Catchment Sensitive Farming
Working together for a healthy environment

Collaborative Carbon & Nutrient Management Project

Portsmouth Water

Farm Carbon Toolkit

S.Woodley Crop Services

Project Description

Catchment Sensitive Farming and Portsmouth Water (PW) work in partnership to tackle diffuse water pollution issues affecting the quality of ground, surface and coastal waters in East Hampshire and West Sussex.
The Carbon and Nutrient Management project is a new collaborative project between CSF and PW set up to investigate the relationship between soil carbon and nutrient retention. The Farm Carbon Toolkit (FCT) and Stephen Woodley Crop Services Ltd were also involved with the carbon footprint assessment and soil sampling/analyses. The project worked with a group of 8 farmers that represented a diverse range of different farm management from conventional to regenerative across the East Hampshire and Western Streams catchment.

The project assessed a number of parameters to determine the relationship between soil carbon and nutrient retention and availability which is critical to understanding how farmers can improve soil health whilst also planning efficient nutrient applications. The ultimate aim was to determine if there was a significant link between high organic matter soils and associated regenerative practices and nutrient retention and availability. This provides a greater case for increasing regenerative practices with the potential to deliver not just carbon sequestration benefits but also water quality benefits to meet Water Framework Directive objectives, therefore maximising the ecosystem services from these practices.
A carbon footprint assessment was also undertaken on the 8 studied farms. This further supported the farmers with information to reduce their greenhouse gas emissions and enhance carbon

Offset	tonnes CO_2e	%
Field Margins (Uncultivated)	-9.91	3.67%
Hedgerows	-13.19	4.89%
Other (E.G. Recycling)	-0.51	0.19%
Soil Organic Matter	-135.26	50.15%
Woodland	-110.82	41.09%
Total	-269.69	100%

Table 1. Sequestration categories for a participating farm

sequestration not only in their soils but through other aspects of farm management and practices (including quantifying the carbon footprint of artificial fertilisers). This holistic approach to carbon management helps prepare farmers for the delivery of more targeted environmnetal initiatives and natural capital through both Environmental Land Management (ELM's); by providing essential public goods (e.g. water quality and carbon sequestration), and private funding opportuntites.

Project Delivery

Soil samples were analysed to assess soil carbon, Soil Mineral Nitrogen (SMN), Additional Available Nitrogen (AAN), macro nutrients and pH. Visual assessments were also carried out on the soil health and structure and included worm counts. AAN testing is a novel measure of nitrogen to influence soil indices scores and is not offered in most laboratories. SMN testing is, however, widely used in the agricultural industry. Research has been undertaken to support the use of AAN and its accuracy in providing foresight as to how much nitrate will become available over the growing season. The SMN data indicated how much nitrate is readily available from the time of sampling. Both SMN and AAN data were used to determine the soil indexes of the sampled fields which reflect the fertiliser recommendations for the following cash crop. This information is valuable for the farmer to ensure efficient nutrient application and reduce the risk of losing nitrates to the environment.

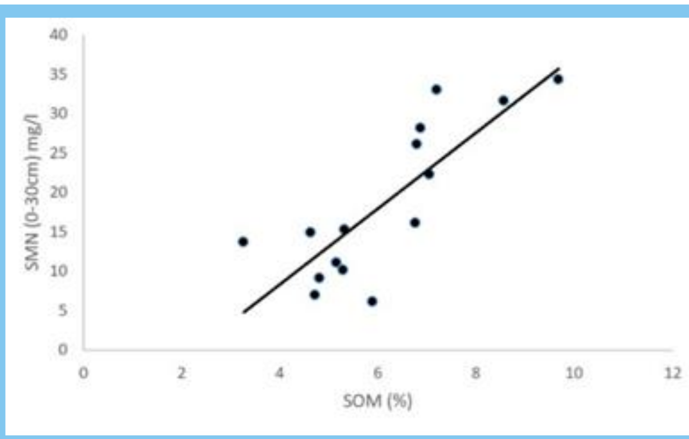
Becky Wilson, Project Manager at FCT worked with the farmers to gather data across their farming operations for carbon emissions i.e. inputs, crops, livestock, fuels, materials etc vs. sequestration i.e. hedgerows, field margins, perennial crops and woodland (Table. 1) in order to gather a baseline for their businesses carbon footprint. An action plan was then provided to each farm which identified practices which could both save money as well as sequestering carbon.

Key results

Across the cohort of farmers involved there was a good range of values showing the difference in soil type, cropping system and management type.

