COVER CROPS – INTERACTIONS WITH CULTIVATION

The New Farming Systems study, delivered through NIAB TAG, aims to explore ways of improving the sustainability, stability and output of conventional arable farming systems, with the research undertaken on a sandy loam soil at Morley in Norfolk.

The research includes studying the impact of cover crops, covering the interaction with:

- **rotations** – a winter wheat and spring break-crop based rotation;
- **cultivation approaches** – comparing plough, deep (c. 20 cm) and shallow (<10 cm) non- inversion;
- **cover crops** – comparing approaches with and without a brassica cover crop.

Key findings have shown:

There is potential for positive yield and financial responses associated with appropriate cover crop use in arable systems.

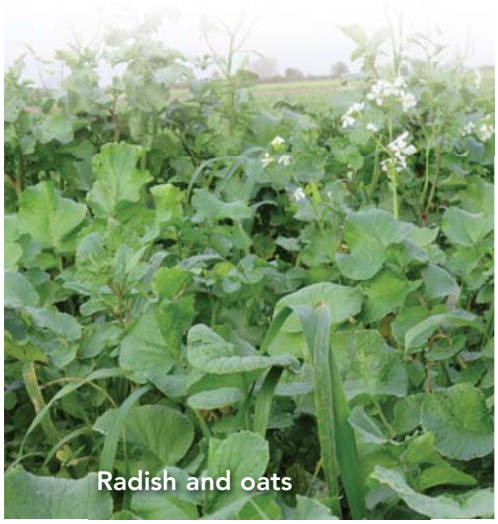
Responses are not always seen fully in the crop following the cover crop; they are sometimes seen later in the rotation.

Think carefully about costs of cover crop establishment and management; consider limiting spend to < £50 per hectare.

Cover crops have positive impacts on soil quality (e.g. improved infiltration rates and soil bulk density).

The repeated use of a brassica cover crop resulted in a c. 6% yield loss in oilseed rape crops in the same rotation.

A brassica cover crop was more likely to give a positive yield response in this study when used in conjunction with a shallow non-inversion tillage system than with a plough-based system.


Radish and oats


Phacelia mustard mix


Sainfoin

When growing cover crops think through what you want to achieve and plan the approach. Once the key objective is defined, important questions will include: how does the approach fit with the farming system; how, and when, is progress measured; and what are the routes for guidance and decision support?

Innovation in SOIL MANAGEMENT

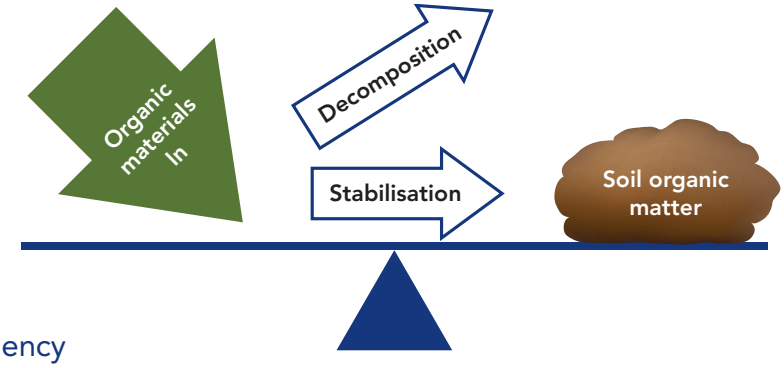
USING ORGANIC MATERIALS AS AMENDMENTS

Soil organic matter is the term used for all living, or once-living, materials within, or added to, the soil. This includes roots developing during the growing season, incorporated crop stubble or added manures and slurries.

All organic matter contains carbon (C), but it also contains nitrogen (N), phosphorus (P), sulphur, potassium, magnesium and a whole range of micro-nutrients.

The amount of organic materials applied to soil is usually given in t/ha, but be careful to take account of whether this is the total amount or as a dry weight. The amount of carbon applied is closely related to the total dry matter application; each tonne of dry matter contains c. 58% carbon.

