

The Morley Long-Term Experiments



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The Morley Long-Term Experiments

An overview of the long-term experiments
funded by The Morley Agricultural Foundation,
delivered by Niab.

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Introduction and History of The Morley Agricultural Foundation

The Morley Agricultural Foundation (TMAF) is a charity which hosts and facilitates scientific agricultural research, education, and training. Promoting the application of effective husbandry techniques, the aim is for high-yielding and profitable agriculture with minimal negative effects on the wider environment & ecosystems.

We achieve this through the use of our own land and commercial farm business for trials and research projects, and as a charity by making grants to organisations and individuals.

We are proud to be working with Niab, BBRO (British Beet Research Organisation) and JIC (John Innes Centre), along with a range of other charities and trusted commercial organisations.

As well as continuing with the traditional areas of study we will be increasingly involved with precision management; through the understanding and use of data, remote sensing, Artificial Intelligence and machine learning, and by supporting the adoption of these technologies on-farm.

TMAF values independent thinking and research, and we do seek collaboration with like-minded partners. We are an open organisation, welcoming involvement, information dissemination and exchange at all levels, we encourage the use of the farm and facilities to enable the communication of ideas, including with the wider public.

UK agriculture is a dynamic and demanding sector, the agriculturalists that prosper in the future will have to be well-informed, trained, and resourced. It is important that TMAF supports the personal and career development of those who can turn research into a practical reality. We will continue to find ways of bringing scientific research and effective techniques to the farm, helping to maintain and improve knowledge and skills across the industry.

Research on the farm continues to focus on soil management and improvement, and increasingly on clean water and air. Our own Soil and Agronomic Monitoring Study (SAMS) is looking in detail at how farming

practices affect the soil over the longer term, and the Niab New Farming Systems project continues its valuable work on cultivations, rotations and soil amendments. Both projects benefit from Morley being able to facilitate long-term research sites.

This publication provides an overview and key findings of all our long term projects. A wealth of data and observations have been collected over the years that are available to all.

The history of The Morley Agricultural Foundation goes back over 120 years when inquisitive landowners wanted to learn more about crop husbandry. Following the second world war the organisation played an important role as food production and security came to the fore in people's minds.

The Norfolk Agricultural Station was formed with farmer members, it was based at a farm near Sprowston north of Norwich. In the mid 60's the land was sold for building and a farm was purchased at Morley near Wymondham west of Norwich. This gave a good cash injection to the organisation. With bigger farms came fewer farmer members.

In the 80's the organisation became Morley Research Centre (MRC) as it expanded to become more relevant to neighbouring counties. MRC had a farm, property and carried out farmer facing research all in house. In 2002 the research part split off and merged with other similar organisations to form TAG (The Arable Group) with a national presence. At this time TMAF was formed as the holder of the assets raised in East Anglia and a grant giving body for research and education. The farm has expanded over the years and is now approximately 700ha. After 10 years TAG joined forces with Niab to be part of a much larger national organisation. TMAF, formerly TAG and Niab have remained closely affiliated and work closely together. Some of the projects mentioned in this publication were initiated in the MRC days and continue to this day.

Niab's Role in Supporting TMAF's Work

The Morley long-term studies has been funded by The Morley Agricultural Foundation (TMAF) and delivered by Niab. Recognising both the practical and strategic importance of these areas, dedicated farming systems research is being supported by Niab, continuing the long-standing co-operation of agricultural field experiments in East Anglia to support the industry in building a more resilient farming industry.

Long-term experiments (LTE's) are a valuable strategic resource that are difficult to maintain through short term or commercial funding and hard to replace once lost. All provide unique data and are excellent research platforms for extension studies. Long-term rotation studies are rare in our industry but they provide powerful agronomic and financial information for UK farmers. Within East Anglia (notably at Morley, Norfolk and other locations in Suffolk) there are several LTE's that would not continue without funding. These experiments are critical for understanding how our cropping systems, soils and environment are responding and what interventions can enhance our resilience.

Table 1. LTE's funded by The Morley Agricultural Foundation.

Experiment	Start Date	End Date	Funders	Location
New Farming Systems: Cultivations	2007	On-going	TMAF, JC Mann	Morley, Norfolk
New Farming Systems: Rotations	2007	On-going	TMAF, JC Mann	Morley, Norfolk
New Farming Systems: The Manure and Organic Replacement Experiment (MORE)	2011	On-going	TMAF, JC Mann	Morley, Norfolk
Sustainable Trial in Arable Rotations (STAR)	2005	On-going	TMAF, Felix Cobbold Trust, Chadacre Trust	Otley, Suffolk
The Saxmundham Experiment: Rotation I	1899	On-going	TMAF	Morley, Norfolk
Morley Fungicide Response Trial in Winter Wheat	1986	On-going	TMAF	Morley, Norfolk
Morley Fungicide Response Trial in Winter Barley	2008	On-going	TMAF	Morley, Norfolk
The Morley Soil and Agronomic Monitoring Study (SAMS)	2018	On-going	TMAF	Morley, Norfolk
Periodic Lift in Sugar Beet	1997	2024	TMAF	Morley, Norfolk
Soil Amendments	2007	2022	TMAF, JC Mann	Morley, Norfolk
Straw Incorporation Study	1985	2019	TMAF	Morley, Norfolk



The Long Term Experiments



NFS Cultivations Study

Overview

The New Farming systems (NFS) evaluating cultivation approaches study explores the interaction between cultivation intensity and cover/companion crop use. The trial was setup in autumn 2007 and has enabled long-term impacts on soil, agronomic and crop performance to be evaluated. The project has also been used as a platform for other researchers and industry partners to collaborate.

The NFS cultivations study uses a single rotation – based on winter cereals with winter and spring sown break crops – in a fully replicated experiment on large plots using commercial machinery. The study compares four levels of cultivation intensity; plough, deep non-inversion (ca. 20 cm), shallow non-inversion (ca. ≤ 10 cm) and a managed regime (decision decided annually based on prevailing conditions and soil measurements). Each of these approaches is repeated with and without the presence of a cover/companion crop in the break crop seasons.

This study has contributed to wider industry collaboration including a project funded by AHDB to test and demonstrate sustainable soil management (<https://ahdb.org.uk/platforms-to-test-and-demonstrate-sustainable-soil-management-integration-of-major-uk-field-experiments>). The project's aim was to understand and improve soil management in cereal production. This was done in the context of perceived threats to soil quality and function (soil erosion, soil compaction, flooding and loss of organic matter). The UK lacked information from robust experiments to address the agronomic, environmental and economic impacts of soil management practices. The project used three long-term and one newer soil management tillage experiments as platforms – two in England and two in Scotland. These platforms were on different soil types and had different rotations but all included a comparison of plough and non-inversion tillage. One of the key findings, was quantifying carbon concentrations under different forms of soil management at multiple sites in the UK. This was one of the first studies that this had been done in long-term agricultural trials.

Table 2. Table of cultivation/Management treatments

- Two management approaches:
 - Current
 - Cover/companion crops – as current but with autumn cover crop before spring breaks or companion crop within winter breaks
- Cultivation approaches:
 - Plough
 - Deep non-inversion (ca. 20 cm)
 - Shallow non-inversion (ca. 10 cm)
 - Managed regime – decision on cultivation regime is based around prevailing conditions and soil measurements

2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
w w	s osr	w w	s bns	w w	s bly	w osr	w w	s oat	w w	w bly	w osr	w w	s bly	s oat	s oat	w w	s bn	w w
	CC		CC		CC			CC			CC*		CC		CC		CC	
																		

Cropping key:

CC cover crop
 ww winter wheat
 sosr spring oilseed rape
 sbns spring beans

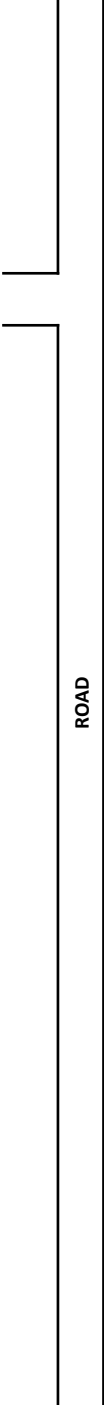
sbly spring barley
 wosr winter oilseed rape
 soat spring oat
 wibly winter barley

