December 2022

Annual Project Report

On-farm trials at
Strategic Cereal Farm East
(harvest 2022)

AHDB Cereals & Oilseeds is a part of the Agriculture and Horticulture Development Board (AHDB).

CONTENTS

1. Managed lower fungicide inputs

Objective

To test whether a managed approach to lowering inputs can be used at different application timings without compromising yield, but improving the cost of production.

Why test a managed lower fungicide input programme?

Disease management in cereals is a challenge. Loss of chemistry and fungicide resistance means that we need new ways to manage cereal diseases.

Our projects help support farmers and agronomists to manage cereal diseases. AHDB's **fungicide performance research** provides information on the effectiveness of new products.
The **Recommended List** can help with selecting the best varieties for your farm.

This trial is testing the cost-benefit of high and low-cost input programmes.

How is the managed lower input fungicide trial run?

The trial design includes untreated plots and seven timing treatments (T1, T2, and T3 combinations). There are two replications of each treatment and four untreated plots. Each plot is 100m x 30m. The field team from NIAB complete assessments in four locations within each plot, measuring 3m x 2m.

Season overview

- Very low presence of disease was observed in this season, therefore limited benefit to using a higher input programme
- Small yield improvements were associated with fungicide use (all combinations of timing and input level)
- As the yield response was small, only half of the treatments were expected to result in a positive margin over the untreated, if crop was sold at £150/t
- High crop prices may promote the use of fungicides, however when disease is low there is significant opportunity to moderate input levels, therefore further maximising outputs.

Disease infection

It was an exceptionally dry spring, in which no single day had more than 10mm of rain and a total of 59.4mm for March, April and May. Disease levels were extremely low across all plots with infections of septoria tritici and yellow rust never reaching more than 5% in the untreated plots on any leaf layer at any assessment timing.

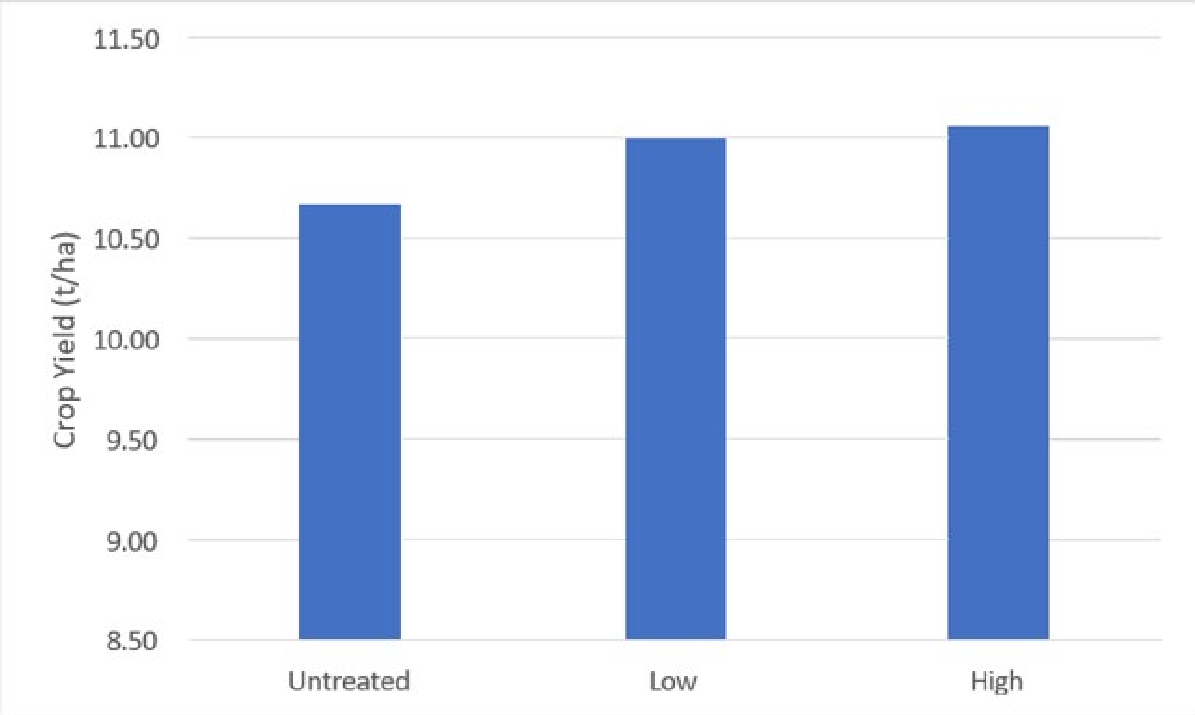
Crop performance

The key indicator of crop performance was final crop yields. The trial had an average yield of 10.98 t/ha, which is above the long-term performance of the field as a first wheat and is representative of the farm's performance in this season.

