Final Project Summary

Project title	Reducing risks associated with autumn wheeling of combinable crops to mitigate runoff and diffuse pollution		
Project number	RD-2007-3386	**Final Project Report**	PR559
Start date	March 2009	**End date**	March 2014
AHDB Cereals & Oilseeds funding	£120,000	**Total cost**	£1.2M

What was the challenge/demand for the work?

This project addresses the need for practical, affordable, and targeted management of fields with combinable crops to help reduce losses of soil and phosphorus (P) from land to watercourses to support sustainable farming and catchment management. Tramline wheelings are an important management tool for cereals, but research has shown that their use for autumn spraying can increase the risk and severity of soil compaction and associated damage (e.g. reduced aeration, infiltration, drainage) and thereby increase the risk of surface runoff, erosion, and losses of nutrients and sediment to water bodies. Agronomically, such sediment losses comprise fertile topsoil which is rich in organic matter, fertiliser and surface-applied plant protection products, and avoiding erosion helps achieve cross-compliance (GAEC 5). Deteriorating water quality caused by sediment hinders fish spawning while excess P promotes eutrophication and toxic algal blooms.

How did the project address this?

- Developing and/or evaluating new experimental methods for characterising the effects of autumn spraying on tramlines on soil physical impacts and hillslope-scale measurements of runoff and associated losses of sediment and P using flow-proportional sample splitters.
- Assessing and comparing the efficacy of several alternative practical tramline management methods in a replicated, statistically robust manner over a range of soil types, slopes and over four winters (with differing weather conditions during and after spraying) in both England and Scotland, both in terms of effects on soil properties and effects on surface runoff and associated losses.
- Estimating costs associated with each alternative method at both field and farm scale, including capital and operational costs and applicable areas, and taking account of carbon footprint, fuel use, equipment speed and use, and associated wheelslip.
- Combining efficacy and cost results to derive cost-effectiveness assessments for the alternative tramline management methods.
- Developing model functions to represent tramlines and the different mitigation methods, based on existing and newly obtained experimental data.
- Upscaling results to derive modelled estimates of whole-field and sub-catchment scale impacts of adopting tramline management methods.

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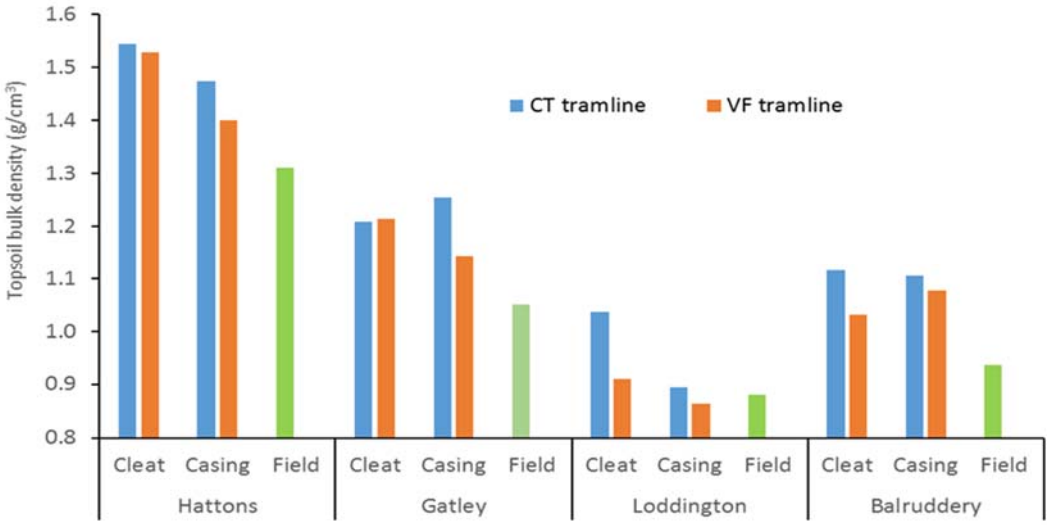
- Developing a synthesis of results integrating outputs from all of the above deliverables, resulting in numerous KT outputs and recommendations to the industry concerning practical, cost-effective options for tramline management when autumn spraying.

What outputs has the project delivered?

New experimental evidence from this project identified novel methods which reduced soil compaction, runoff and erosion from winter cereals by 50% or more compared to a conventional (CT) tyre treatment:

- **Correctly-inflated Very Flexible (VF) tyres** - which operate at half the pressure of conventional tyres



Topsoil bulk density for cleat and casing elements of CT and VF tyres at four field sites. Field reference values are also shown.

