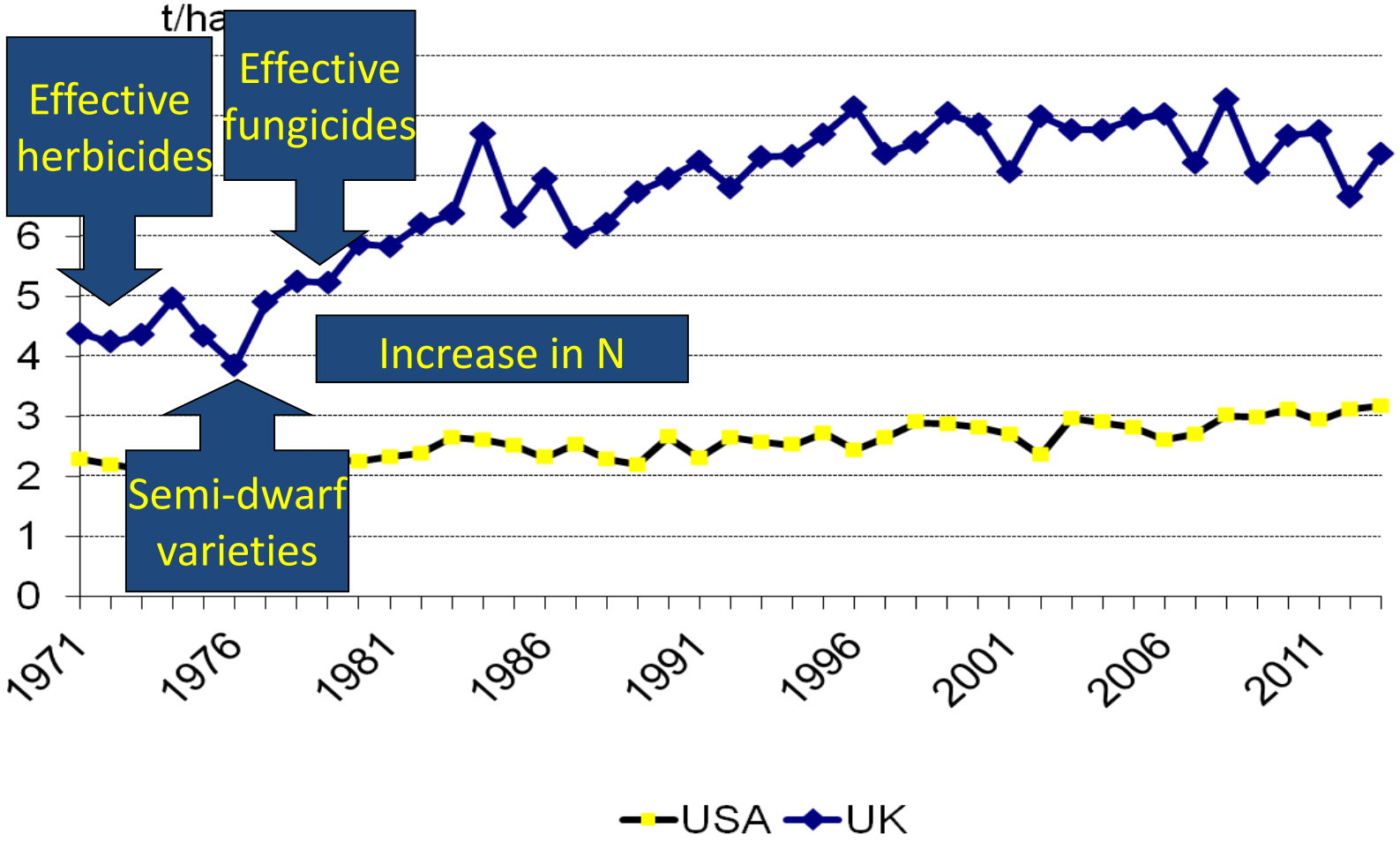
Profiting from Rotations

Jim Orson

UK competitiveness based on technology

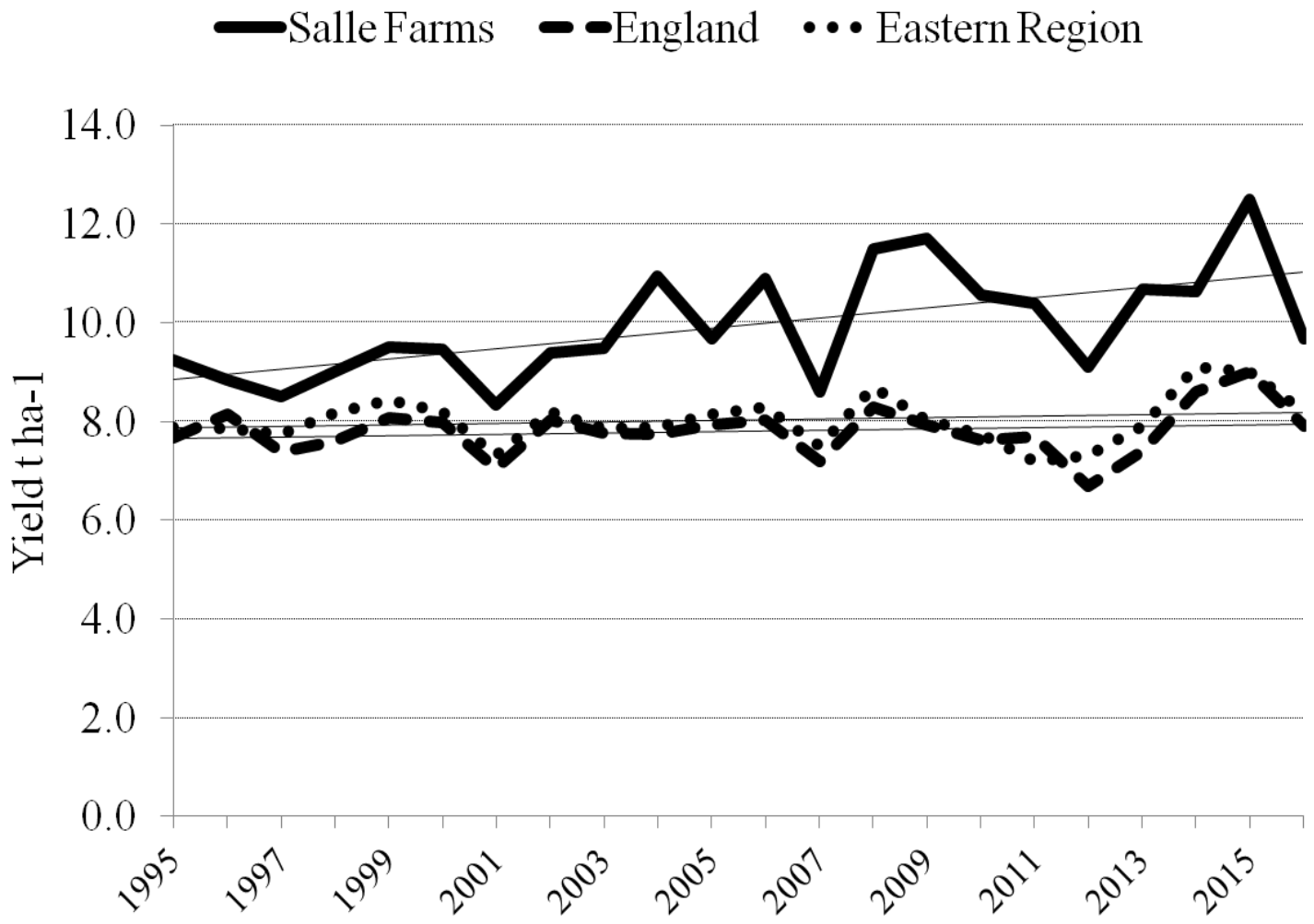