Timing	Low Input	High Input
Untreated	10.67 d	
T1	10.89 abcd	11.10 ab
T2	10.93 abcd	10.83 bcd
T3	11.07 ab	11.01 abc
T1 + T2	11.09 ab	11.06 ab
T1 + T3	11.12 ab	11.23 a
T2 + T3	10.67 cd	11.14 ab
T1, T2 + T3	11.15 ab	11.03 ab

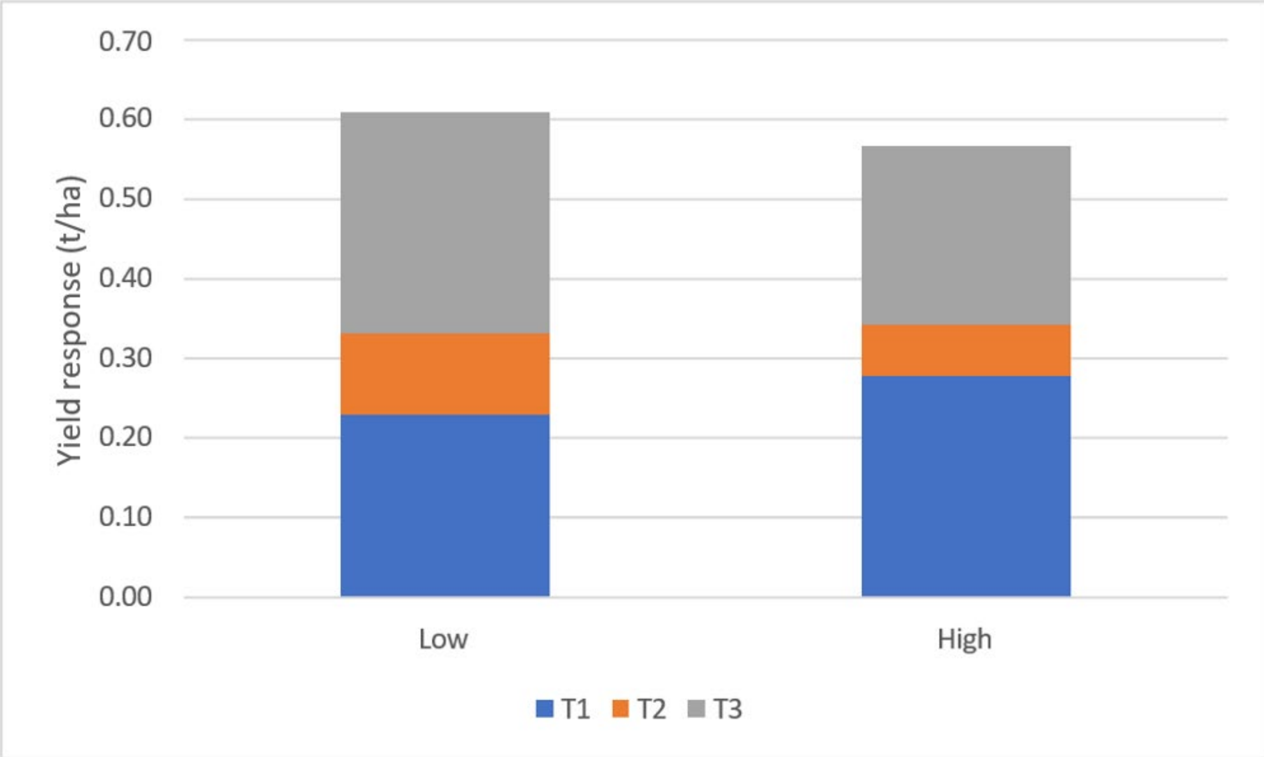
Input level

The use of fungicide was associated with a significant increase in crop yield, however there was significant difference between the two fungicide input levels tested. On average, the low input level increased mean yield by 0.32 t/ha, and the high input by 0.39 t/ha. These are lower than in 2021 (0.48 t/ha for Low, 0.75 t/ha for High).