* Spring bean companion crop in 2019

NFS cultivations trial plan

REP 3					REP 4				
Managed	Deep non-inv	Shallow non-inv	Shallow non-inv	Deep non-inv	Plough	Shallow non-inv	Managed	Plough	Shallow non-inv
	Cover Crop	Cover Crop	Cover Crop				Cover Crop	Cover Crop	Cover Crop
									Deep non-inv

REP 1					REP 2				
Plough	Deep non-inv	Managed	Plough	Deep non-inv	Plough	Managed	Deep non-inv	Plough	Deep non-inv
		Cover Crop	Cover Crop	Cover Crop	Cover Crop	Cover Crop	Cover Crop	Cover Crop	
									Shallow non-inv



On-going research is examining using long-term platforms such as this aims to evaluate the performance of new wheat genetic material (including synthetic hexaploid wheat derivatives, SHW) under regenerative agricultural practices and to lower the nitrogen inputs required for wheat production. While we are still analysing much of the acquired data, the initial results are interesting as we saw higher grain yield under direct drill compared to deep non-inversion drill. There were also some differences in how the treatments (nitrogen level and tillage) affected the varieties performance. This supports the idea that some varieties perform better under a set of agronomic conditions compared to others.

Key findings

- Relative yield return indicates that the plough tillage approach results in increased yields compared to other cultivation approaches, whilst the highest margins are associated with the shallow and deep non-inversion approaches.
- Across the full rotation, the inclusion of cover crops gave no significant yield advantage overall compared to not growing a cover crop, regardless of cultivation approach used. In addition, differences in the performance of the crops in the rotation are being seen as the study progresses, for example, findings show a reduction in oilseed rape yield associated with short (alternate) rotations of brassica cover crops. Mean long-term winter wheat yields

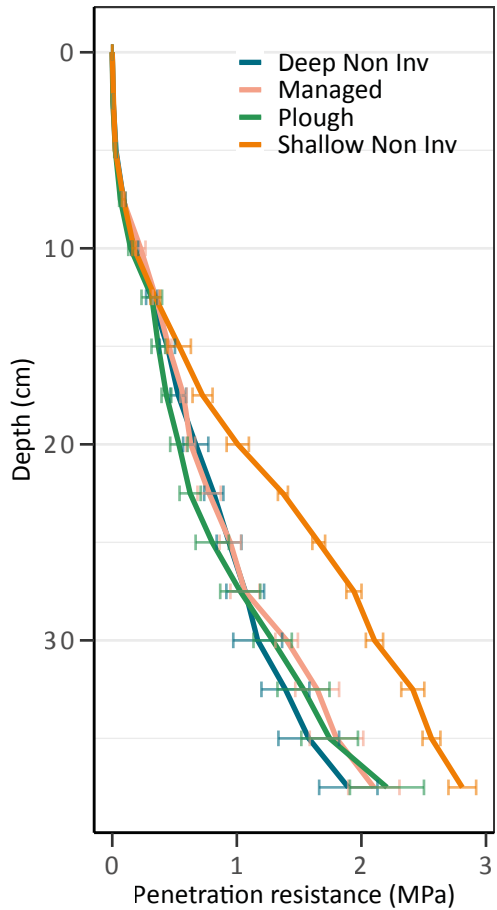


Figure 1. Mean soil penetration resistance between cultivation approaches, 2024. The error bars represent the standard errors of mean.

resulted in little difference between cultivation approaches. However, where a cover crop was used, an increase in yield was greatest under shallow non-inversion tillage. This resulted in yields similar to plough tillage but with less costs associated with seedbed preparation.

- The carbon within the full depth of the soil profile was assessed and appropriate corrections made for differences in soil bulk density and stone content. On this basis, we found differences in the distribution of carbon within the soil profile between tillage systems but no advantage in carbon sequestration with the use of reduced tillage.
- Using a range of indexes, and consistent with other research, we found soil physical condition was well below optimal and in many instances offers very limited opportunity for root proliferation. In soils under non-inversion tillage, we sometimes found large improvements to soil physical conditions over a growing season driven by the growing crop.
- No strong reason for not advocating non-inversion tillage in preference to ploughing was found. In the experiments, using farm-scale machinery, yield data under non-inversion tillage was only marginally lower than under ploughed conditions but when decreased costs of labour and fuel were factored in, gross margins under non-inversion tillage were better than under ploughed systems.

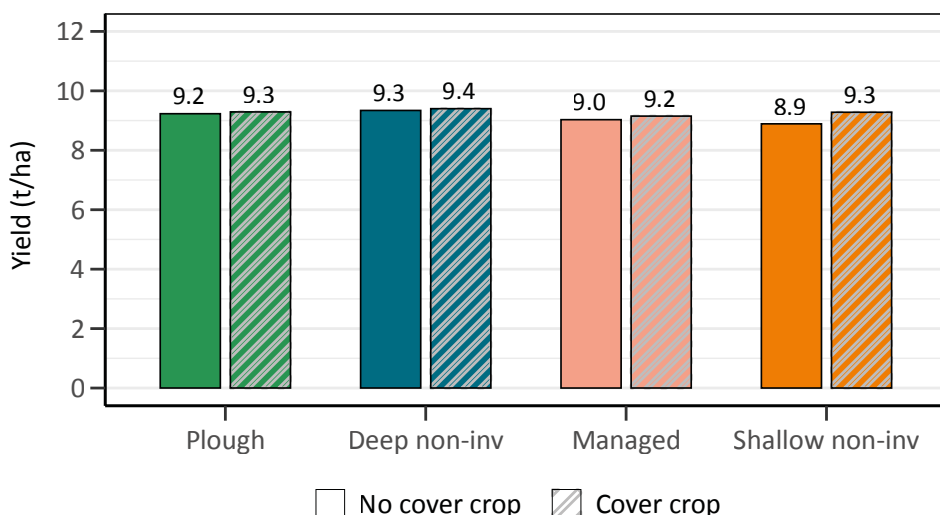


Figure 2. Mean long-term winter wheat yields (2010-2024).

NFS Rotations Study

Overview

The NFS fertility building and cover crops study is a long-term rotational systems experiment examining how novel approaches to cover cropping might contribute to fertility building in arable systems. Understanding the role that cover crops can aid soil structure, soil water movement and moisture retention and carbon storage over the rotation is important in the context of system changes. Understanding dynamics in rotational sequences allows us to improve our understanding of the longer-term impacts that cover crops potentially provide.

This fully replicated experiment contains three crop rotation approaches, based around winter cereals with differing break crop approaches, three nitrogen (N) regimes and four cover crop management systems. The cover crop management approaches specifically explore the use of long-term clover bi-crops, as well as bio-cultivation and legume mix based cover crops, sown ahead of spring sown crops in the rotations.

Currently the study is examining the broader role that cover crops can play in supporting invertebrates, with the aim to identify, quantify and classify ground dwelling indicator species (ground and rove beetles, spiders and earthworms), collected from a set of pre-defined farmland habitats, into distinct groups based on their ecological traits. The influence of agricultural land use and management intensity on the spatio-temporal dynamics of these ecological groups will be investigated. The study will identify and quantify variation in

Winter break	Conventional approach (benchmark for current system)	NITROGEN 1. Untreated (0% of standard dose) for the crop being grown. 2. Half dose (50% of standard) for the crop being grown. 3. Full dose (100% of standard) for the crop being grown.
Spring break	Maximising spring crops for cover crop use in the systems	
Mixed cropping	A mixed rotation with spring and winter cropping	

Table 3. NFS Rotations cropping, cover crop and fertiliser treatments.

