan	14-Apr	aa	I	28-Dec	05-May	aa	I	
TF56000200	170	BURLINGHAM	11-Jan	10-Mar	b	Ш	20-Dec	25-Mar	b	П	28-Nov	15-Apr	b	П	
TF56000200	173	BARROW	31-Jan	20-Mar	а	I	09-Jan	04-Apr	а	I	18-Dec	25-Apr	а	I	
TF56000200	175	BLACKTOFT	31-Jan	20-Mar	а	I	09-Jan	04-Apr	а	I	18-Dec	25-Apr	а	I	
TF56000200	313	DOWELS	11-Jan	10-Mar	b	Ш	20-Dec	25-Mar	b	111	08-Nov	15-Apr	с	Ш	
TF56000200	314	DOWNHOLLAND	31-Jan	20-Mar	а	I	09-Jan	04-Apr	а	I	18-Dec	25-Apr	а	I	
TF56000200	351	DOWNHAM	10-Feb	30-Mar	aa	I	19-Jan	14-Apr	aa	I	28-Dec	05-May	aa	I	
TF56000200	419	EVESHAM	01-Jan	07-Mar	bc	Ш	10-Dec	22-Mar	bc	Ш	08-Nov	12-Apr	с	Ш	
TF56000200	428	EBSTREE	10-Feb	30-Mar	aa	I	19-Jan	14-Apr	aa	I	28-Dec	05-May	aa	I	
TF56000200	442	EASTVILLE	31-Jan	20-Mar	а	I	09-Jan	04-Apr	а	I	18-Dec	25-Apr	а	I	
TF56000200	500	FAIRFIELD	11-Jan	10-Mar	b	Ш	20-Dec	25-Mar	b	Ш	08-Nov	15-Apr	с	П	

Grower F: Workability Days, Workability Codes and Wetness Classes.

Adjusted based on whether for the years 2010-2015 the autumn and spring periods were associated with rainfall considered to fall within the Dry (<25th Percentile), Median (25th -75th Percentile) or Wet Quartile (75th Percentile) relative to the 1940-1970 average.

• Machine learning approaches can be used to quantify the impacts of these tillage/harvesting operations on yield in a rotational context.

Grower G: Tillage operations undertaken outside of 'Workability Days'.

	Machinery Operation	No. of times operation	No. of times operation	% of operations undertaken outside
Crop	Recorded	recorded	occurred outside MWD	Workability Days
	3 Leg Buster	2	2	100%
	Disc and Press	1	0	0.0%
	Flatlifting	3	1	33.3%
Cauliflowers	Plough	37	7	18.9%
	Sumo Trio	3	0	0%
	Top Down	3	2	66.7%
	Spray Operation	51	5	9.8%
	3 Leg Buster	1	0	0%
	Bust Tramlines	1	0	0%
	Disc & Press	17	0	0%
	Fill in Furrows	3	0	0%
	Flatlifting	29	0	0%
	Pea Vining (Harvest)	65	0	0%
Vining Peas	Plough	93	3	3.2%
	Preperator	47	0	0%
	Sumo Trio	22	1	4.5%
	Top Down	5	2	40.0%
	Vardestadt Drill 6m	85	0	0%
	WFL Pea Drill+Cult	16	0	0%
	WFL Spray	511	4	0.8%
			18	© Cranfield University 2016

Susceptibility to compaction



Potential for natural regeneration





SMIS Case Studies: Factors affecting Vining Pea yields

SOIL MANAGEMENT NORMATION SYSTEM ANALYTICS		
> ≅ Browse Database	Rule base browser	
✓ 🗖 Rule Bases	Filtering	
Q Browse Rule Bases	Add filter	Execute 🌾
> 📰 Established Queries	Vining Peas Crop Remove	
	Include literature evidence (unaffected by filtering):	
	Rule base graph	-
	The chiefer of Appleations Tere Elements Tere Elements	

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SMIS Case Studies: Varietal differences in vining pea yields





LE Compaction risk

JE Foot rot inc

↓ PCN level

Le Cavity spot



SMIS Case Studies: Factors affecting Winter Wheat yields















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