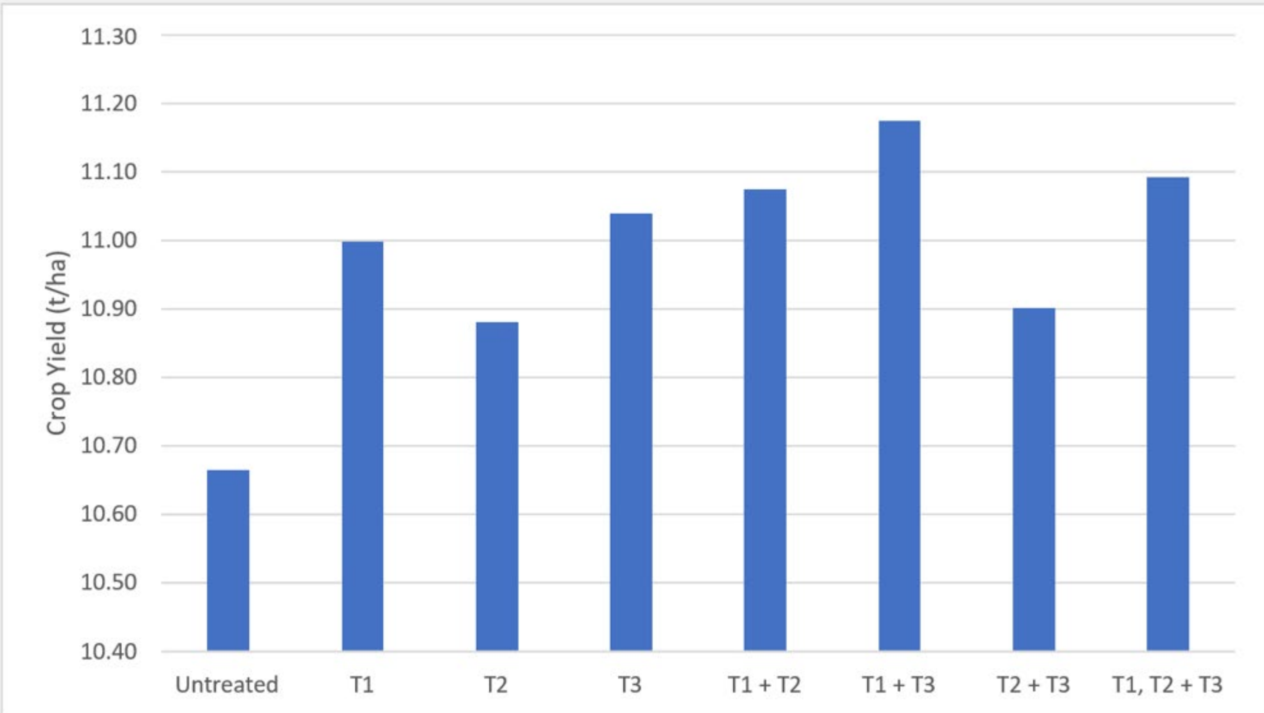


Fungicide response

The design of this trial enables the calculation of yield response from each of the timings. This season had extremely low disease levels, and the yield responses are incredibly modest when compared to the long-term average. In this season, there was a small yield increase associated with the use of fungicides, however the level of this input was insignificant. Similar to the 2021 season, the T1 and T3 applications, when isolated, were responsible for the greatest yield responses, however there was no significant difference across the input levels.



Yield response from each application timing across fungicide inputs (2022)



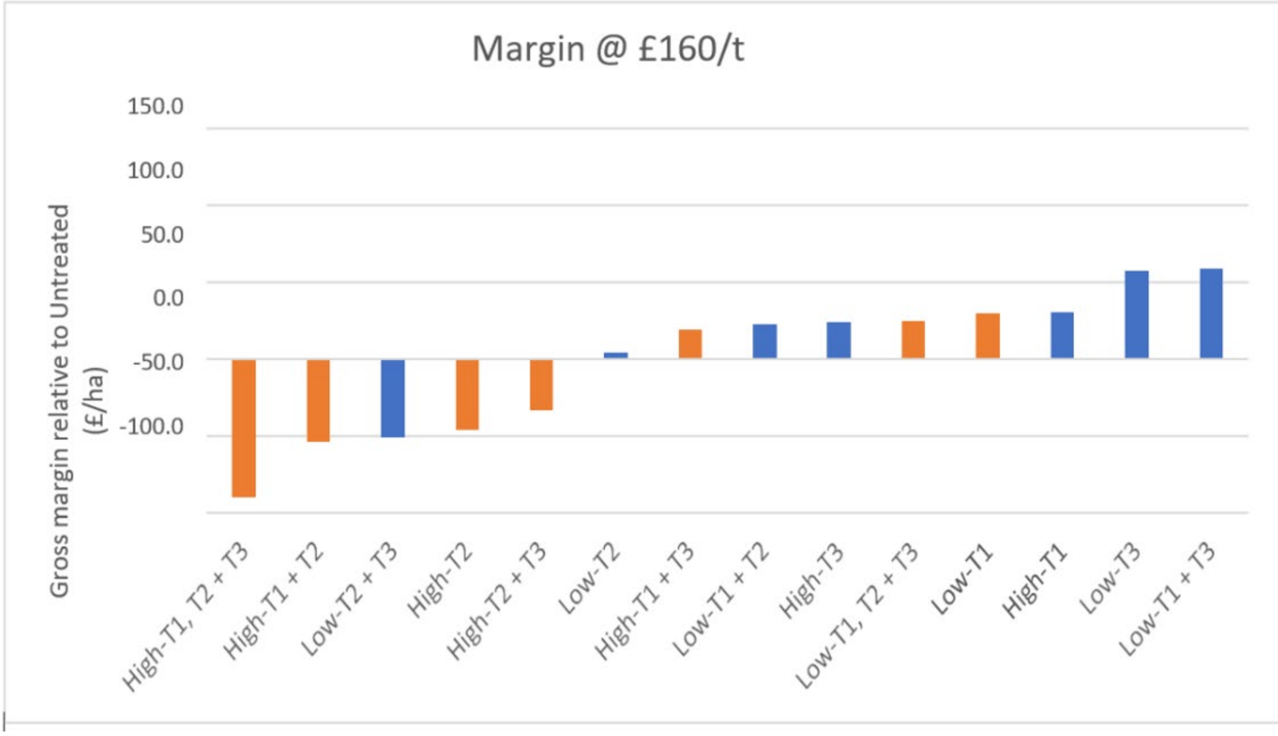
Crop yields when pooled across input levels (2022)

