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The Use of Cover Crops in the UK: A Survey

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Summary

A sustainable soil management survey targeting UK arable farmers was distributed via online platforms throughout the winter of 2016–2017. The main focus of the survey was the use and management of cover crops along with tillage practice and aspects of soil health. Following harvest in 2016 two-thirds of participants used a cover crop, with 56% of those using a cover crop having 3 years or less experience. There is evidence that the species selected as a cover crop is linked to soil type whilst the benefits to soil structure is related to the extent of farmer experience. Of the participants using cover crops 81% used herbicide to terminate the cover crop. Participants provided suggestions for improvements to ecological focus area rules (based on the 2016 Basic Payment Scheme) for cover and catch crops with 70% of participants suggesting they are not suitable.

Key words: Cover crops, tillage, soil health, policy, environment

Introduction

In recent years there has been increased interest in the use of cover crops in arable rotations. Cover crops are reported to benefit numerous soil properties affecting both the following crop and surrounding environment. Published research relating to cover crops, conducted mostly outside of the UK, reports benefits to soil structure (Tonitto *et al*., 2006; Munkholm *et al*., 2013), soil biology (Reeleder *et al*., 2006) soil erosion control (Magdoff & Van Es, 2000) and nutrient management (Wendling *et al*., 2015). In the UK cover crops are often established between winter and spring sown crops and may be used to fulfil Basic Payment Scheme rules under Greening and Ecological Focus Areas (Rural Payments Agency, 2017),which includes rules relating to dates of establishment and allowable species. Whilst there are the reported benefits of cover crops in published research little is known about the farmers' experience of cover crops and whether those reported benefits in the research are materialising on farm. Equally with the uptake of new management practices there will also be undesired outcomes or challenges that arise. The survey conducted aim to collect and collate the farmers' experience of using cover crops.

Materials and Methods

A survey entitled Sustainable Soil Management was distributed via online and social media platforms from December 2016 to March 2017. All survey participants were asked for farm

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and crop establishment information before being asked if cover crops had been established following the 2016 harvest. Participants who had not established cover crops were directed to a different part of the survey where they were asked about their reasons for not using a cover crop. Participants using a cover crop were asked for general information on the cover crops they used and management practices associated with the cover crop; additionally the benefits and challenges of cover crops were also recorded. Finally all participants were asked for a definition of soil health and how they monitor soil health. The survey attracted 117 responses with n>8 for many of the 12 UK regions except Northern Ireland (n=1), Scotland (n=2) and North West England (n=2) regions.

Results

Tillage

The 117 respondents collectively farmed 59,890 ha with tillage information available for 45,322 ha of which 36,584 ha were planted to combinable crops. Winter wheat, winter oilseed rape, spring barley and winter barley accounted for 37.8, 12.3, 9.7 and 7.4% of the area grown, respectively. Table 1 details the tillage practices used to establish these crops.

Table 1. *Tillage practice by area, Ha, used to establish the top four crops grown by survey respondents.*

Tillage	Winter Wheat	Winter Oilseed Rape	Spring Barley	Winter Barley
Plough	3,224 (19)	130 (2)	676 (15)	979 (29)
Power harrow	612 (4)	316 (6)	55 (1)	362 (11)
Sub soil	1,643 (10)	1,284 (23)	340 (8)	119 (4)
Deep tillage	2,772 (16)	1,101 (20)	506 (12)	789 (24)
Shallow tillage	4,202 (25)	198 (4)	597 (14)	477 (14)
Direct drill	1,076 (6)	980 (17)	712 (16)	-
Strip till	935 (5)	605 (11)	425 (10)	85 (2)
Zero till	2,636 (15)	680 (12)	1,074 (24)	532 (16)
Broadcast	-	300 (5)	-	-
Tillage not known	17 (0)			
Total	17,100 (100)	5,594 (100)	4,385 (100)	3,343 (100)

NB: deep tillage = > 7cm; shallow tillage <7cm; direct drill = one pass establishment involving tillage. Value in parentheses = % of total area (ha) per crop cultivated.

Use of cover crops

Of the 117 respondents 78 (66%) used cover crops following harvest in 2016 of which 56% have 3 years or less experience. Those respondents (39) who did not use cover crops following harvest 2016 cited i) cover crops do not fit in the rotation ii) expense of cover cropping and iii) difficulty in measuring their effects, as the top three reasons for not using cover crops. However, almost all (36 out of 39) of the respondents who did not use cover crops would consider their use in the future. Primary reasons influencing their decision to consider using cover crops in the future would be information on i) the economics of cover crops, ii) the effect of cover crops on soil health and yield of the following crop and how to measure this on farm and iii) access to funds/grants to help with establishment costs or seed purchase.

