Royal Agricultural University Cirencester

Research on the Royal Agricultural University Farms

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Outline of the presentation

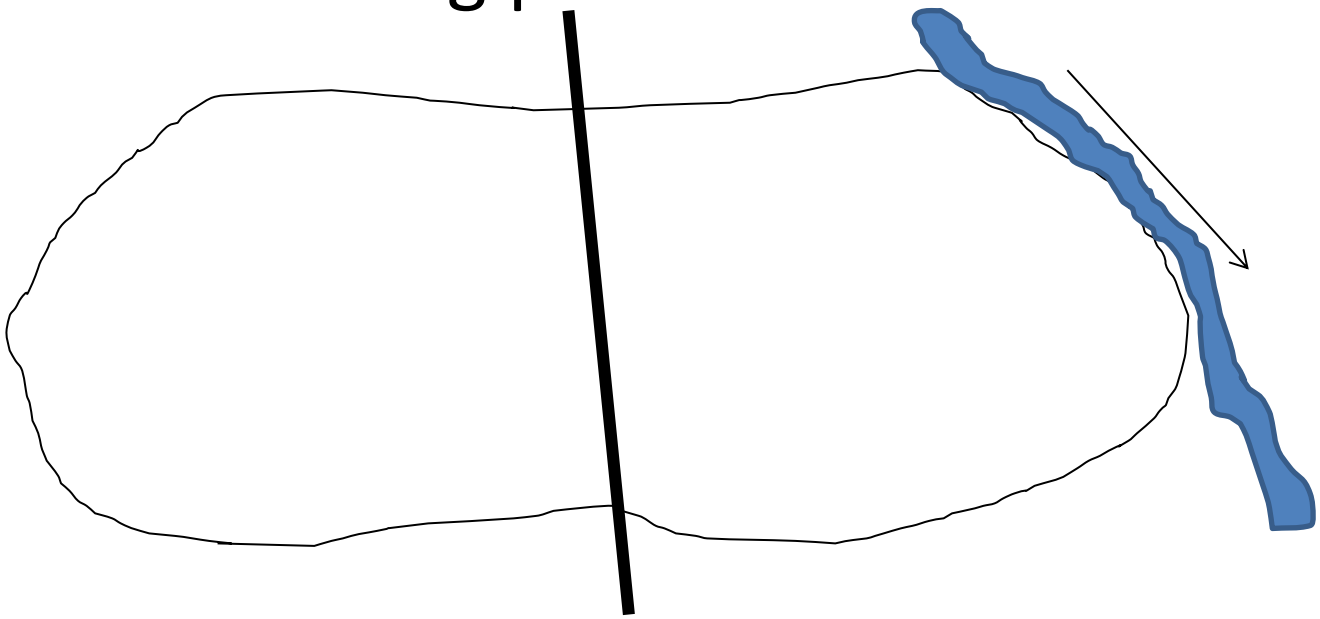
- Current active research projects
- Focus on legume research
- Focus on crop establishment/management research
- Future research objectives

Why do we conduct research at the RAU?

- To enable us to give research informed teaching
- To demonstrate research in practice
- For industry collaboration and furthering knowledge
- To publish referred papers
- To enable students to gain PhD’s
- Working towards RDAP

What is research??

- A questionnaire
- Semi structured interviews with farmers
- Modelling data
- Field trials finding practical solutions



Current crops research on the RAU Farms

- NIAB Tag farmer demonstration plots
  - Varieties
  - Fungicide programs etc
  - Student competition
- NIAB Tag soil amendment study
- BASF various fungicide and herbicide trials
- Stimplex bio stimulants
- Leeds Uni project DART project
- Controlled traffic farming
- The role of hedgerows on farms
- ……Varieties, cultivations and crop establishment

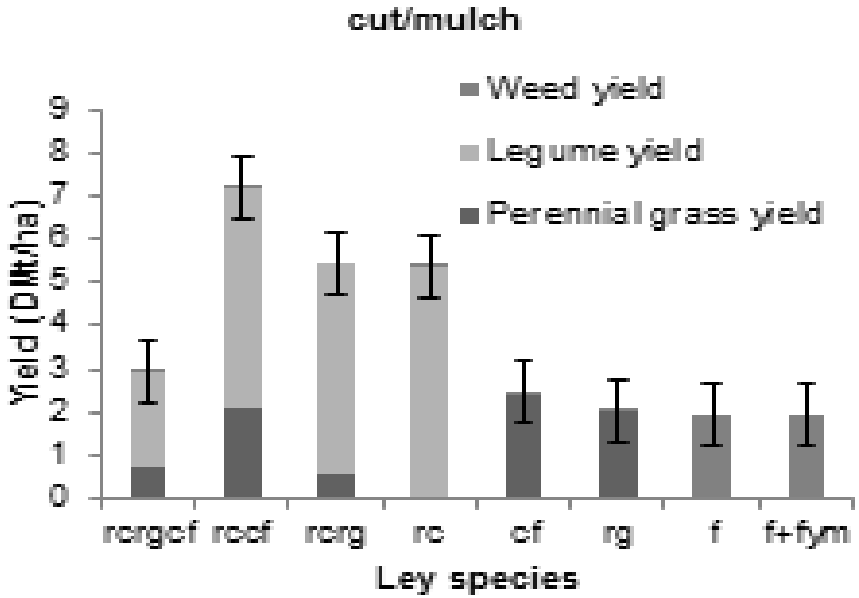
Building soil fertility by natural means

