Final Project Summary

Project title	Platforms to test and demonstrate sustainable soil management: integration of major UK field experiments		
Project number	RD-2012-3786	**Final Project Report**	PR574
Start date	1 October 2012	**End date**	30 September 2016
AHDB Cereals & Oilseeds funding	£703,745	**Total cost**	£723,745

What was the challenge/demand for the work?

This project was commissioned in response to an AHDB call for research to understand and improve soil management in cereal production. This was done in the context of perceived threats to soil quality and function. The threats to soil quality and function are consistent with the threats identified throughout the EU (soil erosion, soil compaction, flooding and loss of organic matter).

While there has been a trend in the UK towards reduced tillage systems, driven by changes in fuel, labour and machinery costs, uptake of these systems has been variable. The weight of agricultural machinery is steadily increasing and crop rotations now tend to have fewer grass leys. In some cases, farmers have reverted to ploughing from non-inversion tillage.

The UK lacked information from robust experiments to address the agronomic, environmental and economic impacts of soil management practices. Soil quality and function for plant growth and root proliferation change over the growing season in response to weather, farm operations and the action of biology. These soil conditions also change over longer times (i.e. multiple years), if major changes in tillage system occurs (e.g. from plough to reduced tillage).

How did the project address this?

The project used three long-term and one newer soil management tillage experiments as platforms – two in England and two in Scotland. These platforms were on different soil types and had different rotations but all included a comparison of plough and non-inversion tillage.

Specifically the project addressed the following key aims:

- To assess differences in soil conditions for plant growth at the three long-term sites – 9 (Hutton), 7 and 4 (NIAB TAG) years
- To quantify carbon concentrations under different forms of soil management at multiple sites
- To measure the impact of soil management on the performance of contrasting cereal varieties
- To determine the broader impacts of the changes in soil management practices to more sustainable systems
- To measure inputs and outputs of production system costs to quantify farm gate impacts of major

shifts in soil management practices, and
- To communicate with the farming community and beyond on the importance of soil management.

Soil conditions from the different platforms were assessed using a range of techniques: from simple to sophisticated. The techniques were selected to reflect the soil's suitability for plant growth and root elongation and its condition in response to the identified threats. The platforms grew cereals at different scales, from plots that allowed the comparison of multiple genotypes to using farm-scale machinery that allowed economic analysis.

What outputs has the project delivered?

The carbon within the full depth of the soil profiles in each platform was assessed and appropriate corrections made for differences in soil bulk density and stone content. On this basis, we found differences in the distribution of carbon within the soil profile between tillage systems but no advantage in carbon sequestration with the use of reduced tillage. Where compost was added to the soil over multiple years soil carbon storage increased. A manuscript is in preparation based on this work.

Based on our results, non-inversion yields were lower than inversion yields but there were no differences between the three inversion tillage treatments. With promotion of, and movement to, reduced (non-inversion) tillage in the UK this suggests a need for breeding programs to consider crop performance under soil conditions created by non-inversion (or no-till) systems. This will be reported at Crop Production in Northern Britain 2017 and then published.

We found no strong reason for not advocating reduced (non-inversion) tillage in preference to ploughing. In the experiments using farm-scale machinery, yield data under non-inversion tillage was only marginally lower than under ploughed conditions but when decreased costs of labour and fuel were factored in, gross margins under non-inversion tillage were better than under ploughed systems. The hesitation from more strongly advocating non-inversion tillage comes from our plot-scale experiment which ran with no crop rotation (for more than 10 years) and developed severe weed problems. Under these conditions, ploughing helped control weeds and thus delivered better productivity. This will be reported at the 3rd International conference on Sustainability Challenges in Agroecosystems and then published.

Using a range of indexes, our study, consistent with other research, found soil physical condition was well below optimal at the sites studied and in many instances offers very limited opportunity for root proliferation. In soils under non-inversion tillage, we sometimes found large improvements to soil physical conditions over a growing season driven by the growing crop.

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Who will benefit from this project and why?
There are multiple beneficiaries, both the in the short and long term. For farmers, the evidence from this project supports the adoption of non-inversion tillage systems for cereal production. However, there is no support for policy interventions that suggest non-inversion tillage systems will lead to carbon accumulation within UK cereal farming. For the plant breeding community, a need has been identified to better link farming systems to the variety selection.

If the challenge has not been specifically met, state why and how this could be overcome

Lead partner	James Hutton Institute
Scientific partners	NIAB TAG, The University of Aberdeen
Industry partners	James Hutton Limited (formerly Mylnefield Research Services)
Government sponsor	This project used existing long-term experiments which have been supported by a range of organizations. The experiments in Scotland have financial support from the Rural & Environment Science & Analytical Services Division of the Scottish Government. The experiments in England have financial support from the Felix Thornley Cobbold Trust, The Chadacre Agricultural Trust, The Morley Agricultural Foundation and the JC Mann Trust.