Average wheat yields (t/ha)



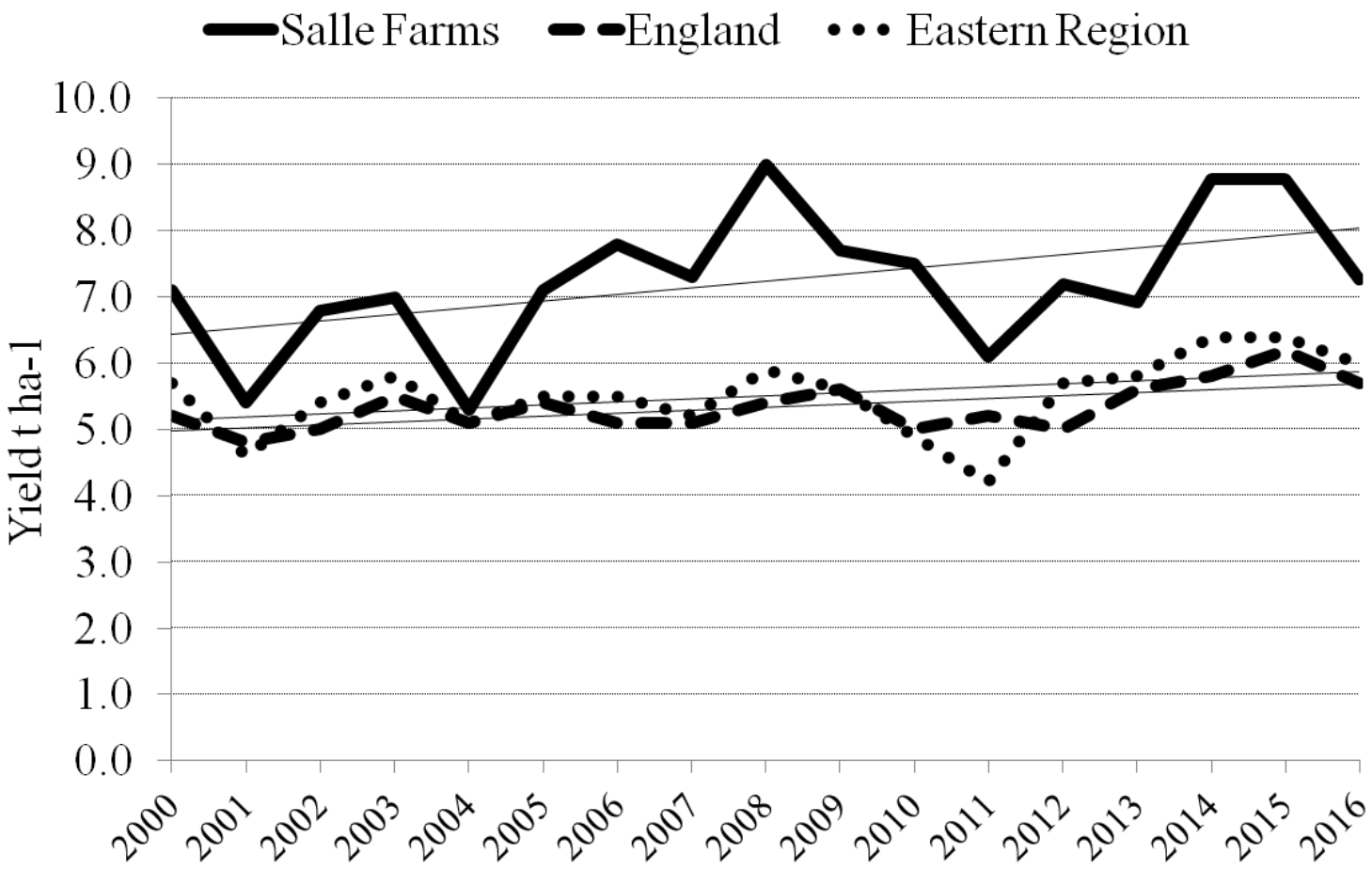
Soil management throughout a revised rotation

