Grower Summary

CP 107c

The application of precision farming technologies to drive sustainable intensification in horticulture cropping systems

Annual 2016

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Project title:	The application of precision farming technologies to drive sustainable intensification in horticulture cropping systems (PF-*Hort*)
Project number:	CP107c
Project leader:	Dr Lizzie Sagoo & Dr Paul Newell Price, ADAS UK Ltd
Report:	Annual Report, March 2016
Previous report:	None
Key staff:	Prof. Bryan Griffiths & Dr Joanna Cloy, SRUC (soil survey work in Scotland) Dr Barry Mulholland (ADAS Head of Horticulture - project director) Angela Huckle & Celia Van Sprang (ADAS Horticulture consultants - precision farming review) Daniel Munro, Dom Edwards, Gail Bennett, Martin Crookes, Daniel Jakes, Michael Morris & Geoff Bailey (ADAS field teams – soil survey work)
Location of project:	Soil structure survey – grower sites around the country
Industry Representative:	Andy Richardson, Allium & Brassica Centre
Date project commenced:	01/04/2015

GROWER SUMMARY

Headline

- *Soil structure survey*: 75 fields covering a range of crops have been identified; pre-planting soil assessments are complete and post-planting soil assessments will be completed in spring 2016.
- *Precision farming review*: information has been collated on the potential of precision farming techniques to improve soil and nutrient management, and associated productivity and profitability in horticulture cropping systems.

Background

Improved soil and nutrient management is key to improving the productivity, profitability and sustainability of horticulture. Poor soil structure can be a key limiting factor for increasing crop production in cultivated systems (Hallet *et al*., 2012; Marks & Soane, 1987) and developing and facilitating industry uptake of good crop rotation and soil management practice forms a key part of the AHDB Horticulture strategic plan.

Precision technology can help to improve the efficiency of farm operations, including cultivation and better targeted fertiliser and agrochemical applications leading to cost savings and improvements in crop yields and quality. Precision farming involves measuring and responding to variability in soils and crops to optimise returns on inputs (i.e. fertiliser applications, soil cultivations etc.). Potential increases in marketable yield of high value crops makes precision farming an attractive option for many growers. Anecdotal evidence suggests that whilst uptake of GPS and soil mapping in horticulture is increasing, the development and uptake of other precision farming techniques such as controlled traffic farming (CTF), canopy N sensing and yield mapping has largely been focussed in broad-acre crops. Some of these precision farming techniques have direct relevance to horticulture and there is now interest from growers in their potential to increase yields and improve profitability and sustainability.

The aim of this project is to evaluate the current and future potential of precision farming techniques to optimise soil and nutrient management in horticulture, and to encourage greater uptake of any commercially available techniques with potential to increase yields and profitability within horticulture.

Phase one of the project (first 14 months; objectives 1-3) includes a field survey of soil structural condition under horticultural crop production and a review of precision farming techniques for improved soil and nutrient management.

Objective 1. To assess the structural condition of horticultural soils and establish baseline information on typical soil management practices across a range of horticultural crops.

Objective 2. To review the current available precision farming techniques used for soil and nutrient management and to assess their potential application in horticulture cropping systems.

Objective 3. Collate the outputs from the soil structure survey (Objective 1) and review (Objective 2) into a practical user friendly 'Guide to improved soil and nutrient management in horticulture'.

In Phase Two (years 2 & 3) the precision farming techniques with the greatest potential for uptake will be demonstrated and evaluated in field experiments on six commercial farms.

Objective 4. Project steering group meeting to agree the soil and nutrient management techniques to be assessed in field demonstration experiments on commercial farms in Phase Two of the project (Objective 5).

Objective 5. To carry out 6 field demonstration experiments to quantify the benefits (crop yield and quality and farm profitability) and trade-offs of selected soil and nutrient management precision techniques compared with conventional production on commercial farms (3 sites per year over 2 years).

Summary

Objective 1 – Soil structure survey

The soil survey has been stratified by crop type (perennial, biennial and annual); and for the annual crops selected is being carried out twice (pre- and post-planting/drilling) in 47 fields across 31 holdings. For the perennial crops (e.g. asparagus, apples) we are carrying out measurements prior to establishment at some sites and in the growing crop at other sites. A total of 75 fields covering a range of crops have been identified (**Table 1**).

Field measurements are being carried out during the late autumn to early spring period when soils are 'moist' or close to field capacity between September 2015 and April 2016, so that measurements in different fields are taken under comparable conditions. **Table 1** shows progress to date with the soil survey.

