December 2023

Final Summary Project Report

PR649

On-farm trials at Strategic Cereal Farm East (2017–2023)

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1. Introduction

Host Farmers: Cousins Brian (pictured) and Patrick Barker
Location: E.J. Barker & Sons, Suffolk
Duration: 2017–2023

AHDB Strategic Cereal Farms put cutting-edge research and innovation into practice on commercial farms around the UK. Each farm hosts field-scale and farm-scale demonstrations, with experiences shared via on-farm and online events to the wider farming community.

E.J. Barker & Sons is a family farm partnership and contracting business that dates to 1957. The 513 ha arable farm business follows a traditional 12-year rotation, incorporating winter wheat (feed), herbage grass seed and break crops of spring barley, beans, oilseed rape or linseed. The soils are medium to heavy, with the cultivation strategy adapted to each field and season (from ploughing to direct drilling).

This Strategic Cereal Farm aimed to develop a long-term strategy to increase productivity and produce high-quality produce without having a negative impact on the farmed environment. The trials for the four topic areas responded to previous results and changes to the UK situation for agribusinesses (Figure 1). The main findings are summarised in this report, with trial details published in the annual reports.

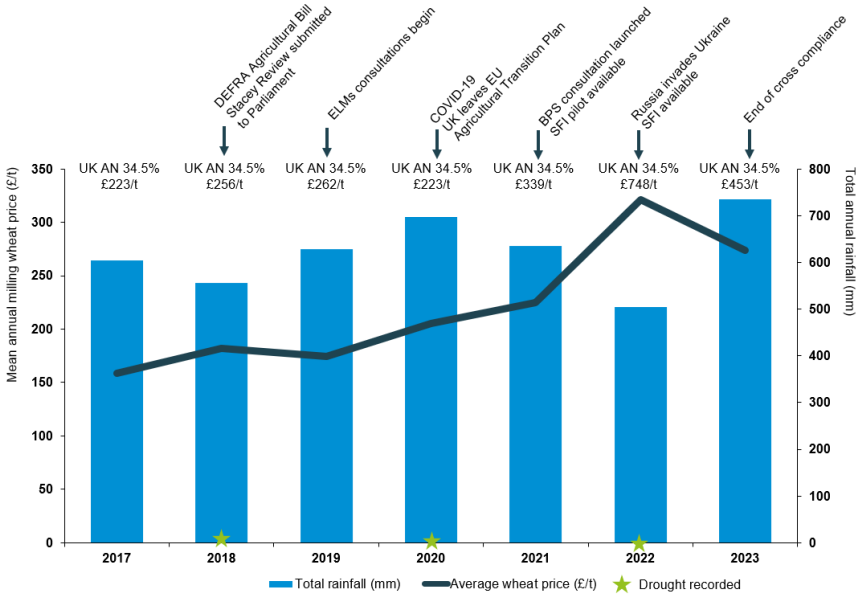

Figure 1. Some of the major changes that affected UK agribusinesses over the six-year period of this Strategic Cereal Farm (2017–2023)

2. Managed lower (fungicide) input trials

2.1. What was done?

Because of chemistry loss and fungicide resistance, new ways to manage disease risks in cereals are needed. This trial tested high-cost to low-cost fungicide programmes. It aimed to establish a balance between reducing inputs (for economic and environmental benefits) and maintaining disease control, crop yield and profitability. The trial used replicated large field plots and evolved across five years:

- In the first two years, three fungicide programmes (low, medium and high) were applied in response to seasonal pressures
- In the final three years, a more complex design was introduced to compare untreated plots, with two levels of fungicide input (low and high) and seven variations in application timings, as well as interaction treatments (Table 1)

Plant counts and normalised difference vegetation index (NDVI) data were collected from crop emergence to harvest. All treatments were assessed for foliar disease, green leaf area and ear disease before and after key fungicide timings. At harvest, yield samples were collected from each treatment.

Table 1. Fungicide input treatments (final three trial years)

Treatment	Application timings
Untreated	Not applicable
Low	T1
	T2
	T3
	T1 + T2
	T1 + T3
	T2 + T3
	T1 + T2 + T3
High	T1
	T2
	T3
	T1 + T2
	T1 + T3
	T2 + T3
	T1 + T2 + T3
Interaction (T1/T2/T3)	Low/Low/High
	Low/High/Low
	Low/High/High
	High/High/Low
	High - Low - Low

2.2. What did we learn?

It was possible to significantly reduce fungicide input and retain net margin.
In these trials, a low level of fungicide applied across all the timings was the best strategy to reduce fungicide input, rather than omitting a spray. This approach was achieved in combination with a robust integrated pest management (IPM) strategy, which covered variety choice, drilling date and good crop establishment.