	Crop 1	Crop 2	Crop 3	Crop 4	Crop 5	Crop 6	Crop 7
Lime & Organic manure		Limex 70 & Turkey manure		Turkey manure		Limex 70	
Cover crop				Opus/ Bio-Drill 50 mm points		Opus/ Bio-Drill 50 mm points	
Cover crop control				Glyphosate		Glyphosate	
First preparation	Carrier Straw harrow	Opus 50 mm points	Carrier CrossCutter	Carrier CrossCutter	Opus 50 mm points	Carrier Cost Cutter	
Weed control	Glyphosate	Glyphosate					
Second preparation	Opus 50 mm points		Opus 50 mm points	Opus 50 mm points	Opus 50 mm points	Opus 50 mm points	Opus 50 mm points
Drilling	Rapid	Opus/ Bio-drill 50 mm points	Rapid	Compactor /Precision drill	Rapid	Rapid	Rapid
Planted crop	Winter barley	W. oilseed rape	Winter wheat	Sugar beet	W. Wheat or Spring barley	Spring beans	Winter wheat

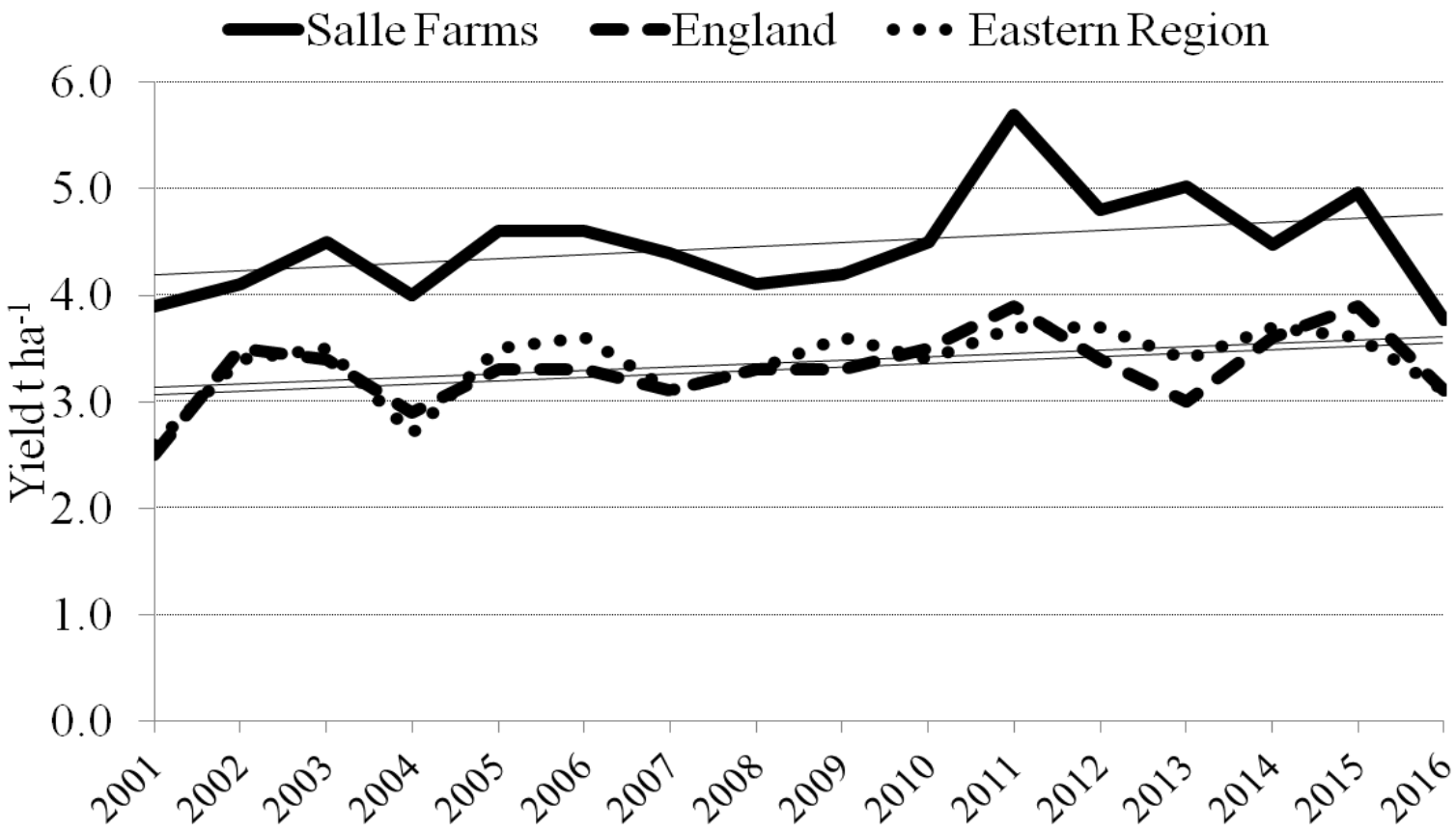
Winter wheat, 1995-2016



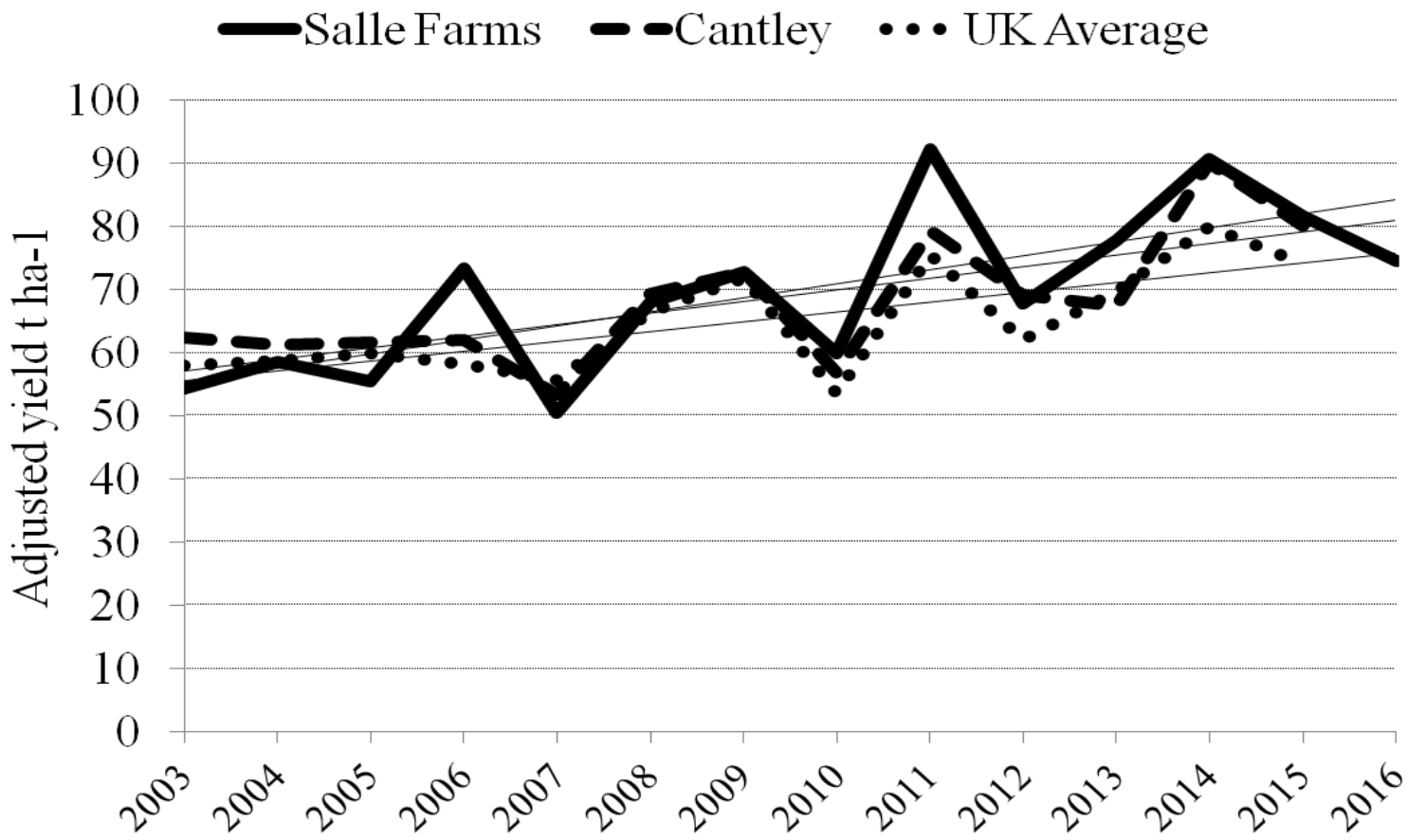
Spring barley, 2000-2016



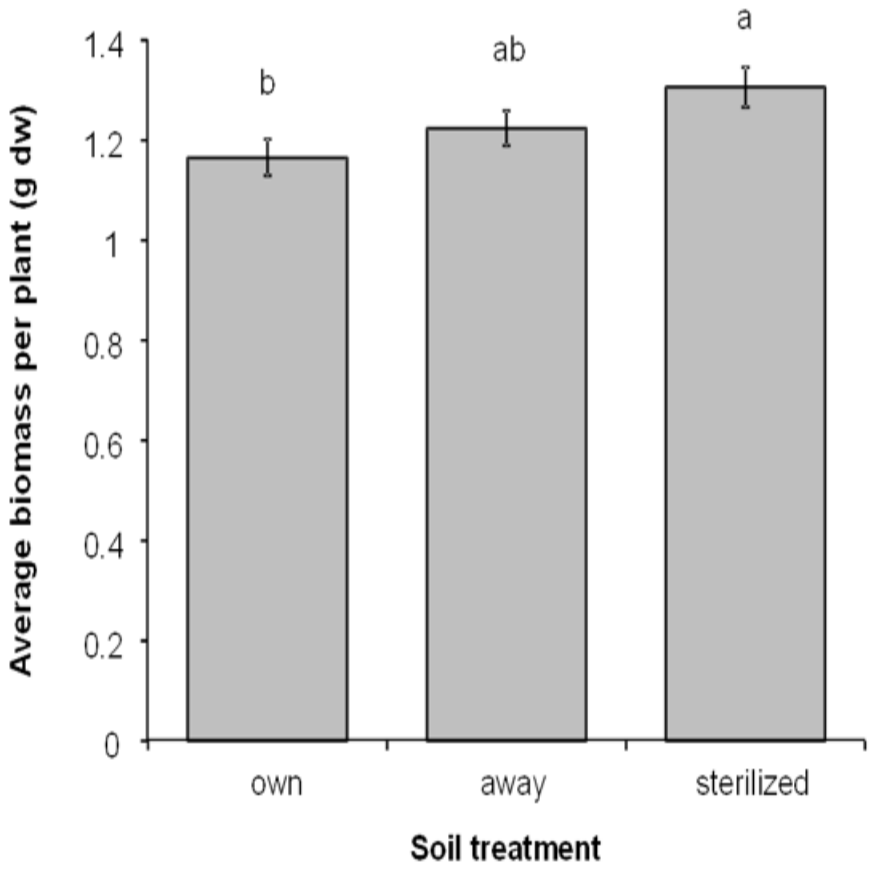
Winter oilseed rape, 2001-2016



Sugar beet, 2003-2016



Plant-soil feedbacks



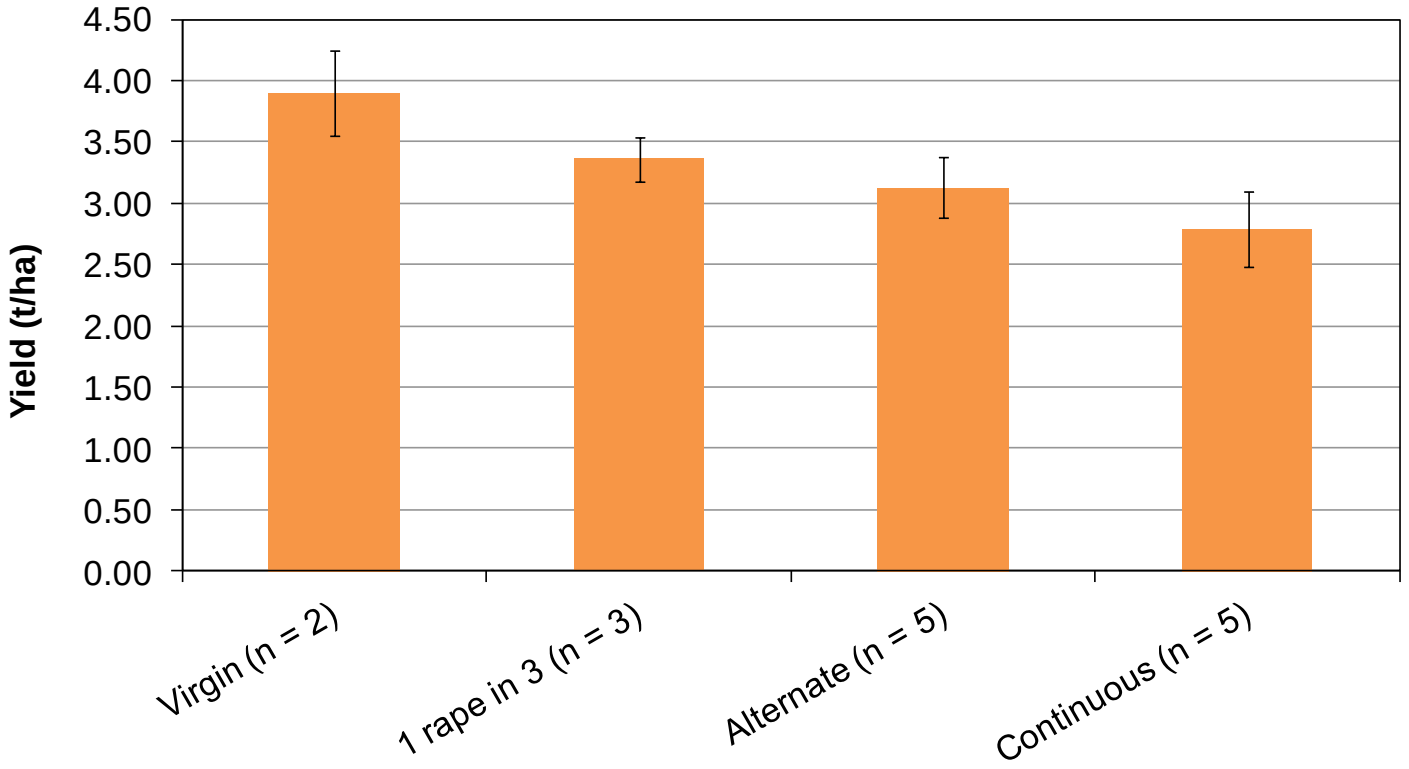
Cortois *et al*., J. of Ecology, Volume 104, Issue 6 November 2016 Pages 1608–1617

Beruti *et al.*, EU Joint Research Council, 2014

The fundamental principle of crop rotation is to exert a control function that prevents particular Arbuscular Micorrhizal Fungi (AMF) from dominating the soil matrix:

- Continuous wheat favours the selection and proliferation of less co-operative and more aggressive fungal symbionts. These are likely to enact similar behaviour to parasitism.
- This can be toned down by 'break crops', such as Brassicae or legumes:
  - Brassicae are non-mycorrhizal crops that act as inhibitors of the dominant AMF species proliferation
  - Legumes are AMF dependent crops that favour the overall propagation of AMF communities

The impact of rotational intensity on the yield of oilseed rape within HGCA project 2922. Data are presented as mean yields from years 3 – 7 (2006 – 2010).