Gross margin analysis

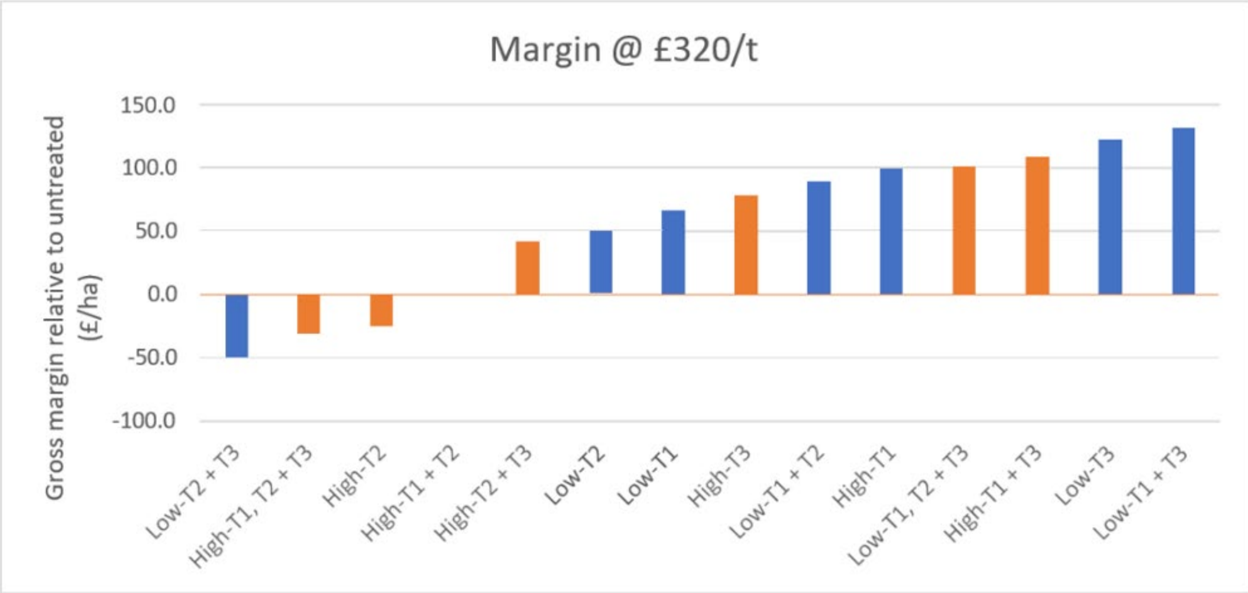
The last year has demonstrated the susceptibility of our farming systems to outside influence, both for input price and output price. Observed at two wheat prices (£160/t and £320/t), there is no clear trend across the treatments, due to the lack of significance between yield.

Plots treated with a low programme of T1, T3, or a combination returned a greater margin than untreated (between £30.30-£58.60), however, on average across all fungicide treatments, there was limited benefit.

When the differences are small, the consideration of application cost has more relevance and, in this example, assuming an application cost of £15/ha per application, then most treatments perform poorer than the untreated. Using the example of the full programme, with a low input level, the gross margin over untreated would drop from £24.90 to -£20.10.

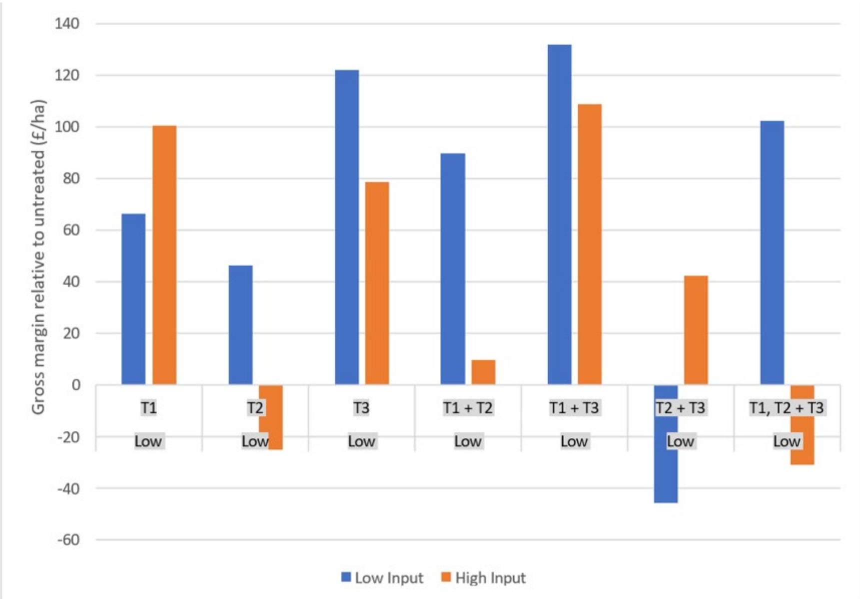


Gross margin of each treatment relative to the untreated, ranked lowest to highest, when crop price is set to £160/t