Rotation	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Winter break	w w	w osr	w w	w bns	w w	w bly	w osr	w w	w oat	w w	w bly	w osr	w w	w w	s oat	w w	s bly	w bly	fmz
Spring break	w w	s osr	w w	s bns	w w	s bly	w osr	w w	s oat	w w	s bly	w osr	w w	s bly	s oat	w w	s bly	w bly	fmz
Mixed cropping	w w	s osr	w w	w bns	w w	s bly	w osr	w w	s oat	w w	s bly	w osr	w w	s bly	s oat	w w	s bly	w bly	fmz
	BC 	BC 	BC 	BC 	BC 	BC 	BC 	BC 	BC 	BC 	BC 	BC 	BC 	BC 	BC 	BC 	BC 	BC 	BC 
		CC 		CC 		CC 	CC 		CC 		CC 			CC 	CC 		CC 		CC 

Cropping key:

BC bi-cropping
 CC cover crop
 w w winter wheat
 s osr spring oilseed rape

s bns spring beans
 s bly spring barley
 w osr winter oilseed rape
 s oat spring oat

w bly winter barley
 fmz forage maize

Cover crop species composition

Legume mix cover crop	Bio-cultivation mix cover crop	White clover bi-cropping
Buckwheat 5.00 kg/ha (14%)	Ribgrass (Plantain) 1.00 kg/ha (25%)	Certified Luxurial black oat 5.00 kg/ha (40%)
Black oats 10.00 kg/ha (30%)	Chicory 2.50 kg/ha (62%)	Certified AberPearl white clover 5.00 kg/ha (40%)
Yellow trefoil 2.00 kg/ha (6%)	Phacelia 0.50 kg/ha (13%)	Certified S184 wild white clover 2.50 kg/ha (20%)
Lucerne 2.00 kg/ha (6%)		
Vetch 5.00 kg/ha (14%)		
Forage pea 10.00 kg/ha (30%)		

specie(s) abundance and distribution associated with intensively managed arable with or without the use of cover crops. Classifying species based on functional traits within an ecological context will provide initial valuable data indicating whether influences of management practices can be detected using broader ecological groups rather than being reliant on the presence of a few key indicator species.

Legume mix



Bio-cultivation mix



Trial plan

REP 3

Spring break	Winter break	Spring break	Spring break	Mixed cropping	Mixed cropping	Mixed cropping	Winter break	Spring break	Mixed cropping
Clover	Clover		Legume mix	Clover	Legume mix	Bio-cultivation mix		Bio-cultivation mix	

REP 1

Winter break	Winter break	Spring break	Mixed cropping	Spring break	Mixed cropping	Mixed cropping	Mixed cropping	Spring break	Spring break
Clover		Bio-cultivation mix			Clover	Legume mix	Bio-cultivation mix	Legume mix	Clover

REP 4

Mixed cropping	Mixed cropping	Spring break	Spring break	Winter break	Winter break	Spring break	Mixed cropping	Spring break	Mixed cropping
Legume mix	Clover	Clover	Bio-cultivation mix	Clover				Legume mix	Bio-cultivation mix

REP 2

Mixed cropping	Mixed cropping	Spring break	Winter break	Mixed cropping	Spring break	Spring break	Spring break	Mixed cropping	Winter break
	Legume mix	Clover	Clover	Bio-cultivation mix	Legume mix	Bio-cultivation mix		Clover	

Key results

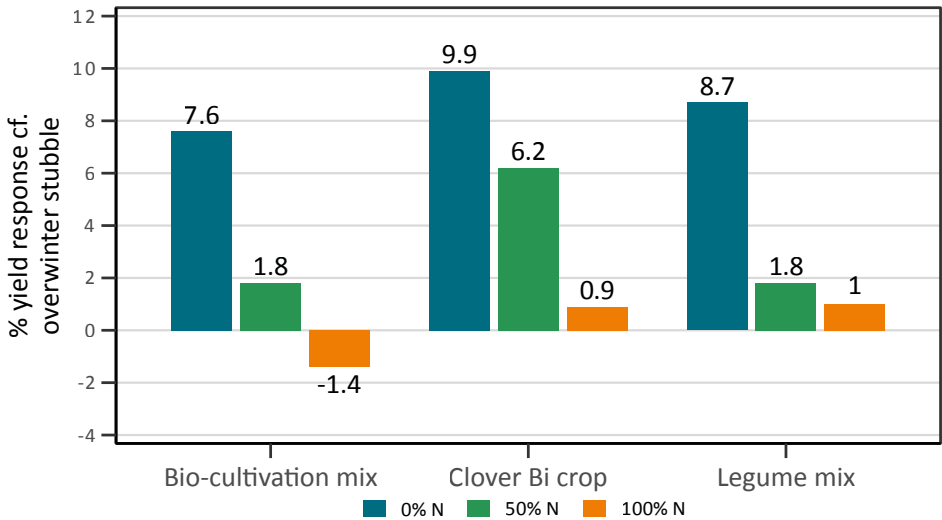
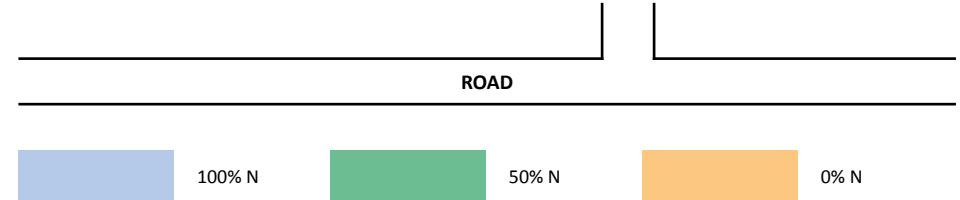


Figure 3. Percentage yield response to nitrogen, compared to overwinter stubble, for each cropping approach, 2008-2025.



Key findings

- Recent findings have demonstrated improvements in soil structure (e.g. reduced bulk density and improved water infiltration rates) from cover crop approaches.
- Maintaining a clover bi-crop within an arable rotation has proven challenging on integrating fertility-building elements whilst maintaining crop productivity.
- Research findings, up until 2025, have indicated a yield response from specific cover crop approaches, particularly at lower N rates.
- Responses from cover crops tend to diminish at full N rate.
- At 50% N rate, the clover bi-cropping increases yield by 6% compared to overwinter stubble. We plan to continue to monitor changes in responses once a further period of cover cropping iterations has been completed.
- The inclusion of cover crops within a long-term monitored experiment has allowed additional studies on beneficial insects and pollinators to be studied (through two Reading University PhD students). On-going monitoring of soil invertebrates is also contributing to the knowledge on cover crops and the potential to increase crop diversity amongst crop rotations and wider soil health benefits.

NFS The Manure and Organic Replacement Experiment (MORE)

Overview

This study examines the use of a wider range of soil amendments and compares these to the use of bagged nutrients.

The rotation follows a typical farm rotation based around combinable cropping with sugar beet.

The experiment is a factorial design, with three replicates, that receives either a dose every twelve years (diminished) application or repeated rotationally (augmented), typically every three years. Additions include turkey manure (ca. 8 t/ha), green waste compost (ca. 35 t/ha) or paper crumble (ca. 50 t/ha).



Table 4. MORE soil amendment applications and cropping treatments

Amendment	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Augmented	✓	w w	s beet	✓ s peas	w w	w osr	✓ s beet	s bly	s oat	✓	w w	s beet	s bly	✓ w oat	w w
Diminished	✓														

Cropping key:

Amendments Augmented or Diminished
w w winter wheat
s peas spring peas
s bly spring barley
w osr winter oilseed rape
w oat winter oat

w bly winter barley
s beet sugar beet
s oat spring oat

Trial plan

REP 2

Untreated	Green compost	Turkey manure	Untreated	Paper crumble	Untreated with potassium	Paper Crumble	Green compost	Turkey manure	Untreated
Diminished	Diminished	Diminished	Diminished	Diminished	Augmented	Augmented	Augmented	Augmented	Augmented

REP 3

Turkey manure	Untreated	Paper crumble	Untreated	Green compost
Diminished	Diminished	Diminished	Diminished	Diminished

REP 1

Paper crumble	Untreated	Turkey manure	Untreated	Green compost	Untreated	Green compost	Paper crumble
Augmented	Augmented	Diminished	Diminished	Augmented	Diminished	Diminished	Diminished

REP 3

Untreated	Paper crumble	Untreated with potassium	Green compost	Turkey manure
Augmented	Augmented	Augmented	Augmented	Augmented