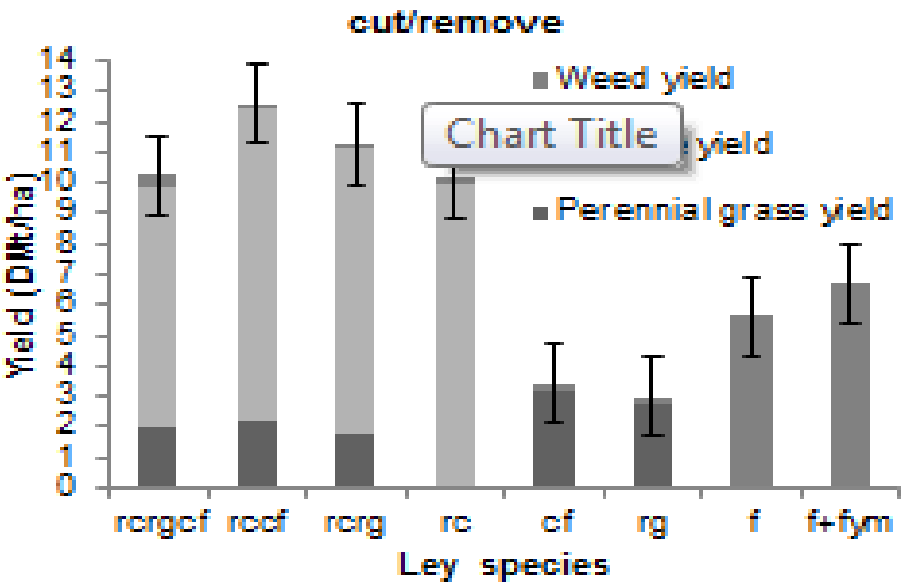
- Investigating the role of red clover, perennial ryegrass and cocksfoot against a control of fallow

In collaboration with Cotswold Seeds Ltd.

Whilst considering

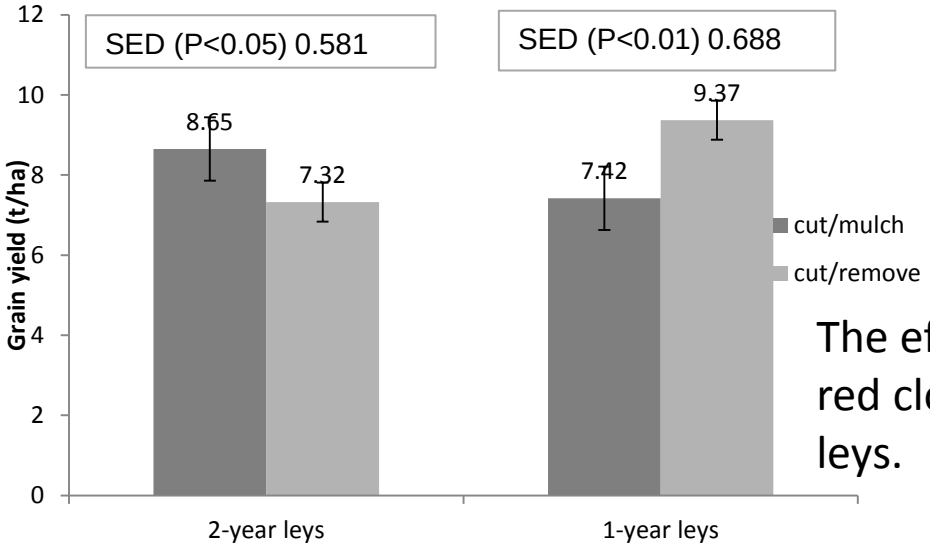
- 1 year or 2 year duration
- The impact of cut and remove against mulching