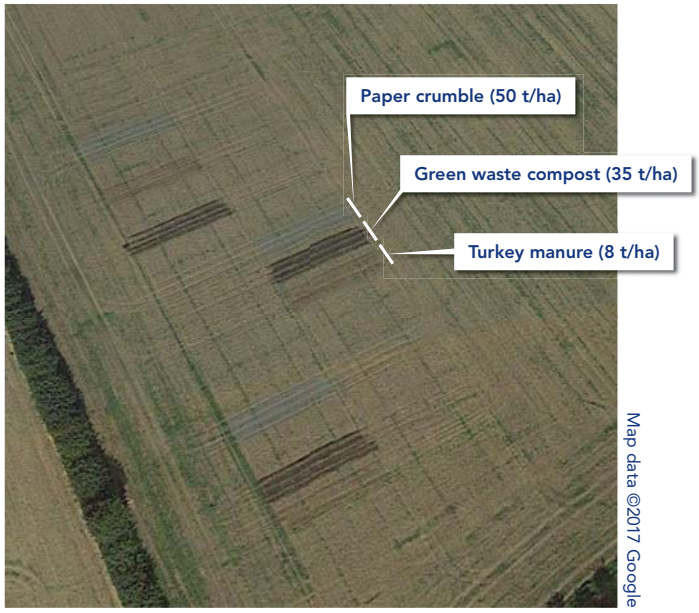
The levels of organic matter in any soil are a result of the equilibrium between the inputs of organic matter and the decomposition of the organic matter by soil organisms. Changes to tillage dominantly affect decomposition and the stabilisation of organic matter in soil. The actual impacts depend on loading rate (rate and frequency of application) – it can take a number of years of repeated management for changes to occur, particularly soil structural improvements.



In general, the simple rule is:

Add more organic materials, build more soil organic matter.

NIAB TAG is testing a range of organic amendments in trials supported by The Morley Agricultural Foundation. AHDB research suggests that it is rarely economic to spend more than £50/t of carbon added to soil (as the total material, haulage and spreading costs). A Defra-funded project concluded that good organic matter management was worth over £100 per hectare per year on average, but that this would be realised only after six years of implementation.



NIAB TAG soil amendments trial – post-harvest application of organic materials, September 2017.

DO ROTATIONS AND CULTIVATION AFFECT SOIL HEALTH?

The Sustainability Trial in Arable Rotations (STAR) project is a long-term large-scale ongoing rotational experiment, managed by NIAB TAG. It has been exploring ways of improving the sustainability, stability and output of conventional arable farming systems on a clay loam (heavy soil) at Otley in Suffolk for over a decade.

The cultivation system research examines the interaction of:

- rotations – continuous winter wheat, winter wheat with combinable break crops (autumn/spring), winter wheat with alternate year fallow (cover crop); and
- cultivations – inversion (plough), deep non-inversion (c. 20cm) and shallow non-inversion (c. 10cm).

Impacts on yield

Winter wheat yields show little difference between cultivation systems. However, with break crops included there is a drop-off in yield (4-11%) under the non-inversion systems.

Rotational choices have tended to have a greater impact on margin than primary tillage decisions, with the winter cropping rotation (all cultivations) providing the highest margin. Tillage results in little difference between the plough and deep non-inversion. Across rotation, there is an increase in margin under non-inversion tillage as a result of lower costs associated with seedbed preparation. However, in the winter cropping rotation, a couple of poor break crops (winter beans) resulted in lower margins under non-inversion tillage *cf.* plough tillage.

Impacts on soil health

Plots were sampled in spring 2018. An assessment was made of treatment (rotation, cultivation) effects on soil health indicators and linked to crop performance (winter wheat) and overall rotational performance.

There were no significant differences between tillage treatments in any of the main scorecard measures. None of the soil health measures currently included in the scorecard, determined in the spring, were well correlated with 2018 wheat yield.

Soil type has an over-riding effect on many of the soil health indicators, irrespective of management decisions (i.e. rotation or cultivation). Timeliness of cultivation, rather than cultivation system per se, is the most important factor controlling impacts on soil.

With little apparent difference in soil health being evident from either rotational or cultivation approaches, further work from autumn 2018 will examine the introduction of a 3-year complex herbal ley to look at restoring soil quality through the regeneration of leys into arable rotations.

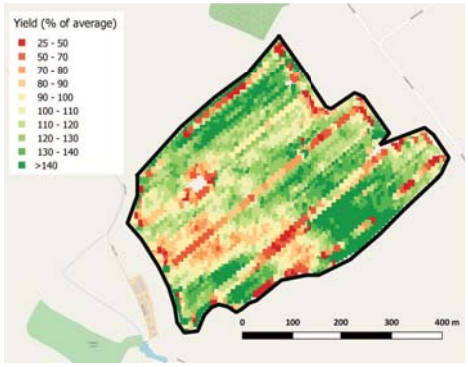
	Plough	Deeper non-inversion	Shallow non-inversion
Crop yield (across rotation)			
Relative yield (% *cf.* plough) cv Shabras, 2018	100	98	99
Relative yield (% *cf.* plough) 2006-2018	100	96	95
£ margin (across rotation)			
Relative margin (% *cf.* plough) 2006-2018	100	104	104
Soil health parameter			
pH	7.2	7.1	7.1
Extractable P (mg/l)	17.1	17.6	17.9
Extractable K (mg/l)	106.2	112.3	110.0
Extractable Mg (mg/l)	57.7	61.1	63.8
Structure, VESS score	2.4	3.0	2.8
Organic matter (%LOI)	3.7	3.9	4.0
CO_2 burst	112	136	130
Earthworm count (total number in a 20 x 20 x 20 cm block)	7.7	4.9	5.9