It is important to note that disease pressures are not always as high in East Anglia as in other parts of the UK. Additionally, reducing fungicide input increased the potential for improved net margin but also the risk of crop loss to foliar disease. Brian Barker and work package leader Will Smith (NIAB) commented that setting up a small low-input area in a field, as part of the rotation, provides a low-risk way to assess how such approaches fair each season, providing a better understanding of risk, which can be managed accordingly.

Will Smith said: “Varieties with robust disease ratings allow the moderation of fungicides. A rule of thumb of spending no more than 50% of the yield response from the Recommended Lists (RL) trials can be applied. This does not guarantee a return on this investment, but it should help to maximise margins in the years when input was required and help to curtail unnecessary spend.”

Yield was the biggest driver of profitability
Even small increases in crop yield (about 0.5 t/ha) represented large uplifts in income. However, with the ‘medium’ and ‘high’ treatments, the economic cost of securing increased yield with investment in fungicide often outweighed the return and the net result was frequently negative. Consecutive, low-disease pressure seasons at the farm contributed to this result.

Overall, this trial confirmed what many farmers observe in practice – decisions on fungicide spend needs to weigh up agronomic and economic factors. This trial showed that the use of varieties with robust disease ratings, appropriate drilling date and creating strong crop establishment can allow the moderation of fungicide input. In turn, this can help maximise net margin in seasons where higher fungicide input spend is required to protect yield and minimise unnecessary spend in seasons when disease pressure is low.

3. Cover crops and water quality trials

3.1. What was done?

Although cover crops can reduce soil nitrate losses to water, it is difficult to predict when nitrogen taken up may become available to subsequent crops and how cover crops interact with cultivation approaches.

This trial investigated how cover crops reduce nitrate leaching and the interaction with cultivation and rotation. It used a split-field design over two fields to compare several treatments, including over-winter cover crop mix (rye, buckwheat, phacelia, oil radish and sunflower) to over-winter plough and over-winter stubble (ahead of a spring crop).