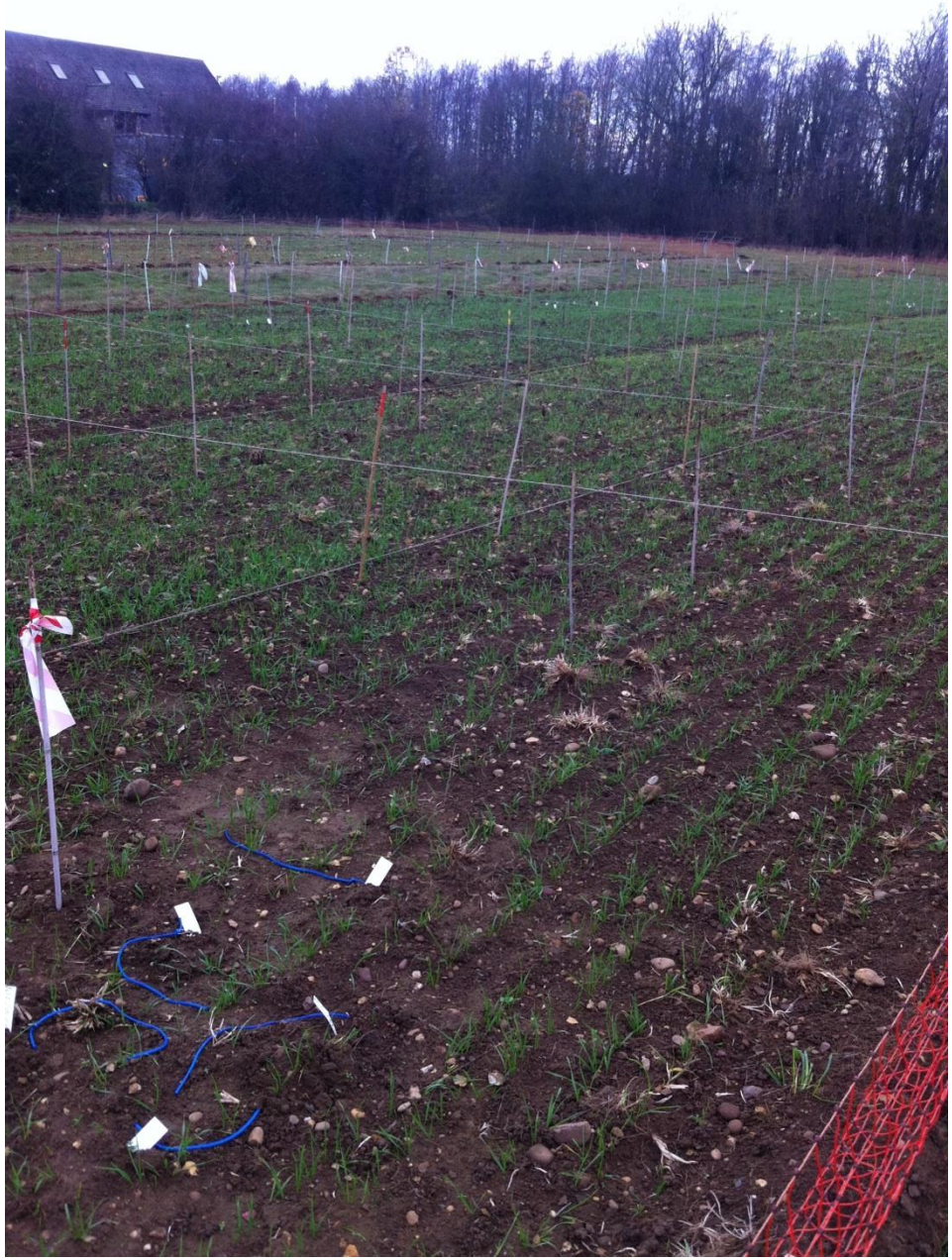


Error bars= standard error.

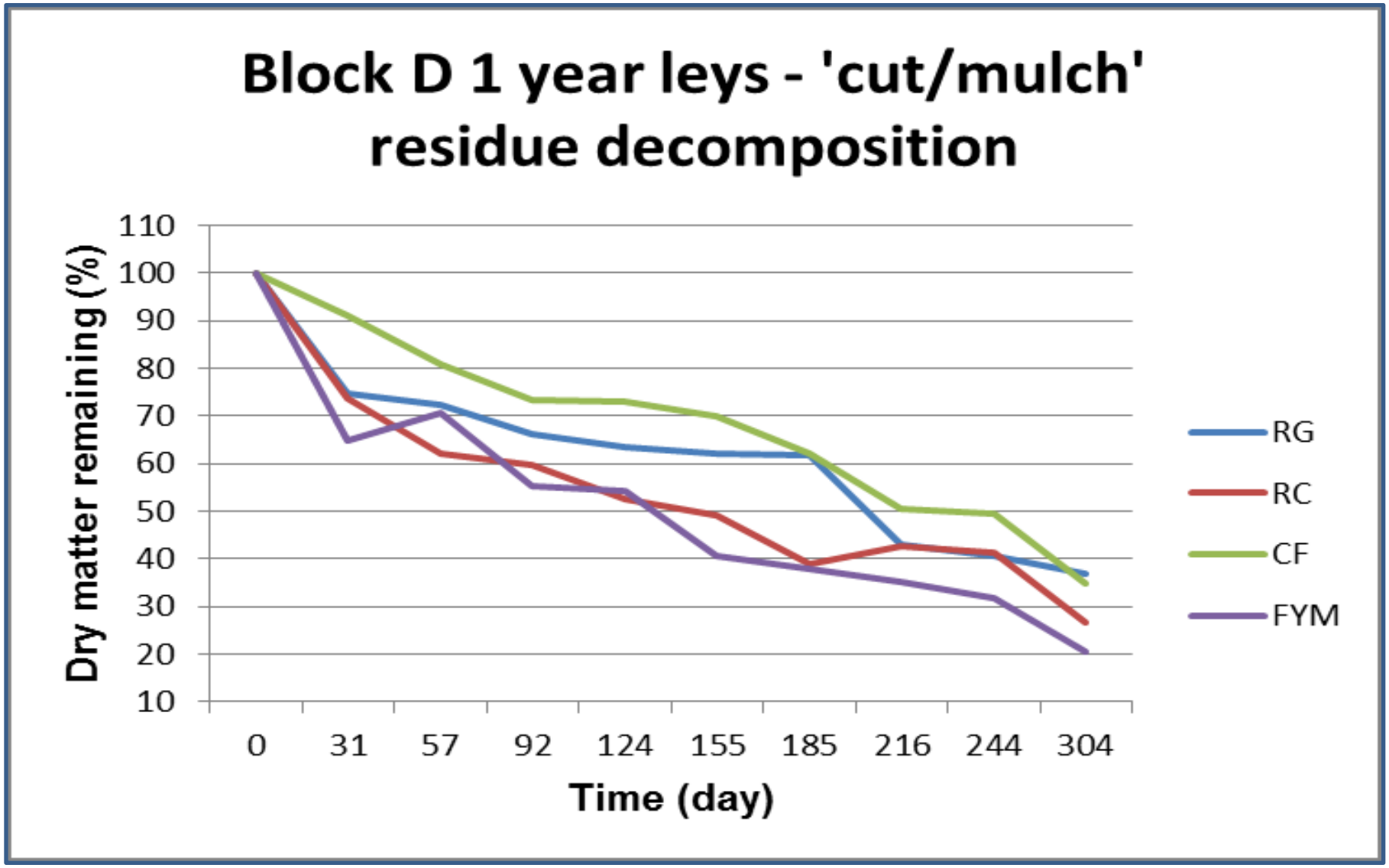
Figure 1. Annual above-ground biomass yields (tDM ha-1) of legume/grass mixtures under 'cut/remove' and 'cut/mulch' systems in 1-year leys.