The predominant tillage types used on a farm were placed into 4 broad categories: Plough (incl. power harrow), Deep Tillage (incl. sub-soiling), Shallow Tillage (incl. direct drill and strip till) and Zero Till. The survey indicates that cover crops were utilised amongst all tillage categories. All farms practicing zero till used cover crops, compared to only half of farms that ploughed. Cover crops were sown in 11 of the 12 regions of the UK except Northern Ireland.

Benefits of cover crops

In the 3rd year of cover crop use over 85% of respondents report that cover crops have had a positive effect on soil structure compared to 69% in the 2nd year and only 47% in the first year. 'Don't know' or 'no change' accounted for all the remaining responses. Respondents reported a benefit to soil erosion control as a result of cover crop in all major soil types – heavy, medium and light. A total of 64% of respondents on heavy soils reported a benefit to soil erosion control using cover crops yet this rises to over 80% of respondents located on light soils. The remaining respondents were either unsure (don't know) or reported no change.

Yield benefits following a cover crop were reported by 22% of respondents in a range of crops namely, wheat, sugar beet, spring barley and linseed. However, 3% of respondents reported yield decreases in spring barley and spring beans crops. Respondents who reported no change or didn't know the effect of cover crops on yield accounted for 30% and 45% of the respondents growing a cover crop, respectively.

Challenges of cover crops

An increase in slug population was reported by 35% of respondents who used cover crops, with 4% reporting a decrease. The remaining responses were accounted for by no change (41%) and don't know (20%). Increases in slugs were reported by 40%, 37% and 33% of respondents who practice shallow tillage (incl. direct drill and strip till), zero till and plough (incl. power harrow), respectively. Another challenge of cover crops is the time and labour requirement with 17% and 40% respondents reporting it is 'always' or 'sometimes' an issue, respectively. Time and labour is no longer an issue for 6% of respondents whilst 37% of respondents report that it has never been an issue. Of the 78 respondents using a cover crop 55% reported that cover crop establishment is 'sometimes an issue' with 10% of respondents indicating that it is always an issue. Cover crop establishment has 'never' been an issue for 19% of respondents with 13% reporting that cover crop establishment is 'no longer' an issue. 'Didn't know' accounted for the remaining 3%.

Topical issues facing cover crop use

Herbicide is used by 81% of the respondents to terminate cover crops, with 17% of respondents predominately using cultivation and/or some form of above ground biomass removal e.g mowing or grazing. One person (2%) relied on the natural senescence of the cover crop.

Of those using cover crops 70% indicated that the Ecological Focus Area Greening rules (part of the Basic Payment Scheme) concerning cover crops (and catch crops) are not suitable. Many gave suggestions for their improvement, these are outlined in the discussion. Of the respondents not currently using cover crops 19% indicated that 'a change in the EFA rules for cover crop species' would influence their decision to adopt cover crops in the future.

Discussion

Unsurprisingly winter wheat is the most widely grown crop (by area) amongst the respondents and is established using a diverse range of tillage practice. Spring barley accounts for the greatest area of spring sown crops and 50% is established using zero till, strip till or direct drilling. This reduction in tillage intensity for spring barley establishment is possibly linked to advice on blackgrass control, where reduced tillage may help to prevent triggering blackgrass seed germination.

Cover crop use has increased dramatically in recent years; three-quarters of respondents have used cover crops for the last 5 years and those with 3 years or less experience account for 56% of respondents using cover crops. A recent USDA survey (Conservation Technology Information Center & Sustainable Agriculture Research & Education, 2016) on the use of cover crops in America reports that 46% of their respondents have 3 years or less experience of using cover crops. The greater experience of cover crop use in America is likely due to their use being supported by a vast volume of research published by universities and research organisations and advice provided by extension services.

Those not using cover crops in the UK cite rotational challenges as the main reason for not using cover crops followed by expense and that the benefits are hard to measure. Concerns regarding expense are understandable given the range and variability of seed price that is dependent on many factors such as seed supplier, cover crop species used and seed rate. The survey found that mixed species cover crops cost on average £30.30 ha^{-1} and single species £22.80 ha^{-1} though across both options the range was £6.60 to £74 ha^{-1}. Additional expenses include extra seeding and termination operations. Benefits from cover crop use may take several years to materialise and can initially be hard to quantify without the use of specialist equipment. However there are methods such as visual soil assessment (Shepherd, 2000) and visual evaluation of soil structure (Guimares *et al*., 2011), earthworm counts/identification and infiltration tests that can be performed in a relatively short amount of time, on farm and at a low cost. Whilst nearly all farmers walk their fields and take a spade with them to 'dig about' only about half perform some kind of qualitative or quantitative method such as those listed previously (survey data not shown). Performing on-farm evaluation would allow farmers to assess and monitor changes to their soils over time following any management interventions such as cover crops or changes to tillage.