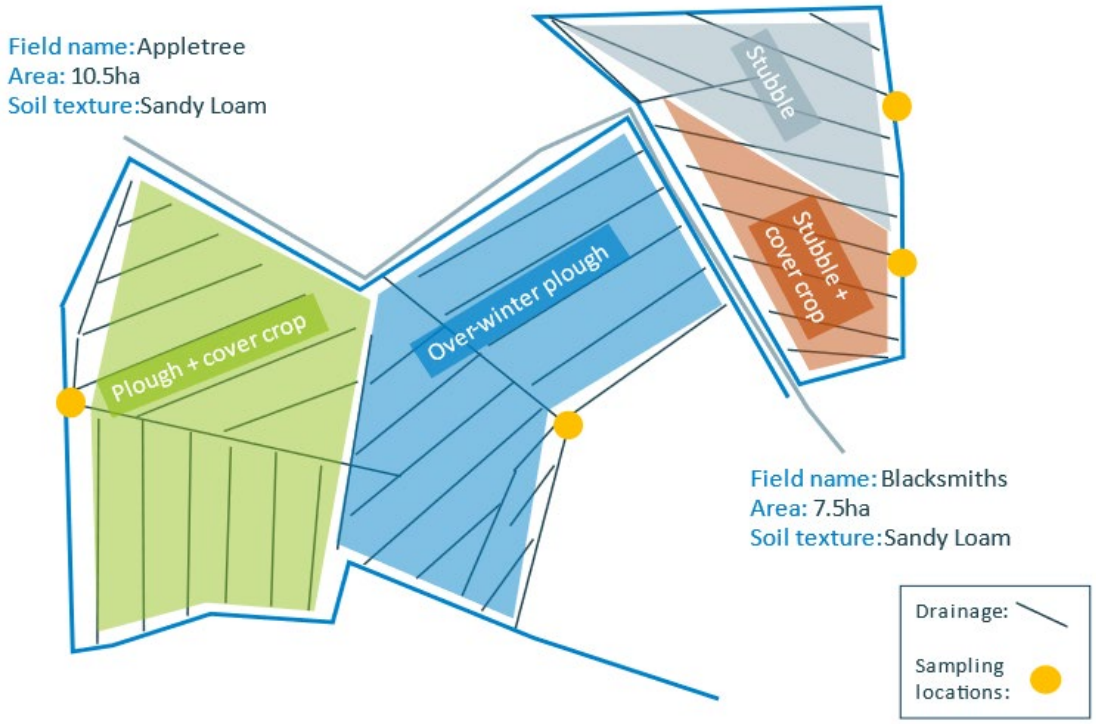

Figure 2. Trial design in two fields (Appletree and Blacksmiths) with drainage layouts, treatment splits and drainage water sampling locations

The trials, over six years, produced comprehensive results, covering soil, crop and drainage water assessments, which showed how nitrogen flowed through the various systems. An additional set of results from a wider set of fields drains across the farm (between 2017–2022) was also collected. These results were analysed for nutrient and pesticide concentrations by Essex and Suffolk Water.

3.2. What did we learn?

Cover crops and cultivation choice affect the amount of nitrate leached to drainage water.

Based on field drain water samples and drain flow rate estimations, average losses (across the experiment) were between 0.1 and 0.8 kg of nitrogen per day. Based on the extremes in these trials, the equivalent cash losses ranged from £0.20 to £3.70 per day (based on ammonium nitrate at £2.00 nitrogen per kg). Although rough estimates, it illustrates the potential costs to the farm associated with nitrate losses.

The trials also found a strong relationship between cultivation intensity and nitrate loss – lower-disturbance, one-pass cultivations (direct drilling and strip tillage) reduced nitrates in drainage water by 55–66% compared with ploughing (Figure 3).

Temporary leys, oilseed rape, winter cereals and ‘out the bag’ cover crops all reduced nitrate losses by up to 50% compared to bare soil and stubble. However, the level depended on the nitrogen legacy left by the previous crop in the rotation. There is flexibility in the establishment of cover crops to tailor it to rotational requirements.

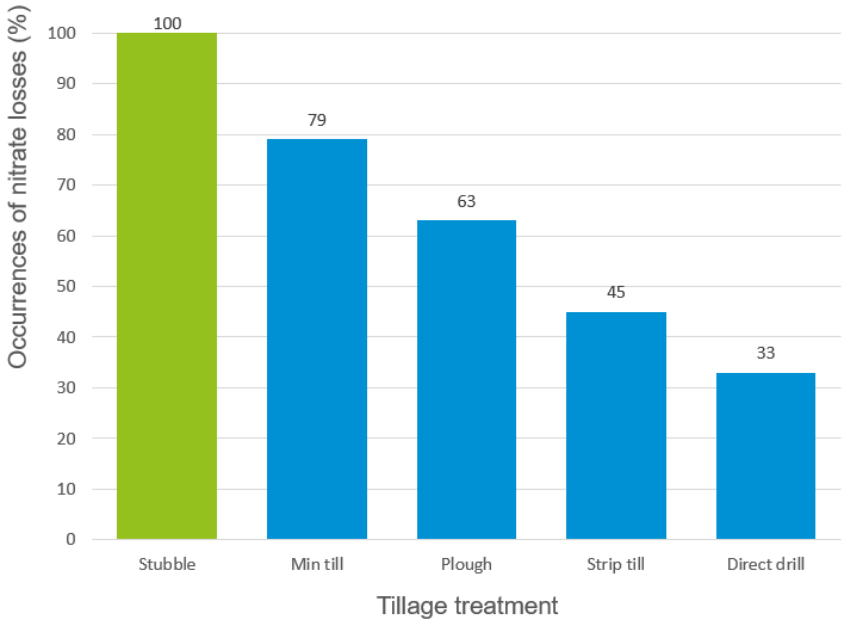

Figure 3. How tillage treatment affected the percentage of occurrence of nitrate losses

4. Flowering strips trials

4.1. What was done?

Integrated pest management (IPM) is an increasingly important management tool in arable agriculture. Flowering strips are important sources of biodiversity, attracting insects that are beneficial for pollination and IPM. The optimum layout and long-term benefits of flowering strips within an arable rotation at farm-scale are not well understood.