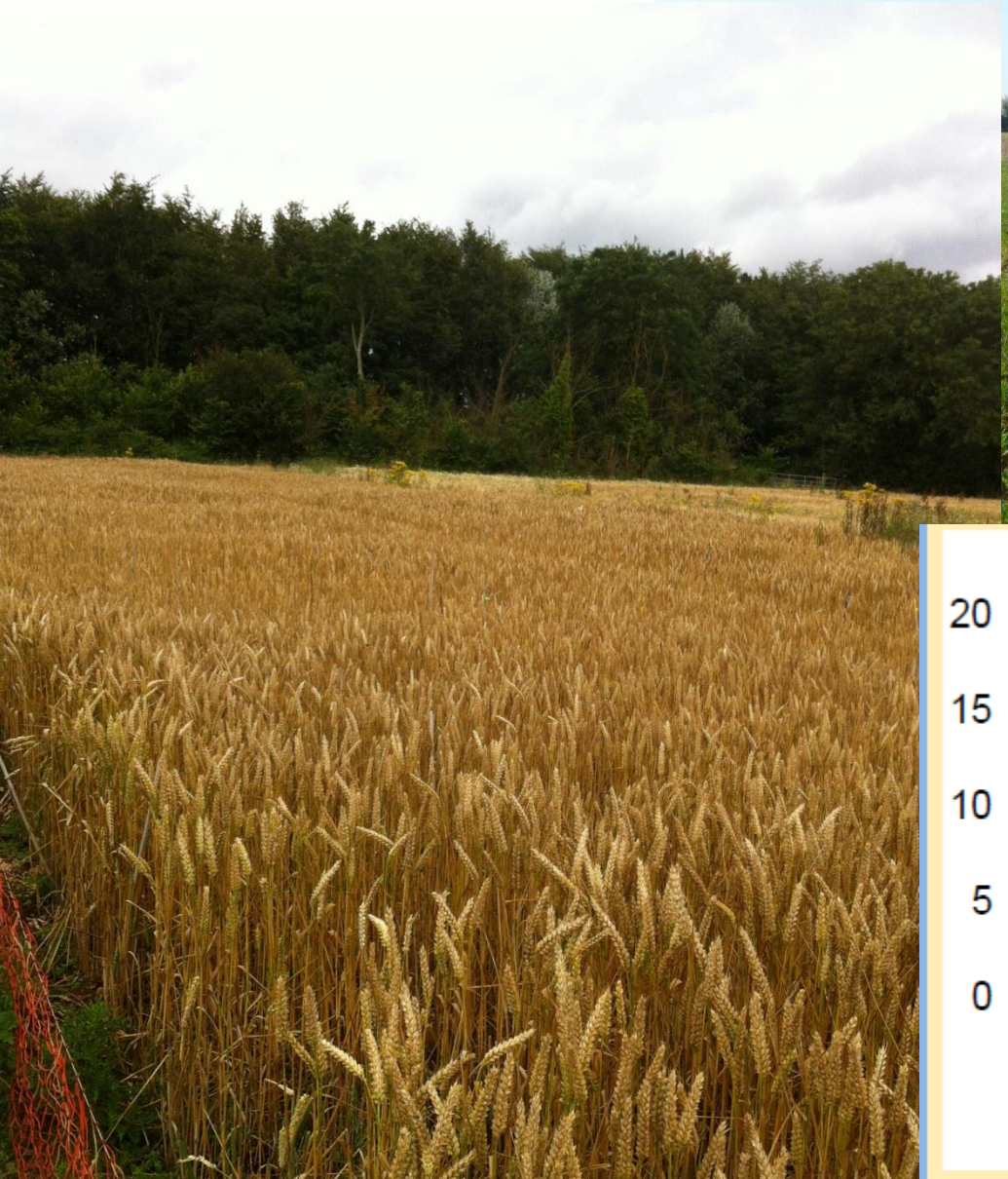
The effect of 'cut/remove' and 'cut/mulch' of red clover leys on grain yield in 2- and1-year leys.