Benefits to soil structure take time to accumulate. This was illustrated by the increasing proportion of respondents reporting a benefit to soil structure as the number of years of cover crop use increased. This is to be expected as cover crops impart subtle changes on the soil environment. Differences between root growing traits e.g tap roots vs fibrous roots, accumulation of cover crop biomass (organic matter input and type) and termination method of cover crop biomass will all effect soil structure. The greater number of respondents reporting soil erosion control on the lighter more susceptible soils to erosion could result from the fact that respondents on light soils, planted cover crop species that have shallow and fibrous rooting traits. These traits help to reduce soil erosion compared to tap rooted species (De Baets et al., 2007) which were predominately grown on the heavier soil types . Cover crops sown on heavy soils were different as the majority of respondents planted a radish, presumably for its compaction-busting abilities (survey data not shown).

Yield response following a cover crop may not materialise in the following crop but may occur in later years following the second cover crop cycle (Stobart & Morris, 2014). Alternatively cover crops may accompany a new farm management approach with respect to soil health and tillage and these combined factors may also influence the yield and soil environment. It is unlikely that the yield data from the respondents are derived from replicated

or split field trials that compare cover crops to a control area (no cover crops). In addition there are other factors that influence yield such as weather and crop husbandry management or timing. However the effect of cover crops on yield is important as it is an instantaneous assessment that directly influences farm economics. For many farmers yield is much easier to quantify when compared to measuring and quantifying changes to the soil health. Improvements to crop yield provide a justification for cover crop use, especially in the short term, and so any yield benefit recorded by farmers is important to justify the continued use of cover crops. A fifth (17 out of 78) of respondents reported a yield increase attributed to cover crops with half of these respondents able to quantify the increase. Only two respondents reported a yield decrease following cover crops; both were spring sown crops and interestingly both respondents farm on heavy soils types with one using zero till and the other a direct drill. More data would be needed to draw conclusions about these farming systems. To draw more accurate conclusions from the yield data provided more information is required about the weather and field conditions under which the crops were grown and how the yield assessments were made and what they were compared to. Due to the complexity of making such comparisons many respondents (45%) were not sure of yield differences following cover crops.

The increased slug populations reported by the respondents are unsurprising. Cover crops can create microclimates that are favourable for slug feeding and breeding habits (Cooper *et al*., 2017), with greater slug damage following legume cover crops than cereal cover crops (Vernavá *et al*., 2004). The greater proportion of respondents using cover crops with zero till and shallow tillage reporting problems with slugs is supported by research as Morris *et al.,* (2010) highlights that slugs are a greater concern where non inversion tillage is used. Surprisingly the survey also highlighted observations of increased slug numbers where intense tillage practices (plough incl. power harrow) were predominately used. Many respondents find that time and labour required to establish and manage a cover crop can be challenging. To allow cover crops the time to develop above and below ground biomass ideally they should be planted as soon as possible following harvest. But many find that the time and labour requirements conflict with the on-going cereal harvest and establishment of other crops. Cover crop establishment itself can be a challenge with dry conditions in late summer prolonging or preventing germination. There may be potential issues with different seed sizes of cover crop mixtures separating out in the drill, also affecting even coverage and germination.

The recent uncertainty in the renewal of the glyphosate license has major repercussions for agriculture in Europe. Herbicide is used by 81% of the respondents for the termination of cover crops. The remainder of the respondents used grazing/mowing and/or cultivations to control cover crops. It should be noted that sometimes a combination of two or more methods was used to control cover crops. The destruction of cover crops is the focus of ongoing work by an Innovative Farmers group (https://www.innovativefarmers.org/field-lab/?id=e05323bd-125e-e611-80ca-005056ad0bd4) who are trialling the Roller Crimper.

Finally with the UK leaving the European Union and large reforms expected to the agricultural policy, there is an opportunity to create a more flexible and inclusive set of regulations concerning cover and catch crop use. Of those using cover crops 70% suggested that the Ecological Focus Area rules regarding cover and catch crops are not suitable and needed amendment. The most commonly suggested amendment was changing the way a mixture is defined and to include more plant species (in addition to the eight species already permitted). Notable plant species currently excluded are nitrogen fixing clovers (Pandey et al., 2017) and buckwheat a quick growing species, suited to sandy soils with the ability to enhance available P to following crops (Boglaienko *et al*., 2014). Amendment of the current guidelines surrounding cover/catch crop mixtures to better suit geographical region, rotation and soil type would further enhance the benefits associated with their use. Additionally the expense of cover crops is a key barrier that should be addressed by research. Case studies and research could

highlight where costs are incurred (e.g. seed purchase and additional operations) but equally where costs maybe reduced or mitigated e.g reduce/ease of tillage, yield gains, increased reliance to extreme weather events. Placing a direct financial value on soil health improvement may prove difficult in the short term though a value could be placed on being able to traffic a field earlier/later or aiding the establishment of a crop following the use of cover crops.

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