The VF tyres caused less soil compaction (and smaller increases in topsoil bulk density), a smaller tyre imprint, and resulted in less surface runoff and erosion to edge-of-field compared to the 'typical practice' (CT) control treatment (i.e. conventional tyres being over-inflated). This effect was statistically significant ($P<0.05$) across a range of soil types and slopes. There was no effect of the wider VF tyres on final harvest yield or associated variables.

- Drilling the tramline ahead of autumn spraying (and then spraying using GPS) had no consistent statistically significant effect on soil compaction or surface runoff.

These results suggest it is predominantly the substantial soil compaction which may be caused during the autumn spraying operation (mediated by soil conditions at that time) which is *primarily* responsible for the risk of runoff and diffuse pollution over winter months; rather than the lack of good ground cover from emerging vegetation.

- **A novel self-propelled rotary harrow** – attached to the rear of the crop sprayer in autumn

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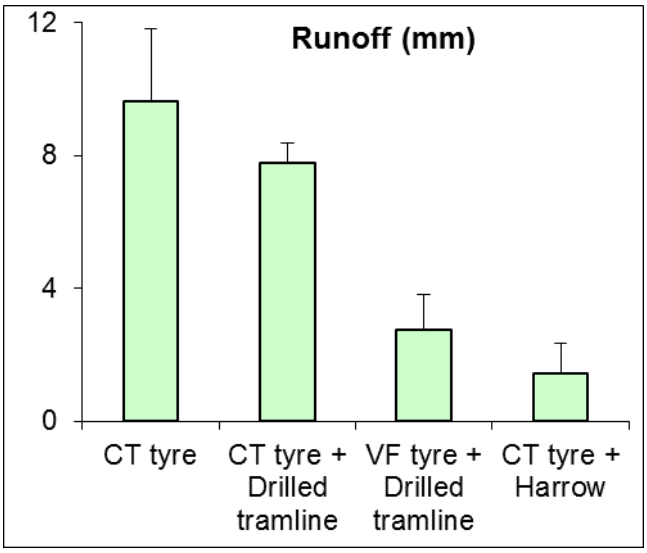
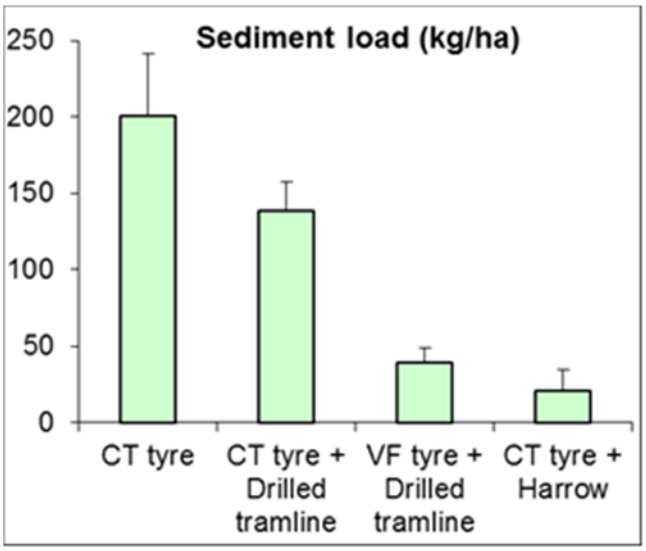
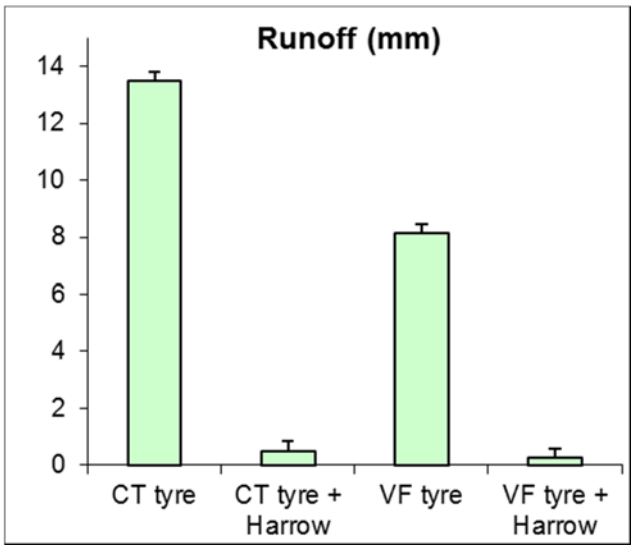
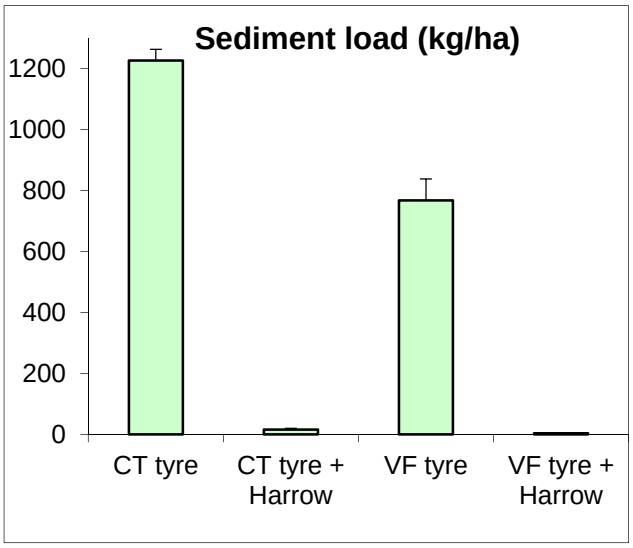
This new unit punctures the soil in several places across a wheeling, increasing infiltration without affecting traction. It is self-cleaning, easy to use, has very low draft requirements (*c.*9hp), and works on both self-propelled and trailed sprayers. A partial (£1500) capital grant towards the cost of such items is now available in the Higher Tier of the Countryside Stewardship scheme (RP31).