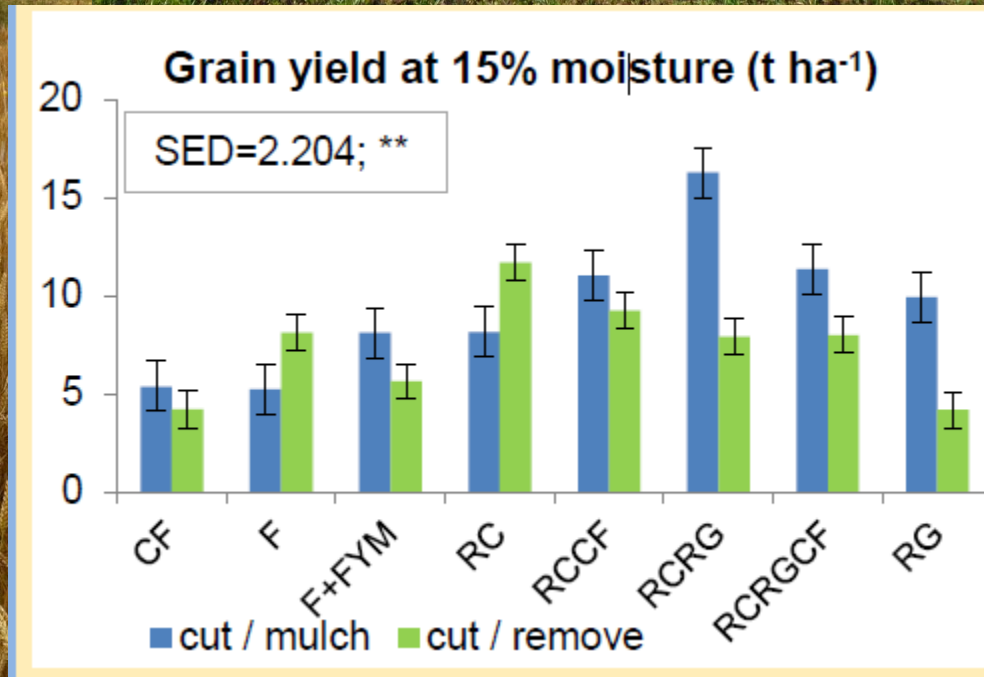


Mesh bags were buried to look at the breakdown of grass/legume residues


Block D 1 year leys - 'cut/mulch' residue decomposition
Dry matter remaining (%)
110
100
90
80
70
60
50
40
30
20
10
0
31
57
92
124
155
185
216
244
304
Time (day)
RG
RC
CF
FYM

Test crop of spring wheat





Results of test cropping year 1

	Plant height (cm)	Ear count (m^2)	Harvest Index	Wheat biomass DM t ha^{-1})	Grain yield at 15% moisture (t ha^{-1})	Nitrogen Harvest Index	Grain N (kg ha^{-1})	Grain protein (%)
Sown species								
cf	66^{a}	435^{a}	53.41	8.94^{a}	4.78^{a}	43.82^{ab}	70.1^{a}	8.40^{ab}
f	71.67^{c}	429^{a}	53.98	12.3^{ab}	6.68^{ab}	43.5^{ab}	96.9^{ab}	8.28^{a}
f+fym	73.08^{cd}	504^{ab}	52.26	13.12^{b}	6.86^{b}	41.71^{a}	97.7^{ab}	8.21^{a}
rc	79.71^{e}	578^{bc}	53.54	18.58^{cd}	9.93^{c}	50.78^{c}	159.1^{cd}	9.16^{d}
rccf	75.12^{d}	628^{c}	53.43	18.93^{cd}	10.12^{cd}	41.11^{a}	146.9^{c}	8.21^{a}
rcrg	75.17^{d}	661^{c}	54.91	21.98^{d}	12.09^{d}	44.38^{ab}	185.1^{d}	8.64^{bc}
rcrgcf	74.33^{d}	631^{c}	52.87	18.07^{c}	9.67^{c}	42.2^{a}	143.3^{c}	8.36^{ab}
rg	69.17^{b}	458^{ab}	53.28	12.92b	7.04b	47.01^{bc}	107.9^{b}	8.83^{cd}
SED	1.213	62	1.015	1.889	1.043	2.405	16.5	0.1691
P-value	***	***	NS	***	***	**	***	***
Cutting system								
cut / mulch	74.3	592	53.64	17.5	9.43	45.09	143.6	8.63
cut / remove	71.8	489	53.28	13.7	7.36	43.53	108.1	8.39
SED	0.607	31	0.507	0.944	0.521	1.202	8.25	0.0846
P-value	***	**	NS	***	***	NS	***	**
Sown species * Cutting system								
SED	1.716	87.7	1.435	2.671	1.474	3.401	23.34	0.2392
P-value	***	***	**	***	***	NS	***	NS

Main conclusions

- Mulching leys over 2 years significantly increased grain yield than ‘cut/remove’, whereas it had the opposite effect in the 1-year leys. The difference was marginal, at 1.3t and 1.95t between ‘cut/mulch’ and ‘cut/remove’ in 2- and 1-leys respectively.
- Although soil PMN was below 100kg N ha^{-1} and 50kg N ha^{-1} for 2- and 1-year leys respectively, it seemed adequate for a reasonable wheat grain yield in both ley trials. The 1-year leys had higher grain yield when compared to 2-year leys but with 1% lower protein content.
- There was a negative relationship between protein content and grain yield in 1-year leys, but a positive one in the 2-year leys which may be ascribed to crop nitrogen status and climatic factors.
- The cut/mulch system had marginal but significantly higher PMN than cut/remove in 2-year leys.
- The wheat yield results imply that mulching red clover leys may be appropriate in building up nitrogen in 2-year leys while cutting and removal of herbage might be suitable in 1-year leys.

Investigating the impact of crop establishment technique in organic cropping

- To assess the impact of different soil tillage techniques (direct drill, minimum tillage and plough and cultivate) on soil physical environment and the impact of these on organic wheat establishment and growth

- To identify the impact of bi-cropping wheat with white clover or black medic in comparison to wheat as mono-crop on wheat establishment and yield

- To explore interactions between cultivation techniques and bi-cropping system on organic wheat growth and yield

Ecodyn

- Direct drill with large tined feet
- Leave a residual legume canopy
- Reduced total energy usage for establishment

Vaderstad

- Minimum tillage
- Disced/press prior to drilling (Simba express)
- ‘Mixes’ top soil
- Common practice in conventional agriculture

Power Harrow drill

- Requires ploughing before drilling
- Common practice in organic crop establishment