Gross margin of each treatment relative to the untreated, ranked lowest to highest, when crop price is set to £320/t

When doubling the grain sale price to £320/t (a point at which markets did exceed in summer 2022) margin increases for all treatments. The graph below shows the side-by-side comparisons of the two input levels with high crop prices, and demonstrates that the low inputs are associated with higher margins.



The side-by-side comparison of each application timing combination across input level when crop price is high (£320/t)

2. Reducing nitrate leaching with cover crops

Using cover crops to mitigate against nitrate losses in water can be successful. However, nitrogen release in the following crops during the rotation is trickier to predict and can be affected by the climatic conditions. The carbon to nitrogen (C:N) ratio of the residues is one of the main factors influencing the dynamics of mineralisation of the nitrogen accumulated by the cover crops. In-season crop management, including nitrogen management according to crop growth, nutritional requirements and crop yield potential should be monitored with applications adjusted where required to minimise losses to water.

Assessments

Soil nutrients:

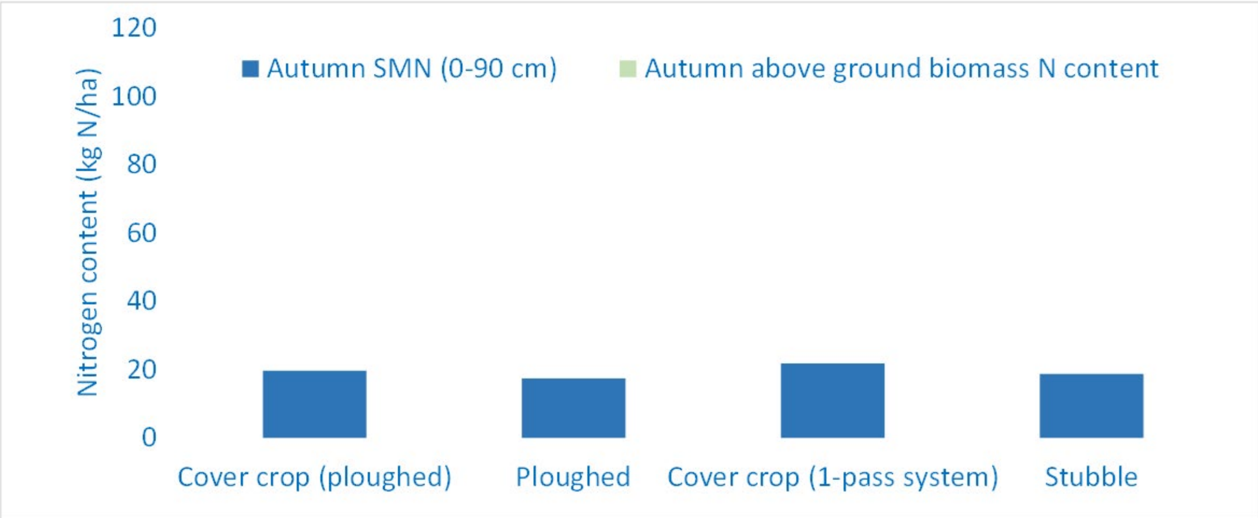
Soil nutrients (0-15 cm) were measured in April 2022 (shown in the table). Little difference was apparent in any of the nutrients with values.

Treatment	pH	*pH SEM*	P mg/l	*P SEM*	K mg/l	*K SEM*	Mg mg/l	*Mg SEM*	O.M. %LOI	*O.M. SEM*
Cover crop (ploughed)	7.2	0.05	14.7	2.37	140	2.49	49	1.98	3.8	0.06
Ploughed	7.0	0.21	17.0	2.75	126	14.66	58	4.87	3.9	0.22
Cover crop (one-pass system)	7.2	0.10	15.3	1.10	158	12.11	58	1.62	4.8	0.01
Stubble	6.6	0.27	23.9	5.87	165	11.01	67	8.09	5.3	0.49

Soil Mineral Nitrogen (SMN) – autumn assessments

Assessments after the regrowth of herbage grass (cut July 2021) indicated that forage grass had not captured detectable nitrogen in plant biomass (<0.2kg/ha), likely due to slow regrowth occurring during the early autumn period.