Key results

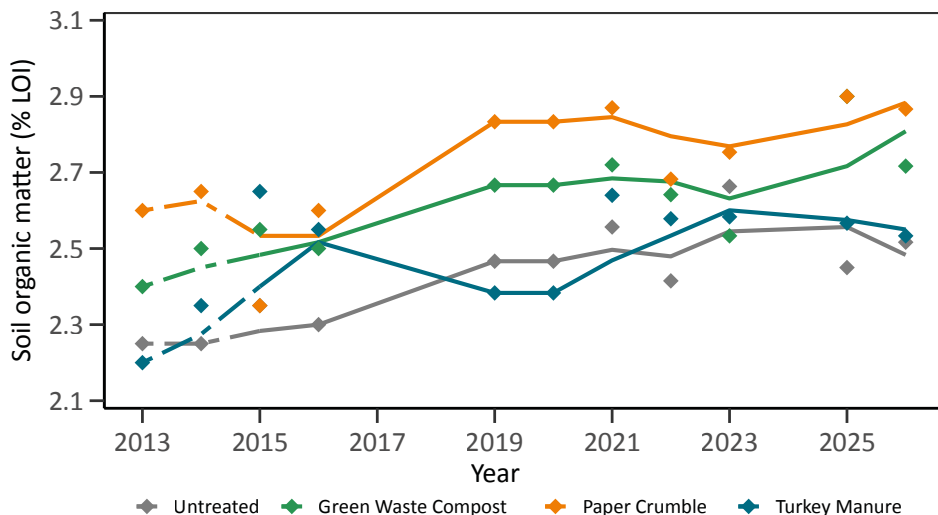


Figure 4. Soil organic matter (0–20 cm depth) in augmented amendments and untreated plots, 2013–2026. The line represents a 3-year running mean.

Key findings

- Increased SOM from 4 applications of paper crumble and green waste compost.
- Trends to lower soil bulk density in paper crumble plots.
- Long-term soil and crop performance is analysed to compare soil amendments, after 14 years, shows that significant yield responses to amendments are not frequently seen.

The Sustainable Trial in Arable Rotations (STAR)

Overview

The STAR project is a long-term rotational systems study examining the interaction between four different rotations and four different cultivation methods.

The research

- Examines different cultivation systems for sustainable arable production.
- Evaluates different rotation systems and how they interact with the required cultivations and inputs.

The STAR project started in 2005 and is located in Suffolk on a clay loam soil. The research uses a fully replicated factorial design and is undertaken on large plots (36m x 36m) using farm scale equipment and techniques.

The four cultivation approaches include:

- Plough
- Deep non-inversion (ca. 20 cm)
- Shallow non-inversion (ca. 10 cm)
- Managed regime – decision on cultivation regime is based around prevailing conditions and soil measurements

The four rotational approaches are:

- Winter cropping
- Spring cropping
- Continuous wheat
- Alternate fallow (up to 2018) now a herbal ley between cropping periods

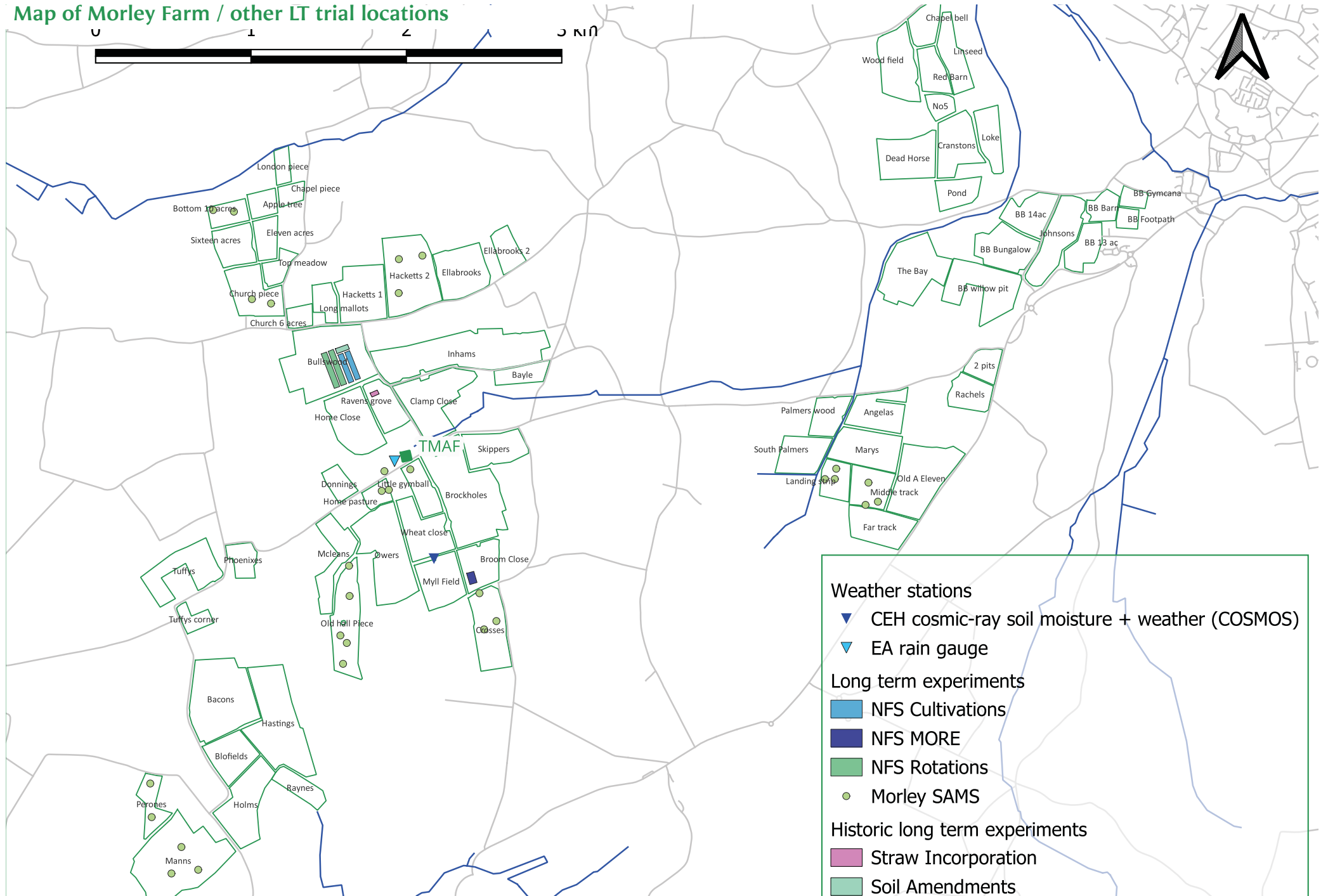
Table 5. STAR cropping and rotational treatments.

Rotation	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Winter cropping	wosr	wwt	wbns	wwt	wosr	wwt	wbns	wwt	wosr	wwt	wbns	1 st wwt	2 nd wwt	wosr	wwt	wbns	1 st wwt	2 nd wwt	-	wosr
Spring cropping	sbns	wwt	soat	wwt	sbns	wwt	slns	wwt	soat	wwt	sbns	1 st wwt	2 nd wwt	sbt	wwt	sbns	1 st wwt	2 nd wwt	-	sbt
Cont. Wheat	wwt	wwt	wwt	wwt	wwt	wwt	wwt	wwt	wwt	wwt	wwt	wwt	wwt	wwt	wwt	wwt	wwt	wwt	-	wwt
Alt. Fallow / Herbal Ley	fal	wwt	fal	wwt	fal	wwt	fal	wwt	fal	wwt	fal	1 st wwt	2 nd wwt	herb	herb	herb	1 st wwt	2 nd wwt	-	herb

Cropping key:

wwt winter wheat
 sosr spring oilseed rape
 sbns spring beans
 slns spring linseed
 sbly spring barley
 wosr winter oilseed rape
 soat spring oat
 wby winter barley
 fal alternate fallow
 herb herbal ley