Block D			Block E			Block F		
Plough	DD	MT	Plough	MT	DD	DD	Plough	MT
BM P-30	C P-33	C P-36	C P-39	BM P-42	WC P-45	C P-48	BM P-51	WC P-54
C P- 29	WC P-32	BM P-35	WC P-38	WC P-41	BM P-44	BM P-47	WC P-50	C P-53
WC P- 28	BM P-31	WC P-34	BM P-37	C P-40	C P-43	WC P-46	C P-49	BM P-52

24m

Block A			Block B			Block C		
MT	Plough	DD	DD	Plough	MT	Plough	MT	DD
C P-3	WC P-6	BM P-9	C P-12	BM P-15	C P-18	BM P-21	C P-24	WC P-27
WC P-2	BM P-5	C P-8	WC P-11	C P-14	WC P-17	C P-20	WC P-23	BM P-26
BM P- 1	C P-4	WC P-7	BM P- 10	WC P-13	BM P-16	WC P-19	BM P-22	C P-25

100m

33.3m

30m

GATE

90m

MT- Minimum tillage treatment

DD - Direct drill treatment

C - Control/no undersowing

BM - Black medic undersown

WC - White clover undersown

P - plot

Experimental details 2011/12

Previous crop (2007-10) - 3 year white clover/perennial rye grass ley

2010/11 - Organci wheat cv. Claire drilled 5th Nov 2010 undersown with white clover and Black medic (April 2011)

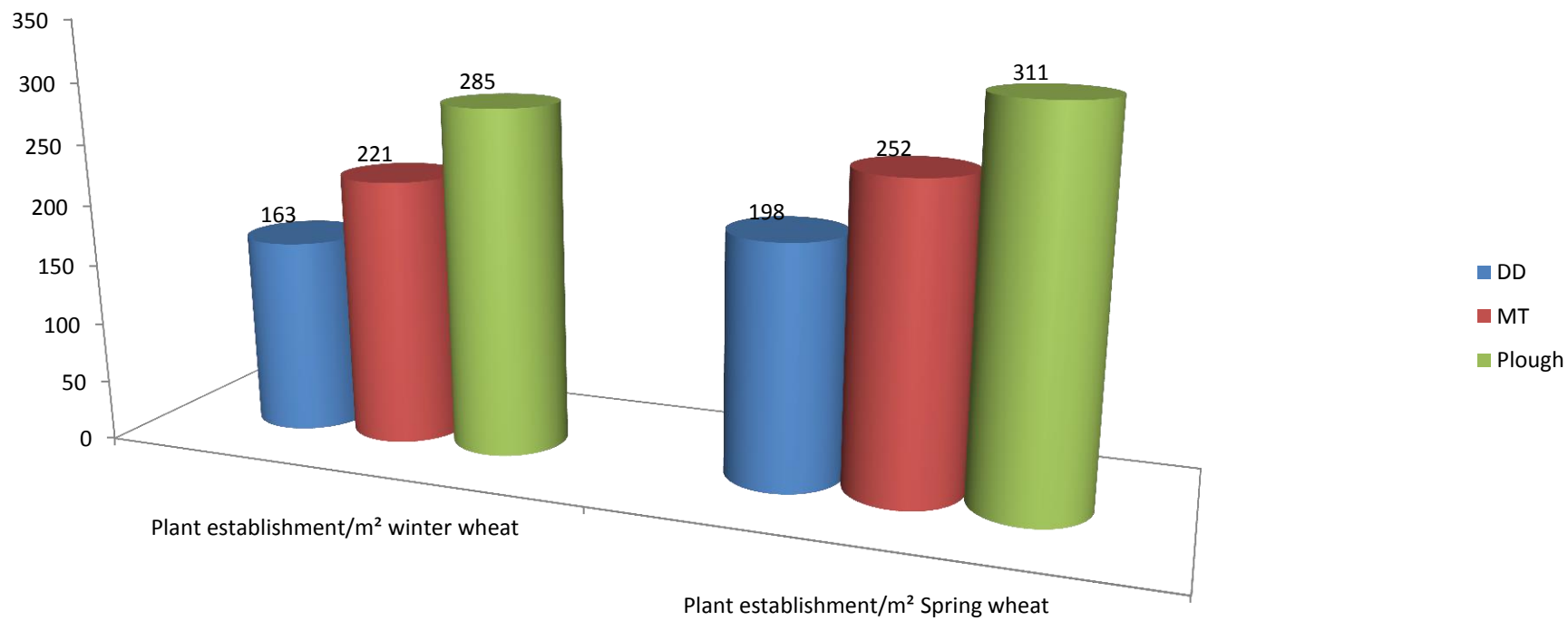
2012 - Organic wheat cv. Paragon drilled 14th March 2012 seed rate: 220kg/ha, Seed number - 420/m²

