

SOIL TILLAGE AND CROP YIELD IN LONG TERM UK FIELD EXPERIMENTS

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Introduction

The ‘Soil Platforms’ project (AHDB Project 3786 - Platforms to test and demonstrate sustainable soil management: integration of major UK field experiments) works with some of the longest running contemporary UK soil tillage experiments. The four sites within the ‘Soil Platforms’ project are at Mid Pilmore (Perthshire, Scotland, established 2003), the Centre for Sustainable Cropping (CSC) (Perthshire, Scotland, established in 2011), Sustainability Trial for Arable Rotations (STAR) (Suffolk, established 2005) and New Farm Systems (NFS) (Norfolk, established 2007). Each site features contemporary tillage, with some also exploring crop rotation. Soil physical conditions and other production characteristics, along with yields and farm gate economics, are being assessed within the contrasting farming system based approaches. The primary focus of this paper is around the interaction of crop yield and tillage.

Materials and Methods

The STAR and NFS sites are fully replicated randomised designs using large plots and farm scale equipment. While soil types differ (STAR - heavy soil, clay loam; and NFS - medium soil, sandy loam) tillage approaches are common to both studies; systems used are plough (inversion to *c.* 20 cm), deep non-inversion (to *c.* 20 cm) and shallow non-inversion (to *c.* 10 cm). Both studies use a common cropping approach of winter wheat every other year with combinable break crops in intervening seasons. The crop rotation (choice of combinable break crop) varies within and between studies; wheat yields presented here are mean data for rotational approaches within each study. Margin data are based on a gross output minus direct input and machinery costs for prices relevant to each production season. Further detail of treatment, system and findings for STAR and NFS can be found in Stobart *et al.* (2014) and Morris *et al.* (2014).

Results and Discussion

STAR and NFS winter wheat yield and margin data are presented in Tables 1 and 2. Comparing yields between plough and shallow non-inversion systems in STAR and in NFS, reduction were 2% and 4% respectively. For STAR significant differences were apparent in some seasons, but across seasons wheat yield did not differ significantly with tillage practice. For NFS significant yield differences with respect to tillage were apparent across seasons, with the lowest yields being associated with shallow non-inversion tillage. Wider ‘Platforms Project’ analysis remains ongoing, but Hallett *et al.* (2014) have identified, at all sites, pans under shallow non-inversion tillage that will limit root growth; potentially impacting on crop performance. Margins (£/ha, based on STAR and NFS prices and practices from Morris *et al.* (2014)) indicate that the highest STAR and NFS margins have been associated with the deep non-inversion systems.

Table 1. Yield (t/ha) and margin (£/ha) data for winter wheat and tillage practices in STAR in years 2 (2006/07), 4 (2008/09), 6 (2010/11), 8 (2012/13) and 10 (2014/15). Cross season analysis for tillage practice is as presented in the table; ‘year’ was significant at $P < 0.001$ and ‘treatment x year’ interaction was NS.

Tillage	Second yield data (t/ha)					Mean yield and margin data			
	Year 2	Year 4	Year 6	Year 8	Year 10	Mean yield (t/ha)	Yield (% of plough)	Margin (£/ha)	Margin (% of plough)
Plough	8.64	8.51	6.83	8.61	11.64	8.85	100	547	100
Deep	7.78	9.00	7.40	8.30	11.69	8.82	100	584	107
Shallow	7.52	8.80	7.32	8.01	11.62	8.66	98	571	104
Mean	7.98	8.77	7.18	8.31	11.65	-	-	-	-
LSD	0.45 ($P < 0.0001$)	0.42 (NS) ($P = 0.14$)	0.49 ($P < 0.05$)	0.57 (NS) ($P = 0.11$)	0.24 (NS) ($P = 0.69$)	1.02 (NS) ($P = 0.91$)	-	-	-

Table 2. Yield (t/ha) and margin (£/ha) data for winter wheat and tillage practices in NFS in years 1 (2007/08), 3 (2009/10) and 5 (2011/12) and 8 (2014/15). Cross season analysis for tillage practice is as presented in the table; ‘year’ was significant at $P < 0.001$ and ‘treatment x year’ interaction at $P < 0.01$.

Tillage	Second yield data (t/ha)				Mean yield and margin data			
	Year 1	Year 3	Year 5	Year 8	Mean yield (t/ha)	Yield (% of plough)	Margin (£/ha)	Margin (% of plough)
Plough	12.75	8.26	10.41	10.70	10.53	100	921	100
Deep	12.55	8.17	10.54	11.27	10.63	101	978	106
Shallow	12.30	7.42	10.48	10.45	10.17	96	930	101-
Mean	12.53	7.95	10.81	10.81	-	-	-	-
LSD	0.30 (NS) ($P=0.16$)	0.77 (NS) ($P=0.11$)	0.21 (NS) ($P=0.56$)	0.68 (NS) ($P=0.10$)	0.16 ($P < 0.001$)	-	-	-

Conclusions

Findings suggest only small percentage yield reductions with shallow tillage (*cf.* plough systems). Over seasons, these reductions were not significant at STAR (heavy soil), but were significant at NFS (medium soil). On both sites deep non-inversion tillage tended to give higher margins and would result in faster working speeds (*cf.* plough systems).

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