Table 1. *Soil structure survey stratification by crop type and progress (21/03/16)*

Crop	Number of fields	Pre-planting	Post-planting
		Fields sampled to 21/03/16	
Cauliflower	15	15	1
Carrots	9	9	0
Onions	5	5	0
Leeks	5	5	1
Lettuce	10	10	0
Vining peas	3	3	0
Asparagus	6	2	4
Blackcurrants	6	2	4
Raspberries	4	1	3
Apples	6	2	4
Narcissus/cut flowers	6	1	1
Total	**75**	**55**	**18**

Objective 2 – Precision farming review

The precision farming review has engaged with industry, including the precision farming companies and machine manufacturers, growers, consultants and researchers to evaluate the potential for precision farming techniques such as controlled traffic farming, soil mapping, remote sensing of crop canopies, variable rate inputs and yield mapping, to increase crop marketable yield and profitability.

Relevant literature has been collected from a wide range of sources including published scientific papers, AHDB reports, conference proceedings and unpublished 'grey' literature. The review also includes a survey of precision farming companies and machinery manufacturers and a targeted survey of horticulture growers who have experience or interest in using precision farming techniques.

To date, interviews have been carried out with the following precision farming companies – AgLeader, Agrii, AgSpace/IPF/Courtyard, Agrovista, Airinov, CF Fertilisers, Fresh Produce Consultancy, Hutchinson's, Precision Decisions, SOYL, Spectrum Aviation and Ursula. Machine manufacturers contacted as part of the review include AS Communications, Claydon, Cultivating Solutions, Great Plains, Grimme, Manterra and Sumo, although some commented that they were primarily focussed on the broad-acre arable market.

Grower interviews have been carried out with Allpress Farm (Jim Thompson), Barfoots (Neil Cairns), FB Parrish & Son (Paul Cripsey), G's (Emma Garfield), Glassford Hammond Farming (Philip Lilley), Jepco (Nick Sheppard), Overbury Farms (Jake Freestone), PDM Produce

(Dermott Tobin), T.H. Clements (Mark Lyon), Vitacress (Andy Elworthy/Nataschia Schneider) and a Scottish producer of bulb flowers.

The combination of the literature review and the interviews with precision farming companies, machine manufactures and growers has provided a comprehensive overview of what precision farming techniques are available to growers to improve soil and nutrient management and more specifically how these techniques may be applied to horticultural crops.

Financial Benefits

This project will provide information on the state of horticultural soils and provide focused, practical and robust guidance on precision farming and other techniques to identify, avoid and alleviate soil compaction, thereby increasing opportunities to carry out field operations; reduce cultivation and other input costs; increase crop yields and farm profitability, while minimising environmental impact (an important consideration for growers in meeting the needs of assurance schemes, environmental audits and demonstrating sustainable soil management):

- Hallet *et al*. (2012) reported that avoiding compaction across a range of arable and horticultural crops can increase yields by 10% to 15%, which in field-vegetable crops such as dry bulb onions could increase gross margins by £1,300-£1,500/ha or 50% to 60% (Nix, 2013).
- Alleviating compaction can increase crop yields by 1% to 10% (Marks & Soane, 1987), although benefits are mainly confined to spring sown crops grown on sandy or light silty soils. However, better targeted sub-soiling in terms of the need for mechanical alleviation and the depth of operation could result in greater and more consistent benefits.
- Controlled traffic systems can also increase yields by 10-15% (e.g. Tulberg *et al*., 2001), which can result in increased revenue of *c*.£150 to £700 per hectare, depending on the initial yield and crop type. These benefits can be accrued within a few years of adopting best soil management practice.

The project will assess the potential for precision farming techniques to better target soil management and nutrient inputs to horticulture crops. The potential benefit of variable rate inputs (fertiliser/seed) is greatest in fields which are inherently variable, where it will result in a more accurate use of inputs and a more even marketable crop.

- Yara (2012) reported an overall yield increase in cereal yields of 3.5% with the Yara N sensor where the same intensity of N fertiliser was used.

- Knight *et al.* (2009) estimated that variable rate P and K fertiliser application in cereals and oilseeds could protect yield worth an average of £5/ha and save fertiliser worth £3/ha.
- IPF (Intelligent Precision Farming) estimate that their customers save £22/ha from applying P and K variably (www.ipf-uk.com).

Action Points

- Soil compaction can be a key factor limiting yields. A significant proportion of fields within the soil structure survey had moderate to poor soil structure.
- Growers can manage the impact of soil compaction by identifying and alleviating compaction where it has occurred and by avoiding soil compaction in the first place, where possible.
- Assess soil structure when soils are moist. If soils are compacted, identify the depth of compaction and target the depth of cultivations to just below the compacted soil layer.
- Precision farming tools such as soil mapping, canopy sensing and yield mapping can provide growers with valuable information about the variability of their soils and crops. Where growers have identified variability in their soil or crop, they should first seek to understand what factors are important in causing this variability before they try to manage it.