Map of Morley Farm / other LT trial locations



	1	2	3	4	5	6	7	8	9	10	11	12
A	Deep	Shallow	Plough	Deep	Plough	Deep	Deep	Deep	Shallow	Shallow	Plough	Shallow
	Winter	Herb Ley	Herb Ley	Herb Ley	Spring	Herb Ley	Winter	Spring	Spring	Cont. Wheat	Winter	Herb Ley
B	Plough	Plough	Managed	Shallow	Plough	Shallow	Shallow	Deep	Managed	Deep	Managed	Managed
	Spring	Cont. Wheat	Herb Ley	Spring	Herb Ley	Cont. Wheat	Winter	Cont. Wheat	Winter	Spring	Herb Ley	Cont. Wheat
C	Managed	Plough	Managed	Shallow	Managed	Managed	Shallow	Plough	Deep	Deep	Deep	Shallow
	Cont. Wheat	Winter	Winter	Cont. Wheat	Spring	Herb Ley	Herb Ley	Cont. Wheat	Winter	Cont. Wheat	Herb Ley	Winter
D	Deep	Shallow	Managed	Deep	Managed	Managed	Plough	Shallow	Plough	Plough	Managed	Plough
	Spring	Winter	Spring	Cont. Wheat	Cont. Wheat	Winter	Winter	Spring	Herb Ley	Cont. Wheat	Spring	Spring

Key results

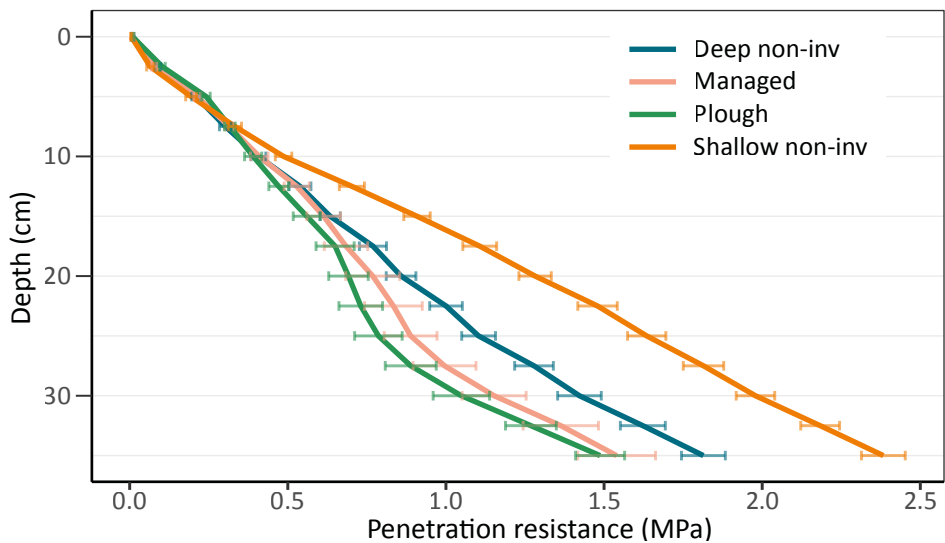


Figure 5. Mean rotational effect of cultivation on soil strength, 2024.
The error bars represent the standard errors of mean.

Table 6. Annual average margin for cultivation approaches (2006-2023) at STAR

Cultivation approach	Average annual margin (£/ha)
Plough	617
Managed approach	652
Deep non-inversion	597
Shallow non-inversion	595

*Margins for herbal ley rotation is not included.

Table 7. Annual average margin for rotations (2006-2023) at STAR

Cultivation approach	Average annual margin (£/ha)
Winter Cropping	679
Spring Cropping	593
Continuous Wheat	573
Herbal Ley	n/a

Key findings

- The impact of rotation and cultivation on weed burden, soil structure and mycotoxin risks are becoming increasingly apparent as the study progresses.
- Soil penetration resistance indicated that shallow tillage approaches are continuing to exhibit increasing soil strength compared to the plough and deep tillage approaches in the 17.5-37.5 cm soil profile. The plough tillage, resulted in the lowest soil strength with the deep tillage approach, intermediate.
- Considering margins (calculated as a gross margin less in-field operational costs) over all crops in the rotation, the difference between cultivation systems is small. The managed approach cultivation system is tending to give the highest margins but margin is barely distinguishable across systems.
- Tillage decisions seem to be more critical in break crops. Rotational choices have tended to have a bigger impact on margin than primary tillage decisions; with winter cropping rotations giving the higher margins compared to a similar rotation with spring breaks.



The Saxmundham Experiment: Rotation 1

Overview

The Saxmundham Experimental Site is the third oldest experimental station in the country. Started in 1899, with 2025 likely marking 125 years since the first harvested plots at the site. The experiment was originally set up to demonstrate that the then relatively new mineral phosphorus, potassium, and nitrogen fertilizers were as effective as traditional farmyard manure applications.

The site has been managed by several organisations since its inception, notably between 1964 and the early 2000s by Rothamsted Research through BBSRC funding. After a few inactive years, in autumn 2014 TMAF, through Niab, reinstated the experiment and spent the first five years baselining the historic treatments. Then in autumn 2019 three historic treatments that hadn't been applied for some years had been shown to have returned to levels similar to the untreated were updated to reflect modern P management strategies.



Table 8. Saxmundham organic amendments and fertiliser treatments.

Trt	Annual application	Target P	Target K	Rationale
Unt	-	0	0	No mineral or organic P applied for over 125 years. Consistently maintained at Index 0.
FYM	25 t/ha	2	2+	Annual application of cattle manure at 25 t/ha, contributing both P and organic matter.
GWC	~18 t/ha	1	2+	Applied to match FYM's organic matter contribution. With lower P content, it aims to build soil organic matter while keeping soil P at a lower index.
AdP	Adaptive P management	0	2+	Adaptive management since 2019. Historically an old N only treatment, Between 2018-2025 received foliar-applied mineral P (Folex P) to explore improving P uptake without increasing soil P. Now exploring the role of buckwheat in improving plant available P in low P soils.
P	P ₂ O ₅	2	2+	Mineral P or K applied individually to isolate their specific effects.
K	K ₂ O	0	2+	Isolates the K response.
PK	P ₂ O ₅ + K ₂ O	2	2+	Annual application of mineral P and K fertilisers, maintaining Index 2 for both nutrients.
P _L K	P ₂ O ₅ + K ₂ O	1	2+	A former K-only plot now receives limited P to maintain Index 1 as a low-P comparison for GWC treatments.

All plots receive farm standard N (230 kg N/ha in winter wheat) and other micronutrient inputs.

Trial plan

40	PK	39	P	38	P _L K	37	PK	36	Unt	35	K	34	P	33	AdP	32	GWC	31	FYM
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30	PK	29	P	28	P _L K	27	PK	26	Unt	25	K	24	P	23	AdP	22	GWC	21	FYM
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20	PK	19	P	18	P _L K	17	PK	16	Unt	15	K	14	P	13	AdP	12	GWC	11	FYM
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10	PK	9	P	8	P _L K	7	PK	6	Unt	5	K	4	P	3	AdP	2	GWC	1	FYM
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See Table 8 for key.

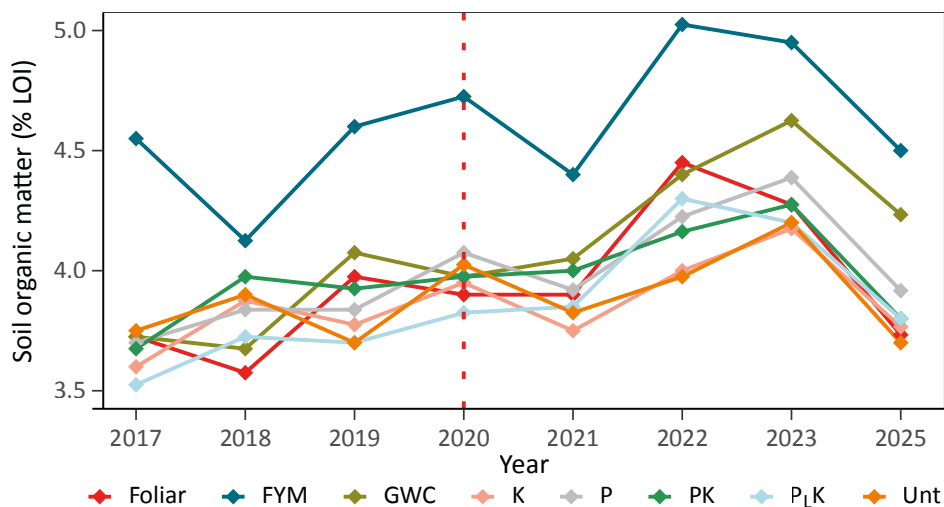


Figure 6. Average soil organic matter concentrations (%) determined through loss on ignition, sample depth 0-15cm. Red vertical dashed line represents the updating of treatments in autumn 2019.