Error bars are a SEM based on the means of individual seasons

Impact on vigour

1st OSR after wheat

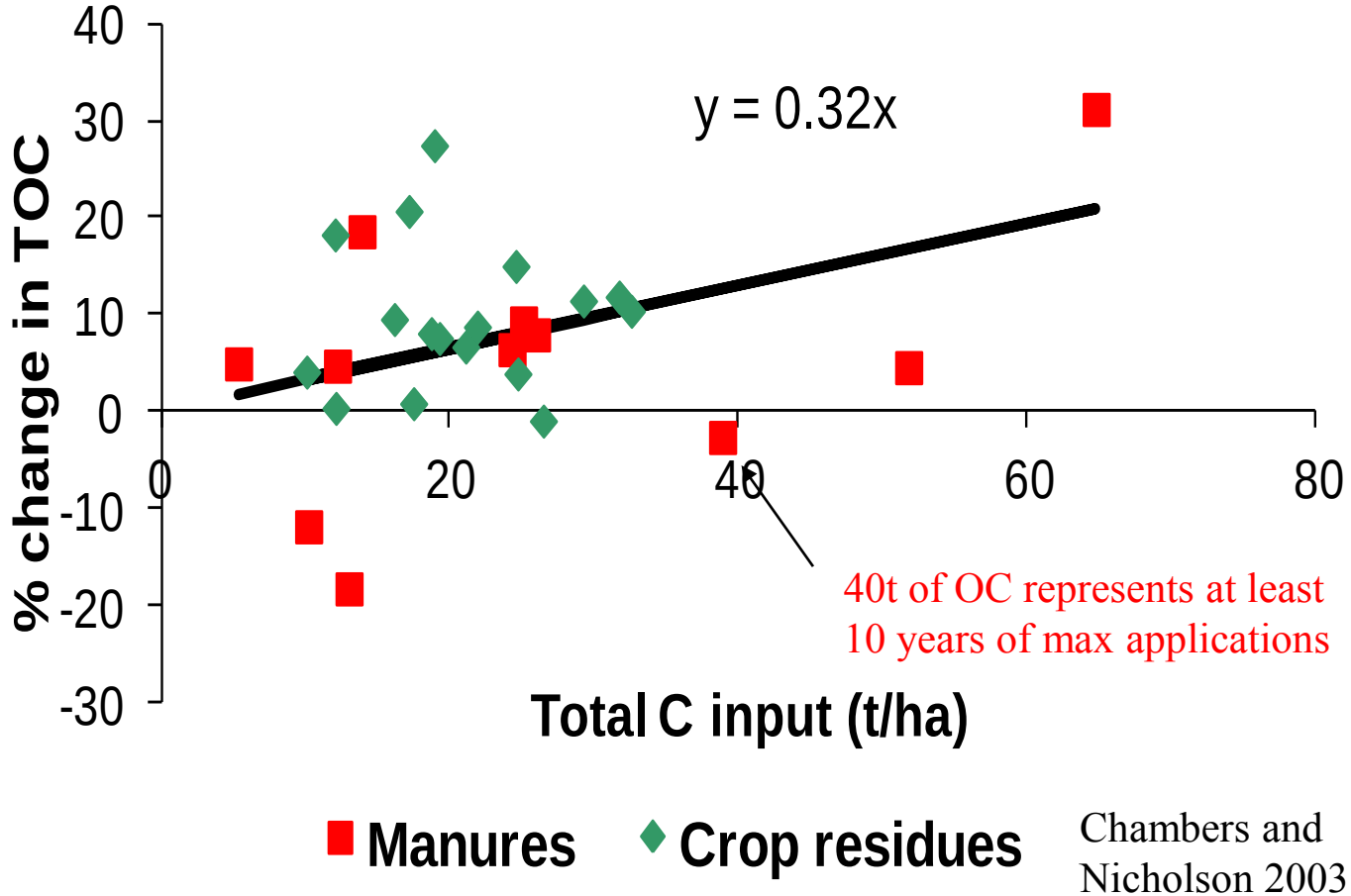
5th OSR - Continuous

Oilseed Rape 2016/7 Crop

No Neonicotinoids

No Slug Pellets

Changes in topsoil total organic carbon (TOC) with total carbon (C) inputs (manures & crop residues)



Chambers and Nicholson 2003

Building fertility: Straw residues

Morley long-term straw incorporation study

NIAB TAG National Agronomy Centre

- Grain yields at Morley
  - ranged from 2 (no N) - 10 t/ha (highest N).
  - incorporation of 3-7 t/ha crop residue dry matter pa (*ca.* 2-5 t OM/ha)
- The incorporation has
  - increase in OM by ca.10% (highest N rate)
  - from 1.57% to 1.74% SOM
- Other changes
  - Microbial biomass increased by *ca.*35% (at highest N rate)
  - Potentially mineralisable N increased by *ca*.60%
  - The ability of the soil to supply N from the decomposition of OM
  - a 10% decrease in penetration resistance
  - indicating that higher N rates make the soil easier to cultivate.

Influence of green manure and cultivation on microbial populations

Figure 5. Carbon dioxide release from incubated soil over six weeks. Cirencester 2006