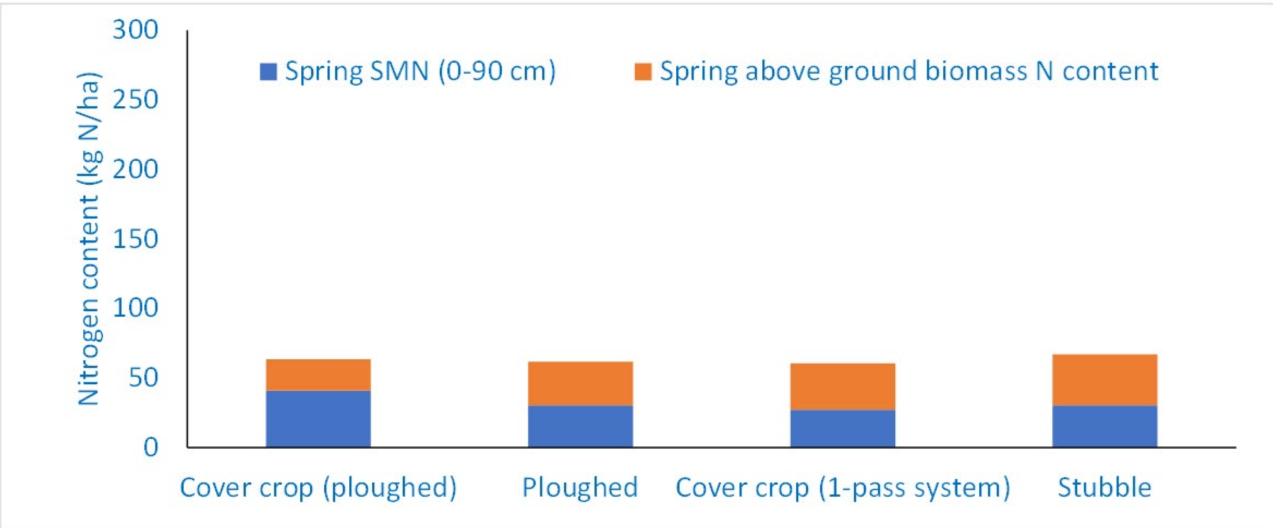
There was no clear difference in SMN between treatments, with all treatments showing a low level of residual SMN following cutting of the grass.



Soil Mineral Nitrogen (SMN) – spring assessments

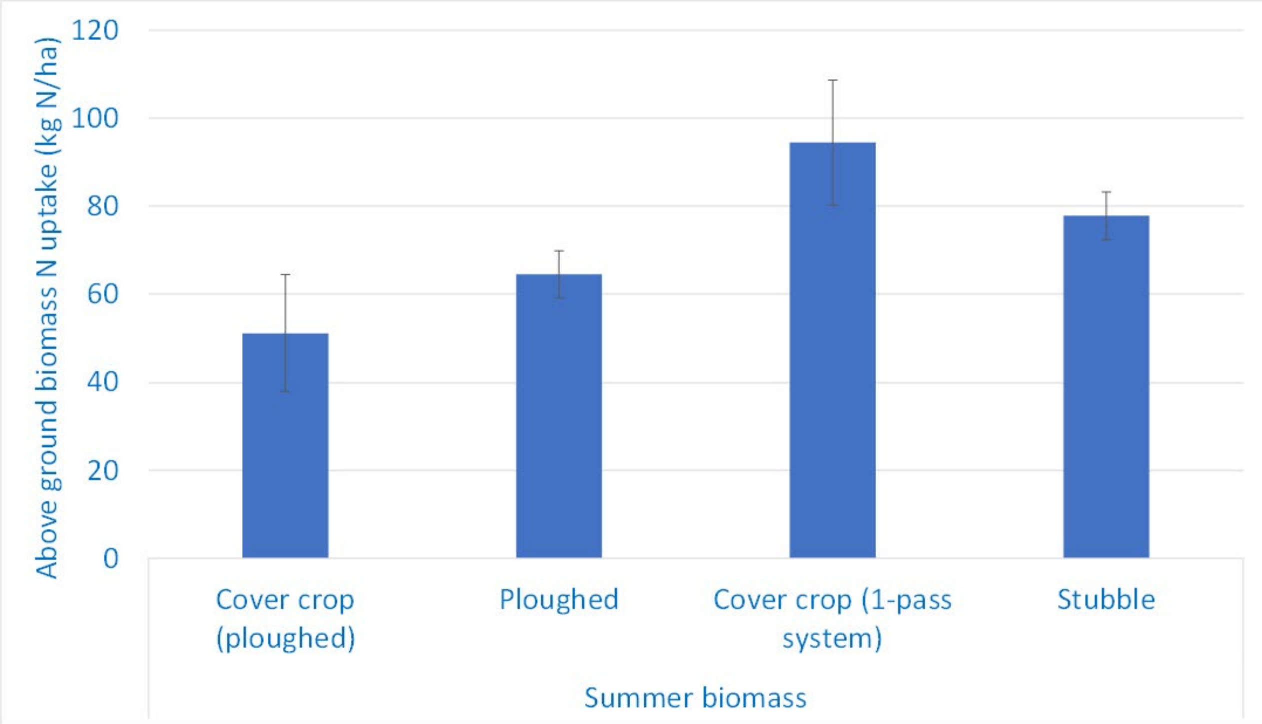
April assessments indicated that forage grass had captured between 23–37 kg N/ha in addition to the SMN which resulted in 27–41 kg N/ha.