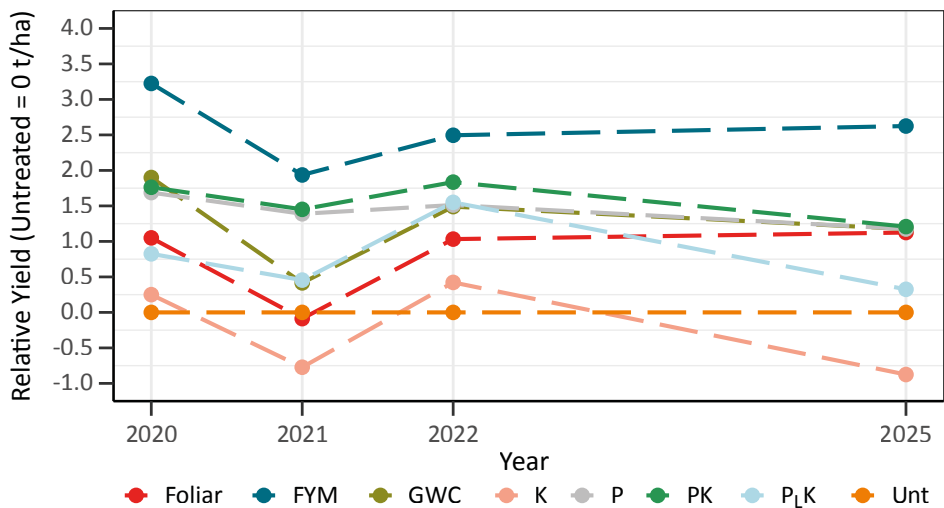


Figure 7. Relative crop yield compared to untreated, 2020-2025.

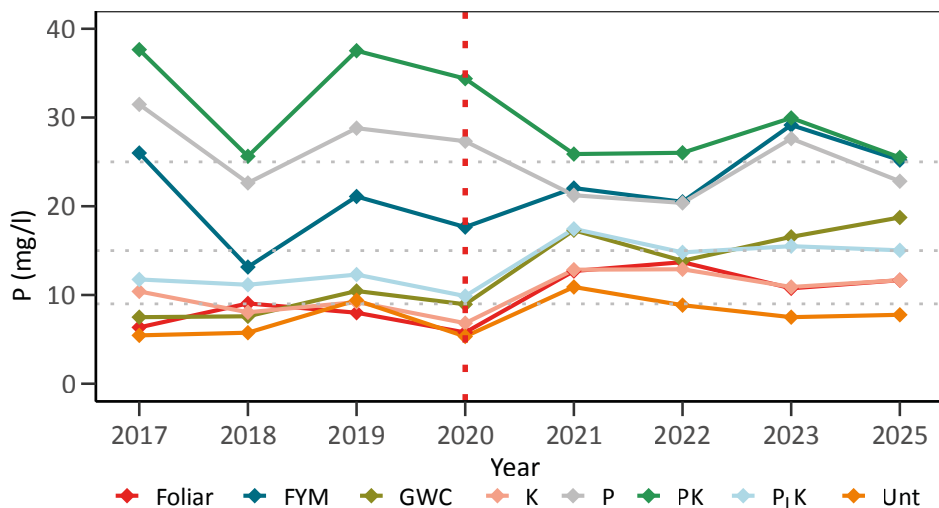


Figure 8. Average soil phosphate concentrations (Olsen's sodium bicarbonate extracted) mg/l across all treatments. Red vertical dashed line represents the updating of treatments in autumn 2019.

Key findings

- Results from the Saxmundham long-term phosphorus experiment demonstrate the critical role of both phosphorus management and organic amendments in sustaining soil fertility and crop yield. Saxmundham has contributed significantly to our understanding of P management in arable soils, summarized in a recent paper by colleagues at Rothamsted (Johnson and Poulton., 2019).
- Regular applications of farmyard manure (FYM) have consistently delivered the strongest agronomic benefits. Since 2017, soil organic matter has been around 0.8% higher in FYM plots than in untreated soils, representing a ~19% relative increase. Introduction of green waste compost (GWC) in 2019 has also increased soil organic matter by approximately 0.4%, showing that detectable improvements can be achieved within a short timeframe through organic inputs.
- Applying mineral phosphorus to soils maintained at Index 2 increased yields by around 35% compared with Index 0, underlining the importance of correct soil P status. FYM provided a further yield uplift of around 18% above mineral P and K alone, likely driven by enhanced soil physical condition and wider nutrient supply. In contrast, no yield response was

observed to mineral potassium, confirming the naturally K-releasing nature of the soil, while foliar P delivered only small, non-significant gains since 2019.

- The Saxmundham experimental site is a unique resource for studying soil-plant P interactions and in 2025 the site was utilized through the Exploiting novel wheat genotypes project supported by TMAF evaluating the performance of new wheat genetic material (including re-synthesised wheat (SHW) lines), under low P soils.



Saxmundham experimental site

The Morley Soil and Agronomic Monitoring Study (SAMS)

Overview

TMAF continue to support a number of long-running replicated field trials, looking at fungicide response in wheat, barley and sugar beet, how long term soil management including cultivations, rotations and organic amendment use impact productivity and soil properties. These detailed plot studies focus on the optimisation of management and opportunities for innovation. The collection of long-term monitoring datasets of actual farm practice alongside these plot-based studies fills a critical gap in the chain linking research and its application.

The Morley Soil and Agronomic Monitoring Study (SAMS) began in autumn 2018. SAMS is a long term on-farm monitoring programme that aims to link soil health and its impacts on yield, profitability, and resilience. We anticipate this long-term monitoring will continue for decades to come. A network of 30 monitoring sites, a mixture of historic high, low and variable yielding areas and 3 headland sites, have been chosen across the farm.

Table 9. SAM’s soil and agronomic properties monitored.

Soil monitoring	Agronomic monitoring
Visual evaluation of soil structure	Plant populations
Penetration resistance	Green area index (GAI)
Aggregate stability	Ear numbers
Earthworms	Grass weed head/broad leaf weed population
Soil mineral N	Disease levels
Soil organic matter	Yield
pH, extractable phosphorus, potassium, magnesium, calcium, sulphur	Harvest index
Bulk density	Specific weight
Water release characteristic curve	Thousand grain weight
Exchangeable micro nutrients	Oil content for oilseeds, sugar content for sugar beet
Respiration assay (CO ₂ burst)	Grain protein, nitrogen and phosphorus content
Potentially mineralisable N	

Trial plan



Morley Fungicide Response Trial in Winter Wheat

Overview

The effectiveness of fungicide programmes is considered by comparison of treated and untreated plots otherwise grown under the same conditions. Given the cost and complexity of fungicide programmes, it is increasingly important to consider not only the overall effectiveness of the programme but also to assess the effectiveness of the separate spray timings.

The winter wheat fungicide response trial (commonly known as the cigarette graph trial) records a snapshot of the yield response to fungicide input and spray programme components in winter wheat each year. It not only looks at the yield response to a complete fungicide programme but the trial design also allows the responses to T0, T1 plus T2 and T3 spray timings to be measured separately. This trial has been running in some form for thirty-nine years continuously (since 1986) at Morley which makes this one of the longest running trials for fungicides in the UK.