Traffic light colours were allocated using the framework under test in the AHDB-BBRO Soil Biology and Soil Health Project, Project 2 Report, 2018

The STAR Project is managed by NIAB TAG in conjunction with an independent advisory group and supported by The Felix Thornley Cobbold Trust and, historically The Chadacre Agricultural Trust.

MEASURING SOIL HEALTH ON-FARM

There are an increasing number of approaches available to measure soil health on-farm, but always remember the simple ones.



Yield map variation

Start with yield

Look carefully at the field yield map and consider how it relates to soil type, nutrient status and potential compaction. If implementing changes in management, consider trying a strip first and measure the impact on yield (where the soil type is the same).

See how it grows

Green Area Index (GAI) is the ratio of green plant material compared to ground area. GAI is a useful measure for assessing the health of a crop and can be calculated in a number of ways:

- Cut and weigh (in kg) 1m^2 of crop (or 0.25m^2 of crop and multiply by 4 etc) then this weight by 0.8.
- Cut 0.25m^2 of crop and see how many times the same area can be covered with green material, i.e. if the area is covered twice GAI = 2.
- With practice GAI can be assessed by eye. Smartphone Apps are available but they vary in accuracy.

Other simple measures such as plant counts or tiller counts could also be performed.

Get a spade out

Examine untrafficked soil beside a hedge to get a glimpse into what an undisturbed, biologically-structured soil of the same texture could look like.

Compare with a damaged soil. It is always possible to find such spots – try gateways and compacted headlands.

The Visual Assessment of Soil Structure (VESS) is a relatively quick and easy method that allows scoring of the structure of your soil. Also look at worms and the distribution of organic materials in the soil at the same time.


VESS scoring

Soil profile samples from different cultivation systems, taken in spring 2018 at the STAR Project trials site in Suffolk. These show distinct differences of residue locations and noticeable layering of the cultivation zone following winter wheat with straw incorporated in autumn 2017.


Shallow non-inversion tillage


Deep non-inversion tillage


Annually ploughed

Check out NIAB TAG's step-by-step videos on VESS scoring and GAI measurements. Scan the QR code with your smartphone.

VESS GAI

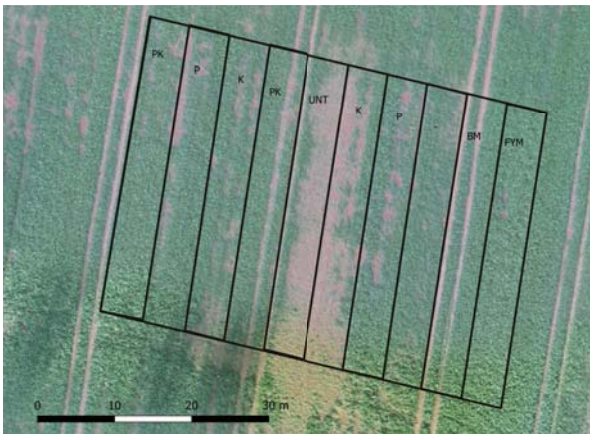
COMPARING LONG-TERM MINERAL FERTILISER AND FYM APPLICATIONS

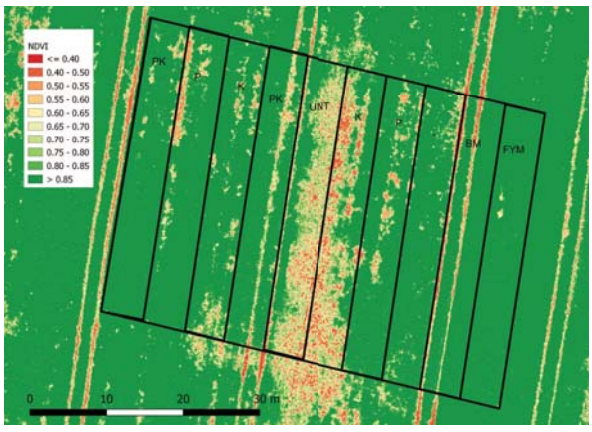
IMPLICATIONS FOR SOIL FERTILITY AND YIELD

Crop and soil experimental work first began at the site near Saxmundham, in Suffolk, in 1899. Despite falling out of service in recent years, the long-term trials work has been resurrected through the intervention of The Morley Agricultural Foundation, NIAB TAG and local farmers.