Cultivation prior to drilling : Minimum tillage/Plough/Direct drill

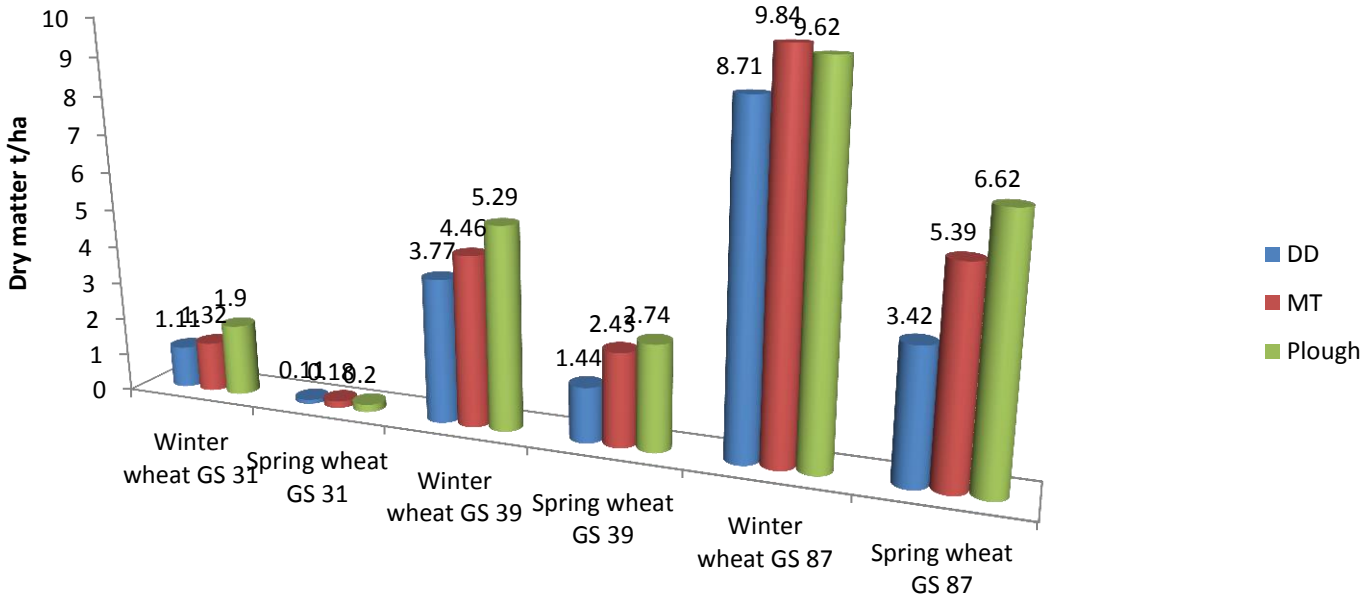
White clover 12.5kg/ha or 0.8kg/plot TOTAL - 14.4kg

Black medic 13.5kg/ha or 0.7kg/plot TOTAL - 12.6kg

Influence of tillage on wheat plant establishment



Influence of tillage on wheat biomass

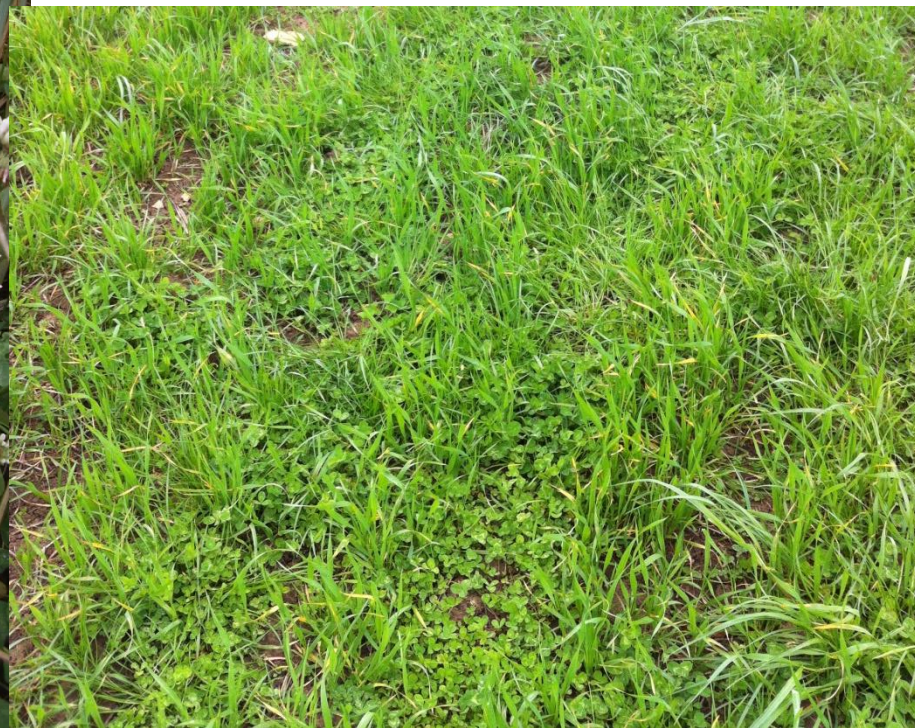


	Year 1: Organic winter wheat-2010/11					Year 2 : Organic spring wheat-2012				
	DD	MT	Plough	SED	Significance	DD	MT	Plough	SED	Significance
1000 grain weight g	40.91a	43.11b	43.85b	0.821	0.001 Significant	30.75a	33.98b	35.62c	0.796	<0.001 Significant
Grain yield tha^{-1}	5.53a	6.58b	7.00b	0.27	<0.001 Significant	2.11a	2.96b	3.52c	0.19	<.001 Significant
DW of total above ground biomass tha^{-1}	10.77a	12.34ab	12.86b	0.46	<0.001 Significant	7.24a	8.1ab	9.04b	0.47	<0.001 Significant
DW of Ears tha^{-1}	6.61a	7.95b	8.40b	0.32	<0.001 Significant	2.68a	3.69b	4.36c	0.22	<0.001 Significant
DW of Straws tha^{-1}	3.19a	4.00b	4.27b	0.17	<0.001 Significant	2.48a	3.6b	4.2c	0.21	<0.001 Significant
Harvest index (%)	56.46a	55.02a	55.28a	0.77	0.144	42.28	40.17	41.52	1.91	0.537