Prior to 2005 at Morley, data was derived from existing trials which were not specifically designed for the aim of this trial. Since 2005, and particularly from the inception of TMAF funding in 2007, the trial has a common treatment design (2025 version shown below in the Treatment Table). A T0 treatment was introduced in 2005. In every season, responses from the various fungicide timings are measured by the same comparisons:

- Benefit of T1+T2 vs untreated
- Benefit of T3 vs T1+T2
- Benefit of T0 vs T1+T2+T3
- Benefit of T1 alone vs untreated
- Benefit of T2 alone vs untreated

It is very important to use these same comparisons every season to allow fair comparison between seasons. Over the years, the fungicide treatments have changed to reflect the typical, relatively robust farm level programme.

Rates and products are chosen to reflect current available technology but also represent what is applied on a typical crop each season.

Over the years, the inclusion of a single or two contrasting varieties have been used, these are selected to have moderate or high disease susceptibility across a range of foliar and ear diseases. These varieties are updated every few years to account for new varietal introductions.

Table 10. Winter wheat fungicide treatment list in 2025 with comments and description.

Variety	Treatments	GS30	GS32	GS39	GS65	Comment
Extase T1-T5 and Gleam T6-T10	1,6	Untreated	-	-	-	Untreated
	2,7	-	-	Revystar 0.8 l/ha + Tebucur 250 0.5 l/ha	-	T2 alone
	3,8	-	Revystar 0.8 l/ha	Univoq 1.25 l/ha	-	T1+T2
	4,9	-	Revystar 0.8 l/ha	Univoq 1.25 l/ha	Tesoro 0.774 l/ha	T1+T2+T3
	5,10	Tesoro 0.516 l/ha + Talius 0.125 l/ha	Revystar 0.8 l/ha	Univoq 1.25 l/ha	Tesoro 0.774 l/ha	Complete

Key results

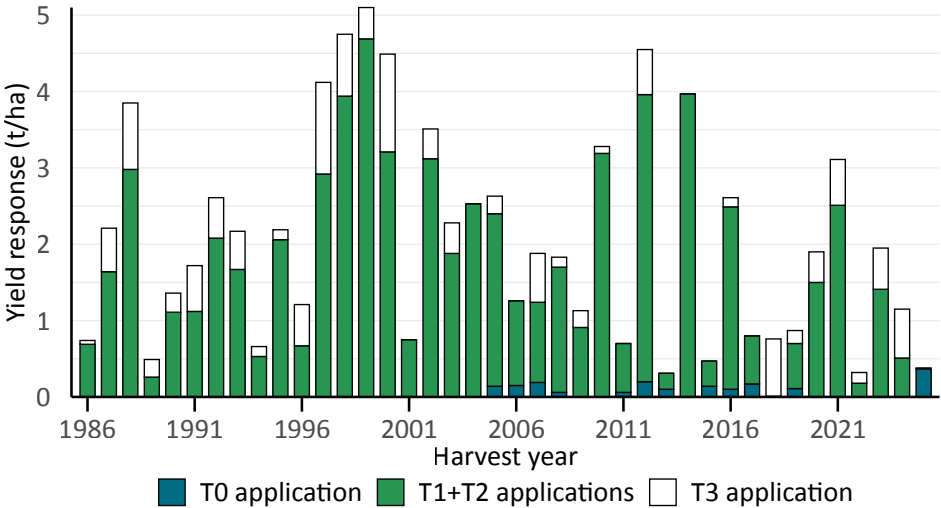


Figure 9. Yield responses of winter wheat (typical farm varieties selected for moderate disease resistance) to fungicide programmes, 1986-2025.

Key findings

- The treated and untreated yields and hence the yield responses to fungicides from the Morley trial show wide variations from season to season depending on weather conditions and consequent disease pressure.
- The mean 39-year fungicide response for T1 + T2 is now 1.70 t/ha, and the fungicide response for T3 is 0.34 t/ha.
- The historical responses can be seen in the wheat “cigarette” graph due to the shape of each individual histogram.

Morley Fungicide Response Trial in Winter Barley

Overview

This trial started in 2008 and is in the 17th year of operation for this trial series and forms an invaluable part of the dataset on fungicide performance. This trial mirrors the winter wheat fungicide response trial, performing a similar function that measures the yield response to fungicides in an average winter barley variety each season.

The trial has not been carried out continuously since 2008 but there are sixteen years data for Morley. The Morley Agricultural Foundation has funded this trial in some way since 2011. The winter barley fungicide response trial measures the yield response to fungicides in an average winter barley variety each season. It not only looks at the yield response to a complete fungicide programme but the trial design also allows the responses to the autumn and spring T0, T1 plus T2 and at T3 spray timings to be measured.

Table of treatments/rotation

Over the years, the fungicide treatments have changed to reflect the typical, relatively robust farm level programme. Rates and products are chosen to reflect current available technology but also represent what is applied on a typical crop each season. From 2017/18, the protocol was revised to continue to do these comparisons but also compare new three spray fungicide programme, with the two-spray standard treatment (2025 version shown below in the Treatment Table). The new three-spray programmes were thought to provide a longer period of disease protection, fit better with growth regulator timings to reduce sprayer passes and give more robust ramularia control. An autumn T0 treatment was removed from 2020 onwards.

In every season, responses from the various fungicide timings are measured by the same comparisons:

- Benefit of T0 alone
- Benefit of T1 alone
- Benefit of T2 alone
- Benefit of T1+T2 (standard programme)
- Benefit of T3 alone

The varieties used are selected to be typical for the area and match local end user specifications. The variety is updated every few years to account for new varietal introductions. The variety is selected to have average disease susceptibility across a range of foliar and ear diseases.

Table 11. Winter barley fungicide treatment list in 2025 with comments and description.

TRT	GS25 (A)	GS31-32 (B)	GS39-45 (C)	GS59-61 (D)	Comment
1	Untreated	-	-	-	UNTREATED
2	-	Siltra Xpro 0.6 l/ha	-	-	T1 only
3	-	Siltra Xpro 0.6 l/ha	Siltra Xpro 0.4 l/ha	-	Standard 2 spray programme
4	Proline 275 0.25 l/ha	Siltra Xpro 0.6 l/ha	Siltra Xpro 0.4 l/ha	-	Spring T0 + standard
5	-	Siltra Xpro 0.6 l/ha	Siltra Xpro 0.4 l/ha	Proline 275 0.25 l/ha	Standard + T3
6	-	Revystar XE 0.6 l/ha	Revystar XE 0.4 l/ha	Proline 275 0.25 l/ha	Revystar XE in place of Siltra Xpro plus a T3

Key results

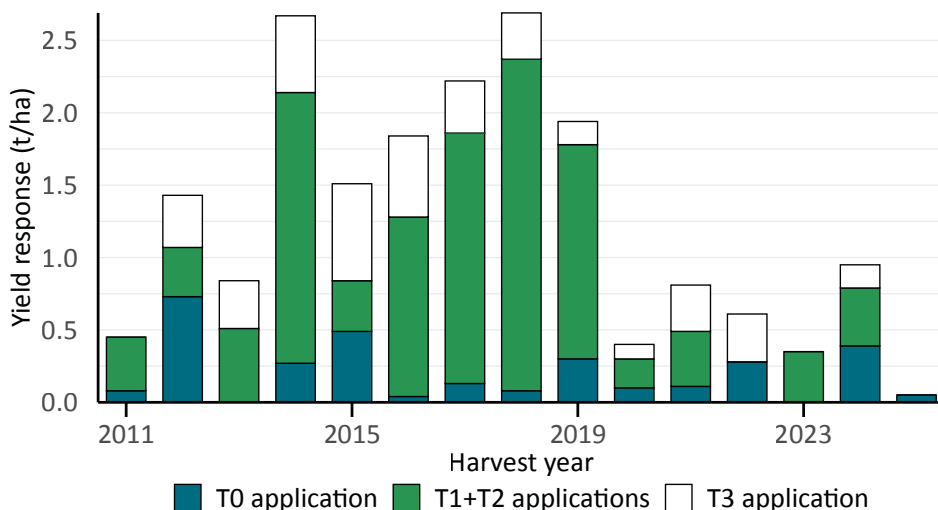


Figure 10. Yield responses of winter barley to fungicide programmes, 2011-2025.