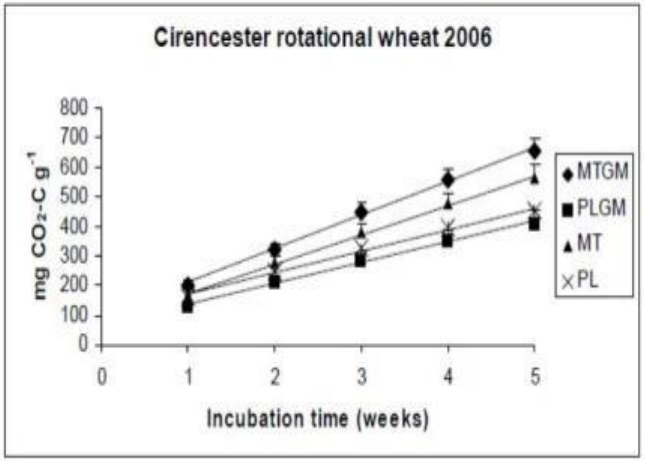
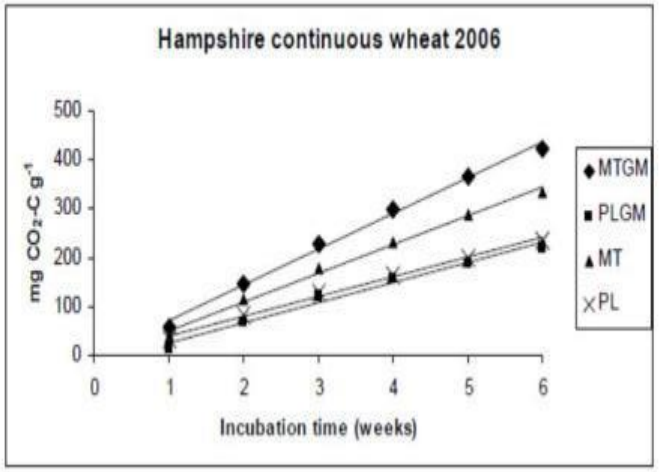


Figure 6. Carbon dioxide release from incubated soil over six weeks. Andover 2006



HGCA project 414

Spring barley following cover crops

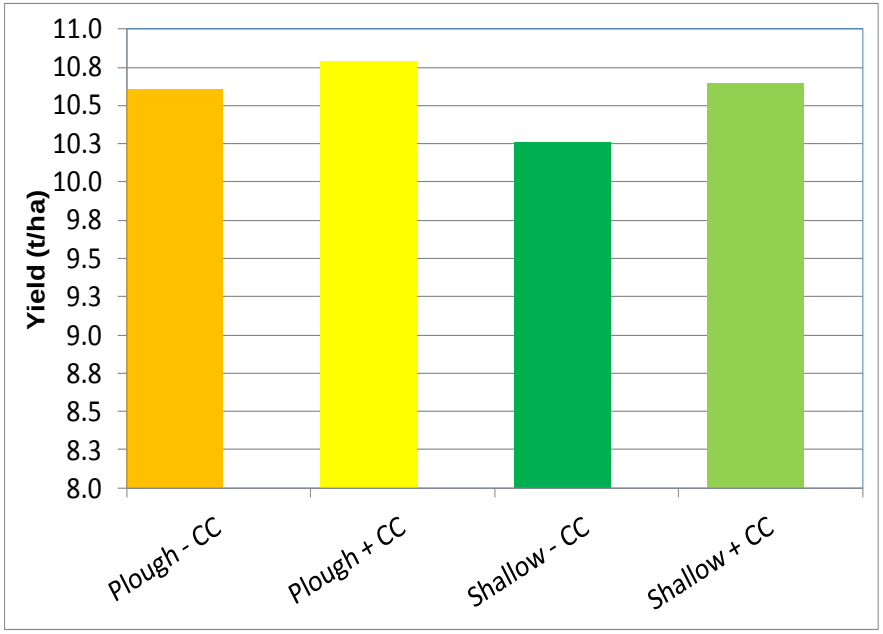
Mean data from studies over 5 seasons:

(assumes N at £0.67/kg and barley at £120/t)

		No cover crop	Following cover crop
Yield (t/ha)			
0 kg/ha N		3.64	4.60
150 kg/ha N		5.56	5.92
Margin over N (£/ha)			
0 kg/ha N		437	552
150 kg/ha N		567	610

Margin at 150 kg/ha with cover crop gave a mean response over 5 seasons of £43/ha

New Farming Systems research using cover crops for bio-cultivation (winter wheat, 2015)