Bi-cropping

Compare:

- White clover (*Trifolium repens*)
- Black medic (*Medicago lupina*)
- Control



Investigating other legume bi-cropping options

	Plant height (cm)	Ear (number m^{-2})	Wheat DM yield (t ha^{-1})	TGW (g)	Grain yield (t ha^{-1})	Legumes DM (t ha^{-1}) (a)	Weeds DM (t ha^{-1}) (b)	Non wheat DM (t ha^{-1}) (a + b)
Non-undersown	81.52a	372a	9.37a	34.86	3.79a	0.130a	0.172	0.307a
Wheat + WC	81.16a	360ab	8.89ab	34.80	3.61ab	0.258b	0.195	0.452ab
Wheat + BM	80.66a	335abc	8.52ab	34.49	3.51ab	0.264b	0.226	0.489abc
Wheat + BT	80.44a	328abc	7.34bc	33.21	2.92bc	0.272b	0.245	0.516bc
Wheat + V	79.25ab	307bc	7.28bc	33.71	2.84bc	0.293bc	0.294	0.586bc
Wheat + RC	77.17bc	290c	6.75c	33.81	2.62c	0.298bc	0.287	0.584bc
Wheat + CC	76.30c	286c	6.60c	32.74	2.52c	0.358bc	0.334	0.692c
Wheat + PC	75.14c	275c	6.26c	31.29	2.27c	0.393c	0.298	0.691c
SED	1.25	30.32	0.956	1.292	0.41	0.0.58	0.080	0.106
Significance	*	**	**	ns	**	**	ns	**

Main conclusions from this study

- Ploughing is a reliable option compared to other tillage treatments.
- Unlike winter wheat, spring wheat with low plant establishment induced by contrasting tillage treatment also emulated on crop growth and therefore crop productivity.
- Bi-cropping is highly reliant on seasonal weather.
- White clover is a more reliable option than black medic.

Building up the yield

- Introduce basic weed control
- Find the appropriate levels of N for low input cropping
- Consider the impacts of reversion from organic cropping back to conventional systems

Objectives of the study

- Estimate the productivity of wheat bi-cropped with black medic (*Medicago sativa*) and white clover (*Trifolium repens*) under a low-input system.
- Evaluate the potential for suppressing weeds of black medic and white clover when sown as a bi-crop with wheat under a low-input system.
- Explore the potential effects on soil fertility and weed and disease control of white mustard (*Sinapsis alba* L.) as cover crops under a low-input approach.
- Determine the effect that different cultivation techniques (ploughing, minimum tillage and direct drill) have on soil compaction, weed pressure, and crop productivity.
- Investigate N availability within all the interactions among components in a low-input system.
- Determine profitability and GHGs footprint in a low-input system.

N Management Strategy

Compare:

- 210 kg N ha^{-1}
- 140 kg N ha^{-1}
- 70 kg N ha^{-1}
- Control

Publications

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Azo, W.M., Lane, G.P.F., Davies, W.P.D. & **Cannon, N.D**. (2009). Conductance model evaluation for predicting yields and protein content of lupin/cereal forage crops in organic farming. *Proceedings of the 7th European Conference on Precision Agriculture (7ECPA), 679-686.* Wageningen Univiersity, The Netherlands.

Azo, W.M., **Cannon, N.D**., Lane, G.P.F. & Davies, W.P.D. (2009). Conductance model assessment for yield and protein content prediction in lupin-cereal forage crop mixtures in organic farming systems. *BGS 9th Research Conference.* 60-64.

Azo, W.M., Lane, G.P.F., Davies, W.P.D. & **Cannon, N.D.** (2011). Predicting dry matter and crude protein yields of lupin and cereal mono- and bicrops using a computer model. *Biological Agriculture and Horticulture* **27**:3-4, 278-293.

Moyo, H., Lane, G.P.F., Davies, W.P. & **Cannon, N.D**. (2011). Strategies for soil fertility – building through improved legume cropping. *Aspects of Applied Biology* **109**, 155-160.

Azo, W.M., Lane, G.P.F., Davies, W.P.D. & **Cannon, N.D.** (2012). Bi-cropping white lupins (*Lupinus albus* L.) with cereals for wholecrop forage in UK organic farming: the effect of seed rate and harvest dates on crop yield and quality. *Biological Agriculture and Horticulture* **28**(2), 86-100.

Moyo, H., Davies, W.P**., Cannon, N.D**. and Conway, J.S. (2013) Influences of red clover/grass management on wheat performance. *Aspects of Applied Biology,* 121 Rethinking agricultural systems in the UK, 143-148.

Vijaya Bhaskar. A.V., Davies, W.P., **Cannon, N. D.** and Conway, J. S. (2013). Organic wheat performance following conventional and non-inversion tillage systems. *Biological Agriculture and Horticulture* **29**(4), 236-243.

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Vijaya Bhaskar A V, Davies W P, **Cannon N D**, Conway J S.(2013). Characterisation of soil quality following conventional and non-inversion tillage for organic farming. *Aspect of Applied Biology* 121*, Rethinking Agricultural Systems in the UK*, 181-185.

Vijaya Bhaskar A V, Davies W P, **Cannon N D**, Conway J S. (2013). Tillage and undersowing effects on organic wheat yield components and yield. *Aspect of Applied Biology 121, Rethinking Agricultural Systems in the UK,* 173-180.

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Future work

- Strategies of arable farmers for coping with a changing climate
- Options for soya bean production in the UK
- The role of cover crops in UK arable production
- Investigating bean/wheat crop mixtures

Questions

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