A linear mixed model was used to analyse the results across eight farms, with between two and four fields assessed per farm. All soil parameters have been included, but there are some factors which will be heavily influenced by fertility regimes for a given crop such as potassium levels. A significant relationship between SMN down to a 30cm depth and percentage of soil organic matter (OM) was identified which demonstrates in the shallow part of the soil, where there are higher levels of OM, there is also more available nitrogen (Graph. 1)

Table 2 indicates that for the arable crops, whether winter or spring drilled, the potential nitrogen availability was lower than all other crops. Furthermore, the soil mineral nitrogen (present available nitrogen) is lower in arable crops



Graph 1. Relationship between SMN and OM at 0-30cm soil depth.

compared to all other crop groups. The combination of these two parameters gives the total soil nitrogen supply (SNS) which was lowest in the arable systems and was significantly lower than the spring beans and the grazed cover crop. For the over winter cover (Table. 3), soil mineral nitrogen at a depth of 30-60cm, was significantly higher in the stubble compared to the cover crops or the winter crops. From the results it would suggest that for reducing winter leaching potential of soils, either a winter crop (wheat or oil seed rape from these farms) and a cover crop would be better than stubble. The farmers that had cover crops had a mixture, rather than straight stands.

	Arable	Spring bean	Grazed cover crop	Oil Seed Rape
AAN	40.71a	69.63bc	84.61c	68.95ac
OM%	5.668a	6.610a	6.356a	9.845b
SMN (0-30)	13.71a	22.77b	31.18b	33.27b
Stones	3.719a	11.388b	7.673a	3.888a
Total SNS	62.37a	106.32b	122.75bc	106.16ac
Total N	7.704a	7.320b	7.792ac	8.042ac
Total Org C	3.001a	3.642a	3.710a	5.684b
K	181.6a	318.3b	154.6a	253.3a
pH	7.704a	7.320b	7.792a	8.042a

Table 2. Predicted means based on Linear Mixed Model to determine the effect of (i) Previous crop; (ii) Current crop; and (iii) Type of over-winter cover (cover crop, crop, or stubble) on soil.

	Cover crop	Winter crop	Stubble
SMN (30-60)	6.600a	5.943a	14.000b
Stones	4.882a	3.509a	9.386b

Table 3. Predicted means based on the Linear Mixed model for over winter cover (grazed and ungrazed data are combined in the column "cover crop").

The addition of the SMN / AAN tests allowed the farmers to reduce the amount of applied nitrogen due to the efficient capture from the cover crops over the winter. 2 out of the 8 farmers which were cover cropping were able to adjust their fertiliser applications by around 10% leading to a reduction in nitrous oxide emissions, improved soil health and a reduction in potential leaching loss. The other farmers were interested in the results and as such, are keen to continue to explore the possibility for AAN testing to provide an evidenced based approach for nitrogen reduction.

Soil Organic matter results were shown to be across the range of 3.26% to 9.68% providing an average value of 6.12%. Assessing the fields that were analysed, a few of the fields that were regularly using cover crops had high organic matter values but there was also a range across soil type. The analysis was concurrent with wider work taking place in the soil carbon project by FCT where those fields that are regularly using cover crops, alongside low disturbance cultivation are building soil organic matter.

When the carbon footprints were analysed, it was difficult to include the sequestration that is taking place within the soil due to management, as for the majority of farmers this was the first set of analysis that has been undertaken (and the calculator requires two sets of data to show a change). For a number of the farmers, a small increase in soil organic matter was modelled to show the impact building soil carbon has on the wider footprint. For these farmers a small annual increase in soil organic matter (of the magnitude 0.05% - 0.1% increase) would turn these farms from net emitters to net sequesters. Alongside the potential for soils, there is still potential to reduce emissions predominantly though a reduction in diesel usage for field operations and reduction in fertiliser usage (which dominates the majority of farm emissions for arable enterprises). Repeating the process across the farms in the following year will allow for a good understanding of whether the modelled sequestration is achieved through the nitrate reduction measures that are supported by Catchment Sensitive Farming and Portsmouth Water.

Next steps

The ambition post collaborative project is to continue soil assessments and analysis so that progress can be monitored over time; in particular for those moving towards a regenerative system.
We aim to involve the farmer's agronomist this year to help raise awareness of how carbon influences nitrate application, retention and availability. Knowledge of SMN in combination with the AAN testing will provide both the farmer and agronomist greater insight to nutrient management, hopefully resulting in wider adoption of regenerative farming methods to build soil carbon and therefore reduce N applications. A farmer workshop was held in July 2021 to present the results of the first year of the project and present the concept to the wider farming community, which we hope to hold again this year.

Key themes from farmer feedback for Year 1 of the project:

- Data useful for setting baseline for carbon on farm
- Specialist adviser required to assist with the data collection & interpretation
- More detail would benefit farms on the specification of crop uptake & measure
- efficacy
- All carbon capture sources need to be accounted

Catchment Sensitive Farming (CSF) is led by Natural England, in partnership with Defra and the Environment Agency.