Runoff and sediment losses from these different treatments are shown overleaf (different rows present data from different site-years):









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- Results highlight the importance of the careful timing of spraying operations, as significant soil compaction (and hence runoff) was not caused when spraying was undertaken under dry soil conditions. This is especially true on heavier soils which rapidly reach their plastic limit, smearing the soil surface and reducing infiltration.

Stakeholder dialogue within KT events identified other methods which could help reduce the risk of soil compaction, runoff and erosion down tramlines on moderate slopes:

- Increase tramline spacing (e.g. move from 18m to 24m)
- Use the correct tyre inflation pressure for the tyre, field operation and axle load (i.e. don't over-inflate)
- Avoid establishing tramlines on loose "fluffy" seedbeds or when soils are very moist (careful timing is critical to avoid or minimise the risk of compaction, runoff and erosion)
- Use an extra headland tramline which is disconnected from the other tramlines, positioned on the lowest end of the field – the area between the two tramlines can then serve as a buffer strip to the major part of the field
- Consider re-orientating crop drilling (and hence spraying) direction so that tramlines do not follow the line of steepest slope.

Who will benefit from this project and why?

- Land managers responsible for sustainable farming practices. Project outputs included advice and recommendations to the industry on the most practical and cost-effective for cereal spraying in autumn to minimise the risk of soil compaction and damage, surface methods runoff, erosion, and associated losses of sediment and phosphorus from fields towards vulnerable water courses. Such guidance is helpful to achieve cross-compliance requirements under GAEC. These farm-friendly outputs have been well received via many different Knowledge Transfer activities including a presence at Cereals 2012–14, AHDB Cereals & Oilseeds farm walks, Open Farm Sunday events, AHDB Cereals & Oilseeds and Scottish government workshops, web articles, a YouTube demonstration, and 12 farming press articles (see report Appendix 1).
- Policymakers (public and private sector (e.g. Natural England (NE), water companies). Policy-oriented material on the costs and efficacy of novel tramline management options (based on experimental results) was requested by NE and has supported the introduction of a capital grant under the Higher Tier of the new Countryside Stewardship scheme. Farm and catchment scale model results support strategic planning and the targeting of catchment management activities.
- Other parties concerned with catchment management (e.g. non-governmental organisations (NGOs) such as the Rivers Trust), and the sustainable provenance of food (e.g. supply chains)

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The return on investment from this project has been excellent given: • the much larger cash contributions received from Defra and Scottish government • the matched in-kind contribution provided by a large number of industry partners • the valuable and varied stakeholder outputs (including KE activities) • the impressive level of industry engagement achieved (e,g. zero cost sprayer modification to kit by Household after official project had ended), and the project's positive role in providing evidence to support the introduction of NE's new capital grant for purchasing tramline management kit – for the first time ever.

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

Lead partner	ADAS UK Ltd.
Scientific partners	Lancaster University, Scottish Crop Research Institute (SCRI), Allterton Trust
Industry partners	Agco Ltd., Allerton Trust, Chafer Machinery Ltd., AHDB Cereals & Oilseeds, Linking Environment and Farming (LEAF), Michelin Group Products, Mylnefield Research Services, National Farmers' Union (NFU), Scottish Society for Crops Research (SSCR), Severn Trent Water Ltd., Simba International Ltd., The Bulmer Foundation, Wright Resolutions Ltd.
Government sponsor	Sponsored by Defra and Scottish government through the Sustainable Arable LINK programme