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Briefing 1290

Rotations and cultivation methods on heavy soils

Summary

The STAR project is a long term rotational study on a clay soil examining the interaction between four different rotations and four different cultivation methods. There are clear differences in soil structure and an increasing grass-weed burden becoming apparent in continuous wheat plots established with non-ploughing systems. Long term data shows that while plough based approaches tend to give the highest yields, the highest margin returns may come from a managed approach - selecting cultivations to suit crops and being guided by field conditions and soil assessments.

This paper is taken from an article in NIAB's Landmark Bulletin. There is more about NIAB's work at http://www.niab.com/pages/id/272/TAG_Research_Online_News. The full report can be obtained by emailing Ron Stobart, NIAB TAG at ron.stobart@niab.com

The STAR project (Sustainability Trial in Arable Rotations) is a long term rotational systems study that was initiated in autumn 2005 in Suffolk on a Beccles/Hanslope series clay soil. The research is funded though the Felix Thornley Cobbold Trust and delivered through NIAB TAG. The objective is to study the sustainability of different establishment techniques within different rotations for arable production on a heavy soil. The study is examining the interaction between four different rotations and four different methods; these are as outlined in Table 1.

Table 1. Rotation and cultivation approaches within the STAR project. STAR treatments (cropping x cultivations)

	Cropping					
Rotation	**2006 (Year 1)**	**2007 (Year 2)**	**2008 (Year 3)**	**2009 (Year 4)**	**2010 (Year 5)**	**2011 (Year 6)**
1 Winter cropping	WOSR	Wheat	Winter beans	Wheat	WOSR	Wheat
2 Spring cropping	Spring beans	Wheat	Spring oats	Wheat	Spring beans	Wheat
3 Continuous wheat	Wheat	Wheat	Wheat	Wheat	Wheat	Wheat
4 Alternate fallow	Fallow	Wheat	Fallow	Wheat	Fallow	Wheat

Cultivation	
1 Annual plough	Treatment is ploughed every year
2 Managed approach	Decision on cultivation regime is not decided until much nearer the time, decision is based around soil/weather conditions, previous cropping, weed burden, soil assessments etc
3 Shallow tillage	Treatment is cultivated to ≈10cm using a non-inversion technique
4 Deep tillage	Treatment is cultivated to ≈20-25cm using a non-inversion technique

Key Results

Soils

The use of specific rotational and cultivation approaches has led to changes to soil structure, with marked differences in both soil penetration resistance and water infiltration rates. The greatest differences, compared to other treatments, have tended to be associated with the long term shallow cultivation treatments. It is often assumed that on a heavier soil, periods of deeper cracking (e.g. in dry summer months) will lead to some degree of self structuring of soils. While cracking has been observed in some seasons, any beneficial effects on soil structure have not been apparent from soil assessments.

Penetration resistance data collected in the winter of 2009 (when the site was at or close to field capacity shows the tighter nature of the shallow cultivation treatments; within specific treatments this has been associated with differences in crop performance and surface drainage.

Weed burden

In the continuous wheat plots there have been substantial changes in weed burden in relation to cultivation approach, with appreciable levels of problem grass weeds, such as brome and black-grass, being detected in non-inversion treatments despite targeted herbicide programmes. Throughout the 2010 season these treatments were subject to an intensive herbicide programme which reduced the number of reduced the grass weeds. However this came at a price with a herbicide cost >£100/ha.

The mixed grass weed populations in these non-inversion plots can present a problematic management scenario. Specifically, meadow brome is known to emerge over a protracted period across the winter months where as the vast majority of black-grass will emerge in the autumn. This gives a dilemma regarding herbicide timing to maximise control and minimise crop competition.

In continuous wheat inversion plots and all other rotations grass weed numbers have remained low and easier to manage.

Yields and margins

The results from year 5 (a break crop year) are presented in Table 2. The dry spring undoubtedly had an impact on the spring bean yields and this is reflected in the margin. Equally the effect of the grass weed populations on the non-inversion continuous wheat plots can be seen in the yield responses, while the increased herbicide cost means this is exacerbated in the margin figures. The results from the oilseed rape treatments averaged around 3.5 t/ha with the best performing system being the sub-cast approach.

Table 2. The impact of rotation and cultivation system on yield (t/ha) and margin (£/ha)

	Yield (t/ha)				Gross margin – machinery cost (£/ha)			
	Winter	Spring	Cont	Alt Fallow	Winter	Spring	Cont	Alt Fallow
Plough	3.47	2.70	8.21	–	486	77	524	-96
Managed	3.61	2.63	8.29	–	558	67	534	-96
Shallow	3.35	2.17	6.88	–	531	33	322	-96
Deep	3.55	2.13	6.96	–	542	16	322	-96
Average	*3.50*	*2.41*	*7.59*	–	*529*	*48*	*426*	*-96*
LSD t/ha	0.47	0.53	0.92	–				
CV %	6.8	11.0	6.1	–				

Prices based on Wheat £130/t; Beans £140/t; OSR £280/t; Diesel 50p/l; Nitrogen 66p/kg N (AN) or 56p/kg N (Liquid)

Long term trends

Summary data for long term yield and margins are presented in Table 3; yields are presented as a percentage of the plough treatments when averaged over the first five years of the project, while margins are presented as cumulative margins using input, fuel and gain prices that were appropriate for each season of production.

Table 3. Long term trends in yield (t/ha) and margin data (£/ha). Margin data based on spot prices from the year of production

	Relative yield return (relative to ploughed approach)					Cumulative gross margin – machinery cost (£/ha)				
	Winter	Spring	Cont	Alt Fallow	*Average*	Winter	Spring	Cont	Alt Fallow	*Average*
Plough	100	100	100	100	100	2463	1450	1079	1171	1541
Managed	95	99	109	91	98	2470	1451	1356	992	1567
Shallow	93	88	97	93	93	1885	1383	1046	1103	1354
Deep	97	95	94	94	95	2563	1427	870	1091	1488
Average	–	–	–	–		*2345*	*1428*	*1088*	*1089*	

While data taken across the project does suggest higher yield returns from plough based systems the average performance of all other approaches are not too far behind. Margin is probably the more pertinent parameter and the cultivation system giving the best performance on average is the 'managed approach' (that is selecting a cultivation approach to suit the crop and being guided by field conditions and soil assessments).

The shallow approach is delivering the poorest performance (despite the lower costs) and conversely; in the light of increased weed management concerns we are perhaps approaching a time when the plough may well move back into favour! Of course even this interpretation needs to be refined when we think of the overall farm system. For example, while ploughing may be delivering a relatively robust return on a per hectare basis this would not necessarily be reflected in speed of working, timeliness and land area covered. Similarly it could be argued that overall mechanisation approaches in shallow tillage systems could present substantially different cost structures (e.g. smaller equipment with potentially lower fuel costs). However, such things tend to be very farm specific.

Alan Spedding, 31 May 2011

RuSource briefings provide concise information on current farming and rural issues for rural professionals. They are circulated weekly by email and produced by Alan Spedding in association with the Arthur Rank Centre, the national focus for the rural church. Previous briefings can be accessed on the Arthur Rank Centre website at http://www.arthurrankcentre.org.uk/projects/rusource_briefings/index.html

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