This trial compared three treatments (Figure 4) of 'no flowering strips' (field a), 'flowering strips at the edge of a field' (field b), and 'flowering strips at the edge and within a field' (field c). Biodiversity within the flowering strips and movement into the arable crops was measured each season using a combination of trapping, nest monitoring and on-plant counts.

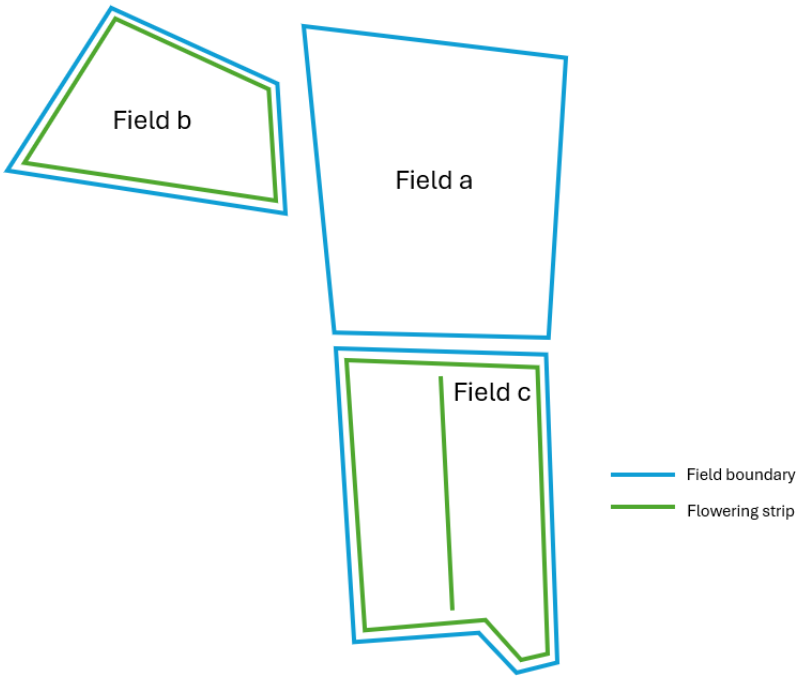

Figure 4. The three fields in the flowering strips trial. Field a (Big Guinea Row) = no strips. Field b (Top 50) = edge strips. Field c (Bottom 59) = edge strips and in-field strip

4.2. What did we learn?

The presence of flowering strips made a significant positive difference to overall insect species richness.

The greatest insect abundance was recorded where margins were adjacent to another persistent semi-natural habitat, such as a hedge (as opposed to where floral strips were isolated in the field). The trial found no clear evidence of an impact of distance into the crop on pest or beneficial insect abundance. However, there is a lot of evidence from larger studies that the number of beneficial insects reduces further into the field.

Farm staff commented that adding a flowering strip within the field made field operations much more difficult. In some cases, extra turns were required, which reduced efficiency and field productivity. This highlighted that planning is a key consideration when siting flowering strips to account for surrounding habitats and practical management.

Predators of slug eggs, including beetles and spiders, benefitted from the grass habitats in flowering strips.

Flowering strips offer a refuge for slug predators from in-field crop management. Slugs were present in all fields, with a slight trend (across years) for higher numbers in the field centres.

Best management of flowering strips is determined by the weather.

Prolonged periods of high temperatures and a lack of rain during the June-to-August period in 2023 appeared to stop some species flowering. Recommended practice is often to cut hard and remove or bale the flowering strip in the first years after establishment. In this trial, however, areas uncut in autumn 2022 delivered more flowers in summer 2023.

Work package leader Aoife O'Driscoll (NIAB) said: "Reliably estimating insect numbers requires good identification skills. It is also time consuming. Don't spend a lot of time trying to identify and count species. There is a huge benefit in just becoming familiar with the various insects in and around your crops."

5. Marginal land trials

5.1. What was done?

The economic and regulatory landscape shifted through the tenure of Strategic Cereal Farm East (Figure 1). It became clear that determining which fields perform strongly or marginally (in terms of arable crop performance) was important to the farm business. Once identified, areas performing marginally could be improved to boost crop production or put into stewardship schemes or new enterprises.

With data in various formats and linked to various crops across multiple years, it can be a challenge to collate. This trial collated and analysed the farm's data to understand variation in crop performance to inform management decisions. Three main research questions were:

1. What are the causes of in-field variation in crop performance?
2. Can the economic performance of marginally performing yield areas be improved?
3. Can zoning economic performance help assess and manage environmental risks?