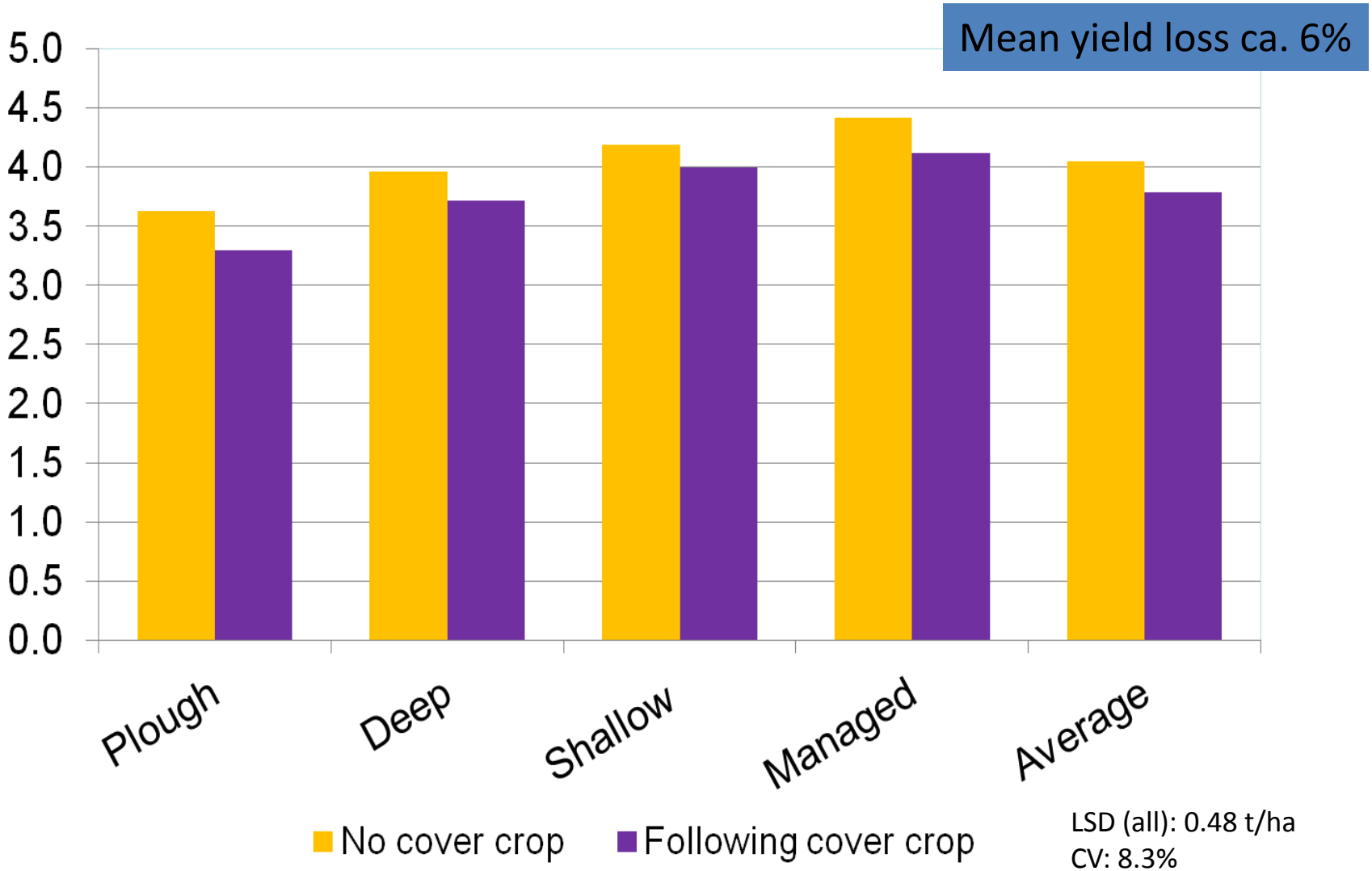


	Cover crop (CC)	
	- CC £ ha^{-1}	+ CC £ ha^{-1}
Plough	741	761
Shallow non-inv	732	779

Costs based on 2012 spot prices for the year of production: wheat (£120/t), diesel (£0.64/L) and liquid fert (£0.67/kg N).

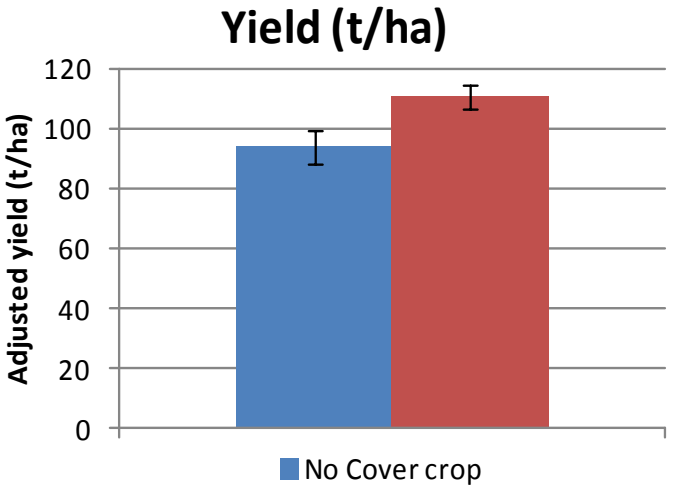
- Increases in margin over input costs in cover crop comparisons
- £47/ha (comparing shallow tillage ± radish)
- £38/ha (comparing 'plough - cover crop' to 'shallow tillage + cover crop').
- Does not include cover crops costs.

The impact of cultivation and cover crop on OSR yield (t/ha) 2014

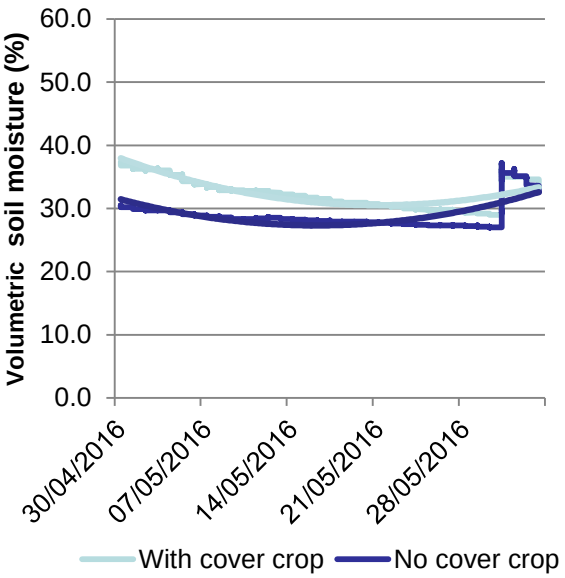


SIP: Field scale cover crops at Morley

- Recent field strip highlights:
  - Increases in N retention and earthworm biomass
  - Sugar beet shown 11% population increase and GAI from 1.2 to 1.9
  - Yield responses of 7 t/ha
  - Little difference in sugar or amino-N



Soil moisture @ 10cm depth (+ or - cover crop) – in sugar beet



A few comments

- Consider the whole rotation:
  - each crop type should not be assessed individually but as a contribution to the whole rotation
  - the rotational plan should also involve a soil management plan – cultivation type and depth, organic amendments, cover crops
  - need to reduce reliance on glyphosate?
- Advances in the identification and assessment of soil microbial biomass may result in improved guidance for rotational planning
- Nitrogen and cover crops – the role of legacy N?