The site is now supported through TMAF's Morley Educational Training and Outreach (MENTOR) initiative, led by NIAB TAG. It is cropped in locally typical rotation with winter cropping (wheat, wheat, barley, oilseed rape). In 2017-18, the site was cropped with winter oilseed rape (cv. Django).

The main on-going trial studies the effects of cumulative application of P and/or K fertilisers and farmyard manure (FYM) in different combinations. While there have been some changes since the experiment started, the principles of the trial have largely remained consistent for over 100 years.





Impact on soil properties

Treatment		P mg/l	K mg/l	Structure VESS score	Soil OM	Earthworm count (per m²)
FYM	25 t/ha	13.2	147	3.4	4.1	96
P	75 kg P_2O_5 /ha	22.6	113		3.8	
K	60 kg K_2O /ha	9.6	186		3.8	
Untreated		7.4	117	4	4.0	21
PK	75 kg P_2O_5 /ha 60 kg K_2O /ha	25.6	192	3.7	3.9	50

Impact on yield

Treatment	2015 (WW) t/ha	2016 (WB) t/ha	2017 (WW) t/ha	2018 (WOSR) t/ha	Relative rotational (average % of fully fertilised)
FYM	11.6	12.1	6.9	4.8	110
P	11.3	10.1	6.8	4.8	101
K	10.4	8.8	5.1	2.5	83
Untreated	7.7	6.5	4.7	1.7	64
PK	11.8	10.6	5.7	4.6	100

21st Century monitoring of a 19th Century trial

As part of the MENTOR New Technologies study the site was surveyed, in December 2017, using a 5-band multispectral camera from which Normalised Difference Vegetation Index (NDVI) was calculated.

OSR plant numbers were similar in all treatments in early December 2017 (38-45 plants/m²). There was much less vigorous plant growth after establishment in plots with long-term low P additions. In the winter oilseed rape crop this allowed pigeons to land more easily and feed compared with the FYM and PK treatments, resulting in very low OSR yields in 2018.

Ensuring good plant growth after emergence is important to reduce impacts of pest and weed pressure for all crops.

For all soils, ensuring that there are regular additions of organic matter to feed the soil is more important than achieving any particular measured value of soil organic matter.

UK SOIL HEALTH initiative

STRATEGIES FOR IMPROVING SOIL HEALTH IN COMBINABLE CROP ROTATIONS

There is no 'one-size' fits all blueprint to improve soil health; this must be built on existing practice, soil type, climate, etc. But there are options for all farmers to enhance both productivity and soil health. Working together across the agri-industry, the UK Soil Health Initiative seeks to help farmers and growers understand how to manage soils for both improved productivity and increased sustainability, based on healthy soils.

First steps to soil health

Know your site and soils	Know the land use constraints and their variability – hydrology, slope, erosion risk… Know soil texture (including subsoil). Understand the catchment scale context – NVZ, diffuse P risks. Record your soil observations/data so you can refer back to them easily.
Optimise nutrient management	Use soil testing regularly to optimise fertiliser and lime use (pH, P, K, Mg). Maintain pH (liming/gypsum as needed). Use robust information to aid nutrient planning e.g. Nutrient Management Guide, Tried and Tested. Match fertiliser type to soil type to increase N use efficiency and minimise NH_3 emissions. Select best practice application methods to match manure/organic material and soil types.
Improve soil physical condition	Ensure drains are present and maintained where needed. Assess soil structure – regular visual inspection (VESS). If you cause damage, put a remediation plan in place. Use lightweight vehicles wherever possible. Minimise compaction – use appropriate tyres and tyre pressures. When cultivating, assess soil conditions regularly and stay within the workability window. Minimise/optimise cultivation intensity – you will need flexibility season by season. Take a targeted approach to address compaction directly through sub-soiling as needed in the right conditions.
Manage run-off in the field	Incorporate designed buffer strips alongside watercourses, ditches and hedges. Minimise run-off/erosion risk – consider the direction of cultivation. Capture run-off and sediment in field.
Maintain soil organic matter and biological activity	Keep soil covered overwinter wherever possible – no bare ground. Incorporate crop residues wherever possible or return via manures. Make OM measurements – understand results for your soil type and respond through action. Track your own biology – count earthworms.

Supporting partners: NIAB, CFE Championing the Farmed Environment, aic agricultural industries confederation, love every drop anglianwater