Across the farm's 35 fields, 154 management zones were identified. Some of the lowest-performing zones (38 ha) were entered into stewardship schemes in 2022. Despite the removal of this land from arable production, 150 ha still had an average annual net margin loss of over £100/ha compared to the best-performing management zone in the same field.

In 2022, 12 sampling sites were chosen across 3 fields (6 sites in winter wheat, 6 sites in winter barley). In 2023, 12 sampling sites were chosen across 4 fields, which were all in winter wheat to make analysis simpler (Figure 5).

Table 2. Field assessments and sample collection timings

Assessment	Timing
Soil mineral nitrogen	February
Basic soil variables (pH, organic matter and texture)	February
Potentially mineralisable nitrogen	February
Soil health metrics (VESS, earthworm count, soil bulk density)	March
Tissue nutrient test	April
Tiller count, green area index, SPAD analysis, disease score	April
Head count, green area index, SPAD analysis, disease score	June
Grain nutrient analysis	August
Soil mineral nitrogen	August
Yield (yield mapping)	September

5.2. What did we learn?

Long-term patterns in yield mapping and crop economic performance identified areas that were consistently underperforming in arable production. Areas suitable for stewardship schemes were removed from arable production and those field areas with 'marginal' economic arable performance were studied.

The use spatial datasets, such as yield maps, satellite imagery and proximal soil scans, can help target soil assessments to improve understanding of management zones, such as high-performing and low-performing field areas.

Yield map analysis helped to guide nitrogen management. In general, cutting nitrogen rates did not compromise overall yield or grain quality. The exception was in high-yielding management zones, where grain nitrogen concentrations were below optimal.

Grain analysis showed nitrogen and phosphorus were oversupplied in headlands, where arable performance is generally lower than average. Reducing nitrogen application rates had a positive impact on headlands, reducing nitrate pollution risk. Repeating grain and soil measurements over years will allow nutrient management to be refined.

Figure 5. Yield maps and sample sites for winter wheat for harvest 2023 (yellow = lower yield and blue = higher yield)

6. Resources

- The main findings are summarised in this report, with trial details in the annual reports available via: ahdb.org.uk/farm-excellence/strategic-cereal-farm-east-2017-2023
- Watch Patrick Barker summarise the lessons learned at Strategic Cereal Farm East: https://youtu.be/JnFJkcMfYNs

Managed lower inputs trials

- Watch Brian Barker explain how he used 'look-see' trials to reduce fungicide inputs: https://youtu.be/lNXvL0rQyt8
- AHDB fungicide performance research provides information on the effectiveness of key products: ahdb.org.uk/fungicide-performance
- The AHDB Recommended Lists (RL) can help you select varieties of cereals and oilseeds: ahdb.org.uk/rl

Cover crops and water quality trials

- AHDB guidance on cover crops is available at: ahdb.org.uk/cover-crops
- New Farming Systems (NFS) long-term cover crop study (Norfolk) tests four cultivation techniques and two rotations: niab.com/research/agronomy-and-farming-systems/research-projects-agronomy-farming-systems/new-farming-systems
- Wensum Demonstration Test Catchment (DTC) project focuses on the intensive arable production (Norfolk), using cover crops and non-inversion tillage to mitigate diffuse pollution: defradigital.blog.gov.uk/2016/09/21/demonstration-test-catchments-open-data/
- South East Water: corporate.southeastwater.co.uk/about/our-environment/cover-crops/
- Anglian Water: anglianwater.co.uk/siteassets/household/help-and-advice/nitrogen-retention-in-cover-crop-trial-.pdf
- South Downs Farming Cluster group: southdownsfarming.com/networks/arun-to-adur-farmers-group/

Flowering strips trials

- Watch Patrick Barker describe the flowering strip trials: https://www.youtube.com/watch?v=s85qD2p-Ov4
- How to use traps to monitor insect populations in the field: ahdb.org.uk/knowledge-library/how-to-use-traps-to-monitor-insect-populations-in-the-field
- Encyclopaedia of pests and natural enemies: ahdb.org.uk/pests

Marginal land trials

- How to identify marginal land foundation video youtube.com/watch?v=WvVrM8UPT2E and advanced video youtube.com/watch?v=GZ562VNn3e0