Key findings

- The treated and untreated yields and hence the yield responses to fungicides from the Morley trial show wide variations from season to season depending on weather conditions and consequent disease pressure.
- Compared with the mean yield response across the sixteen-year trial period, there was a 0.19 t/ha yield response to a spring T0 alone, a 0.81 t/ha response to the addition of a T1 + T2, and a 0.25 t/ha response to a T3.
- A T0 plus a two-spray fungicide programme (T1 + T2 timings) is responsible for most of the yield uplift in barley.

Historic LTes



NFS Soil Amendments

Overview

This NFS project examined the use of green waste compost originally comprised of three rotational systems (continuous wheat, spring breaks, and spring breaks with cover crop) with and without the annual application of 35 t/ha of green waste compost, applied in consecutive years between 2008 and 2011. In 2019 onwards, the study switched to a single rotation to monitor the legacy effect of the green waste compost.

Key findings

- Repeated applications of green waste compost can significantly improve yields in a continuous wheat rotation for at least six years after the final compost application.
- This yield response is likely a result of a combination of higher levels of available nutrients (phosphate, potassium and magnesium) and benefits from increased SOM.

Periodic Lift in Sugar Beet

Overview

Sugar beet lifting season varies from year to year, but usually begins as soon as the factories open from mid/late September and may continue until February, with the factories staying open until March. In 1997 a long-term study was initiated at Morley to examine the relationship between yield and lifting date in sugar beet; this is known as the 'periodic lift study'. Between 2007-2018 the monthly comparisons of adjusted yields were carried out either following, or in the absence of, a summer fungicide regime (using triazole and strobilurin based products). For 2019-2024 monthly lift timings have been condensed into 3 timings throughout the campaign (September, November and January). The objective of the study is to determine the benefit in terms of growth rate and yield of sugar beet treated with and without a triazole based fungicide programme during summer and early autumn.

Key findings

- Annual reports can be found on the TMAF website at <https://tmaf.co.uk/morley-lots/>
- The response to fungicides varies across seasons due to disease pressure and weather conditions. Generally, mid-season lifting favours higher yields and the accumulation of sugar content compared to earlier timings.
- Later lift timings in the season can lead to a reduction in sugar percentage due to exceptionally cold weather.

Straw Incorporation Trial

Overview

Crop residues are no longer seen as a waste but an increasingly valuable resource. In some areas and seasons, the value of straw sold from the farm can almost equal the value of the grain. Straw is a long sought-after resource for animal bedding (with around 60% of wheat straw used for this purpose). Small amounts are used as bedding for carrots, mushroom compost and also increasingly for energy generation and as an input material for various industrial processes. Therefore, the debate more recently has been whether to sell or to incorporate straw. Long-term studies comparing treatments with and without straw incorporation, such as those carried out at Woburn show increases in soil organic matter where straw is incorporated rather than removed. A small proportion of the carbon added in the straw is retained in the soil (c. 13%).

The long-term experiment straw incorporation experiment at Morley was began as part of a series of experiments which looked at different approaches to cultivation in the presence of chopped straw and the following N response. These experiments which preceded the burning ban showed that chopped straw could be ploughed down successfully without pre-plough mixing and that no autumn N was required. The long-term experiment has continued to study the impacts of crop residue returns (and their incorporation) at a range of different fertiliser nitrogen application rates.

The trial was established in 1984, with three replicates of each treatment. The trial was initially designed as a part of series to investigate the effects of timing and depth of straw incorporation on establishment and yield of following crops. Before the experiment straw had not been regularly incorporated. Following the 1989 harvest the objectives of the experiment changed and the focus was on the impacts of straw incorporation on crop N requirements, soil mineral N and losses of N through leaching.

The rates of fertiliser (N1-N6) used depend on the crop grown:

- Winter wheat and winter barley: 0-250 kg N/ha in 50 kg increments
- Winter OSR: 0-200 kg N/ha in 40 kg increments
- Spring cereals and sugar beet: 0-150 kg N/ha in 30 kg increments

Key findings

- Yields vary from year to year. However, as expected, there is a significant response to N fertiliser application in all crops where N is applied – with the economic optimum most often lying between the N4 and N5 treatments.
- At the start of the experiment the plots contained 1.7% organic matter (OM) on average. No change in OM content in the plots was detected after ten years. However, after 20 years, in the plots receiving no N fertiliser had OM levels of 2.6% and the organic matter in the plots receiving the highest doses of N was 2.9%. Similar OM levels were measured in 2014 after 30 years.
- This highlights the win-win approach of farm management that optimises crop yield in also helping to maintaining soil organic matter.
- These data fit with the general observations from other trials that impacts on soil organic matter usually become detectable after about 8 years and soil organic matter content usually continue to increase to a new equilibrium point (where inputs and outputs are again in balance) after 25-50 years. Hence, fields which had residues burned before 1992 and now have residues incorporated (whether annually or rotationally) are now likely to be slowly reaching their new equilibrium organic matter content, further increases will require further changes in management either increasing inputs of organic matter (cover crops, composts etc) and/or reducing rates of decomposition (usually by reducing tillage intensity).

Morley Farms as a Platform for Trials

The farm is obliged to keep records like any other arable farm. We do also collect further data that proves useful of on farm decision making but also provided reliable data for research analysis.

For example;

- An onsite COSMOS weather station provided by the Centre for Ecology and hydrology (CEH). This is a comprehensive weather station that remotely records and sends data back to CEH for verification before making a monthly summary for TMAF.
- The Combine harvester has been yield mapping for 18 years. In 2021 a near infra-red (NIR) grain protein meter was installed. It gives grain protein measurements in real time. This is helping understand Nitrogen use efficiency across the farm.

Morley Clean Water Project

The aim of the Morley Clean Water project is to take measures to ensure the water leaving the farm is as clean, or cleaner than when it arrived.

The motivation is that we want to be good farmers and custodians of the landscape, but also to demonstrate good practice to other stakeholders.

Any activities or measures employed should be at a modest cost and effort. For example, alterations can be made to farm ditches or farm tracks with just farm labour, skills and machinery. Any such intervention will not compromise crop productivity, e.g. field drainage will not be impeded.

Clean water is ultimately water that meets the UK drinking standards. In the context of this project the target is to reduce nitrate, phosphate and turbidity. Turbidity is a measure of solid particles in the water. However, it is well known that pesticides and nutrients attach themselves to soil particles.

Water testing

To get an understanding of what the background water quality is like, water quality measurements are being taken at different locations. Using a colorimeter, we hope to be able to identify areas of most concern. Monthly water samples have been taken since 2020 at 8 locations around the farm. The water is measured for nitrate, phosphate and turbidity. Despite what people might think the water rarely exceeds the drinking water standard for nitrate.

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Abbreviations

Abbreviation	Meaning
AHDB	Agriculture and Horticulture Development Board
BBRO	British Beet Research Organisation
BBSRC	Biotechnology and Biological Sciences Research Council
CEH	UK Centre for Ecology & Hydrology
COSMOS	Cosmic-ray Soil Moisture Observing System
EA	Environment Agency
FTCT	Felix Thornley Cobbold Trust
FYM	Farmyard Manure
GAI	Green Area Index
GWC	Green Waste Compost
JC Mann	John Colman Mann Trust
JIC	John Innes Centre
LOI	Loss on Ignition (used to estimate soil organic matter)
LTE / LTEs	Long-Term Experiment(s)
MORE	Manure and Organic Replacement Experiment
NFS	New Farming Systems
NIR	Near Infra-Red (used to measure grain quality)
PK	Phosphorus and Potassium
REP	Replicate
SAMS	Soil and Agronomic Monitoring Study
SHW	Synthetic Hexaploid Wheat
SOM	Soil Organic Matter
STAR	Sustainable Trial in Arable Rotations
TAG	The Arable Group
TMAF	The Morley Agricultural Foundation
TRT	Treatment

All the trials described in this booklet are supported by charitable funding. Consequently, the data generated and reasonable access to the trial sites for monitoring, research, or other scientific studies may be made available upon request.

For further information or to discuss access, please contact one of the editors listed on page 2.



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