There was little difference between any treatment, in terms of nitrogen content, with a total of between 61–67 kg N/ha.



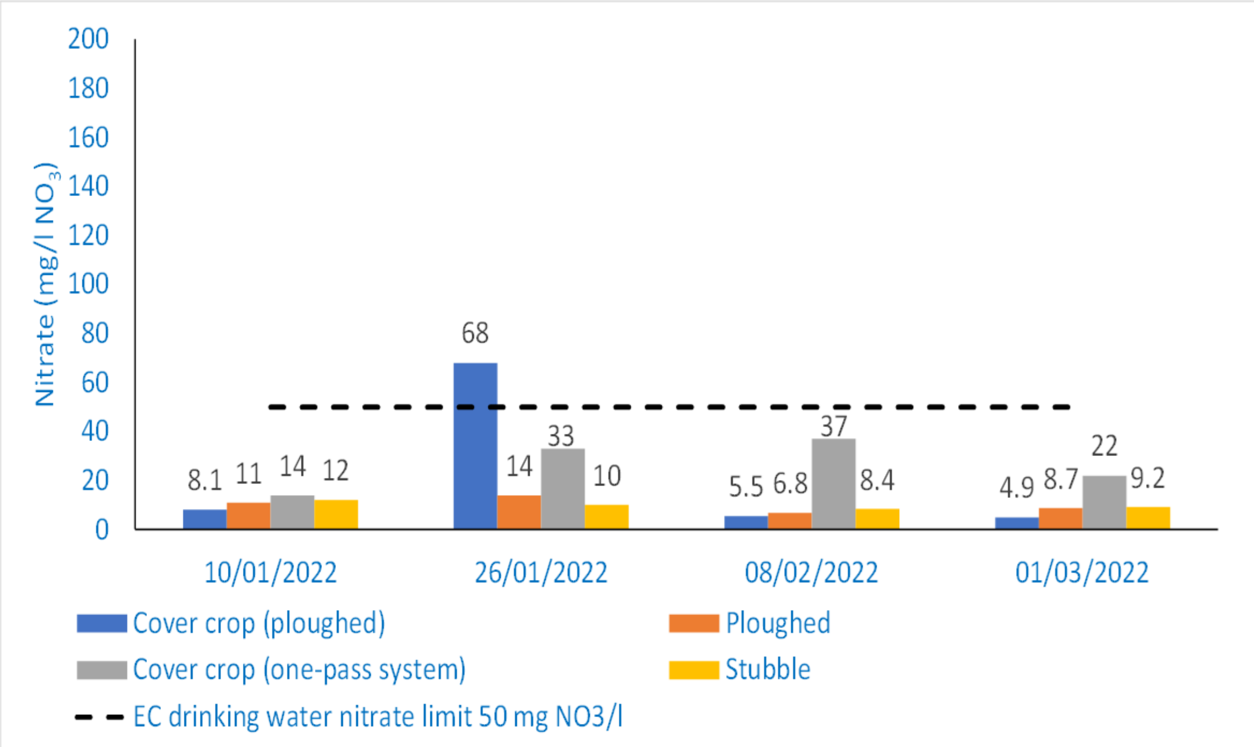
Summer assessments:

July assessments showed above-ground biomass nitrogen uptake was 51-94 kg N/ha. Highest nitrogen supply was in the 1-pass system treatment, with clear differences between fields. Slightly heavier soil type of the 1-pass system and stubble treatments showed higher biomass, possibly due to higher soil moisture during a the very dry season compared to the cover crop (ploughed) and ploughed treatments.



Drainage water:

The low levels of residual SMN and the lack of rainfall during the season, resulted in lower nitrate (NO_3) concentrations in drainage water. At one sample timing (26 January), nitrate concentrations exceed the EU drinking water nitrate limit, which may be due to continued mineralisation during the mild winter.



Soil nitrate concentrations:

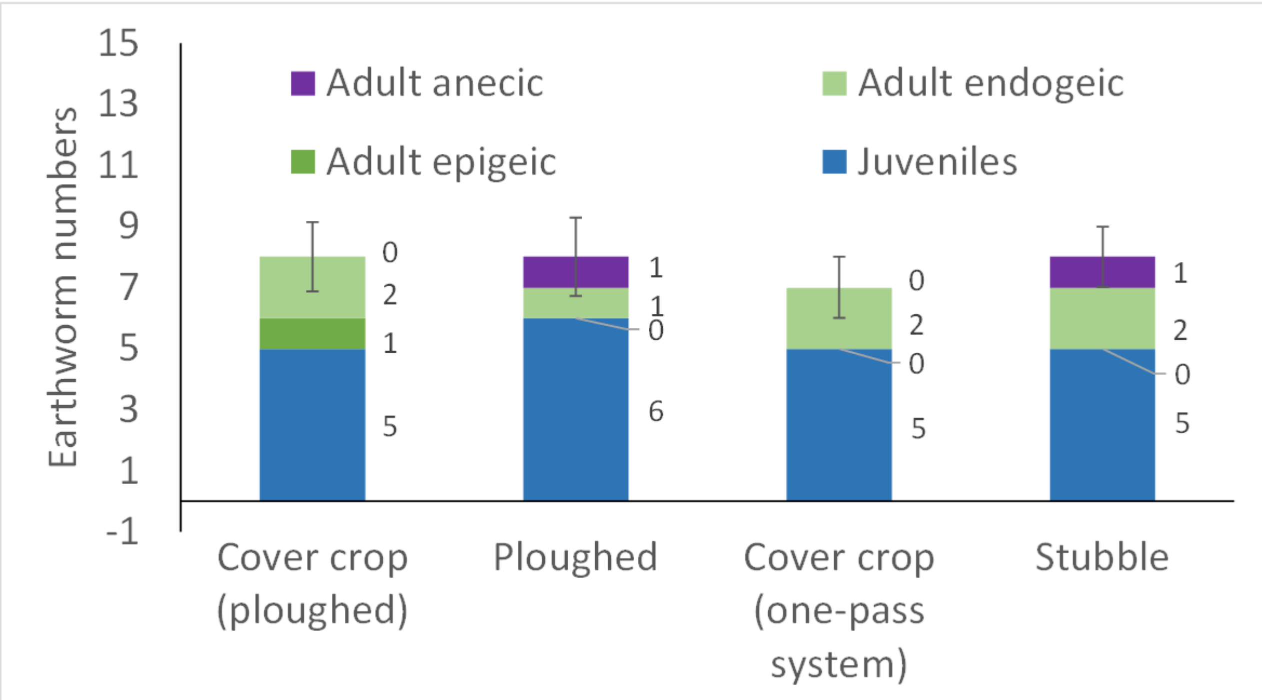
- Highest in the cover crop, peaking at around 10 January at 10 and 15 mg/kg at 10 and 25 cm depths, respectively
- Little increase after nitrogen fertiliser was applied and remained below 20mg/kg at all monitoring times

Legacy effect of cover crops:

- No effect on topsoil bulk density, visual soil structure (VESS score) or earthworm numbers
- Significant difference observed in penetrometer resistance in the cover crop one-pass system at the spring assessment, with a higher soil strength at 30cm depth compared to other treatments

Treatment	Bulk density (g/cm^3) [a]	Earthworm count (No./pit) [b]	VESS Score	Maximum penetration resistance at 30cm (MPa)
Cover crop (ploughed)	1.48 (a)	8 (a)	2.5 (a)	1.25 (a)
Ploughed	1.46 (a)	8 (a)	2.5 (a)	1.41 (a,b)
Cover crop (1-pass system)	1.46 (a)	6 (a)	3.1 (a)	1.61 (b)
Stubble	1.51 (a)	6 (a)	3.1 (a)	1.37 (a,b)
P [c]	NS	NS	NS	<.001
SED	0.086	1.393	0.256	0.113

A good number of earthworms were seen in all treatments, with >8/pit being the threshold for arable soils



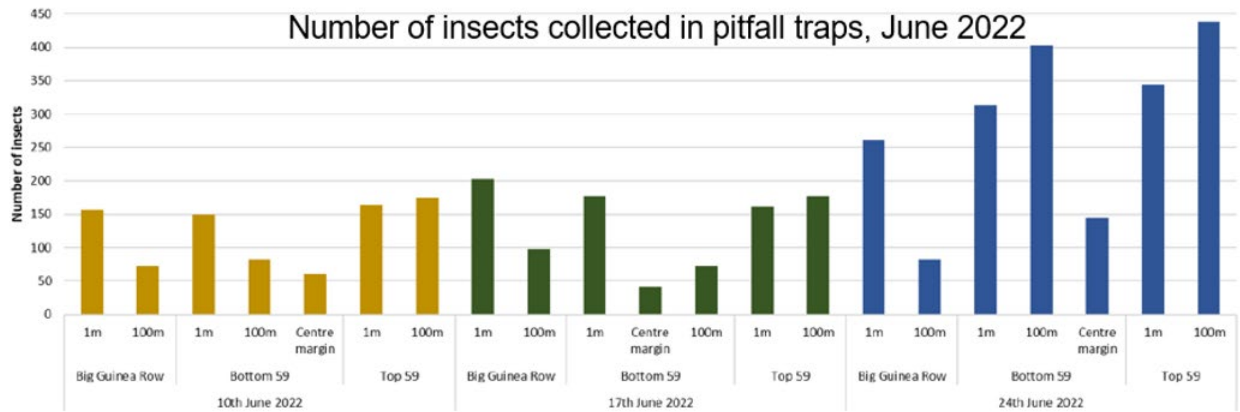
3. Flower strips in arable fields for pests and beneficials

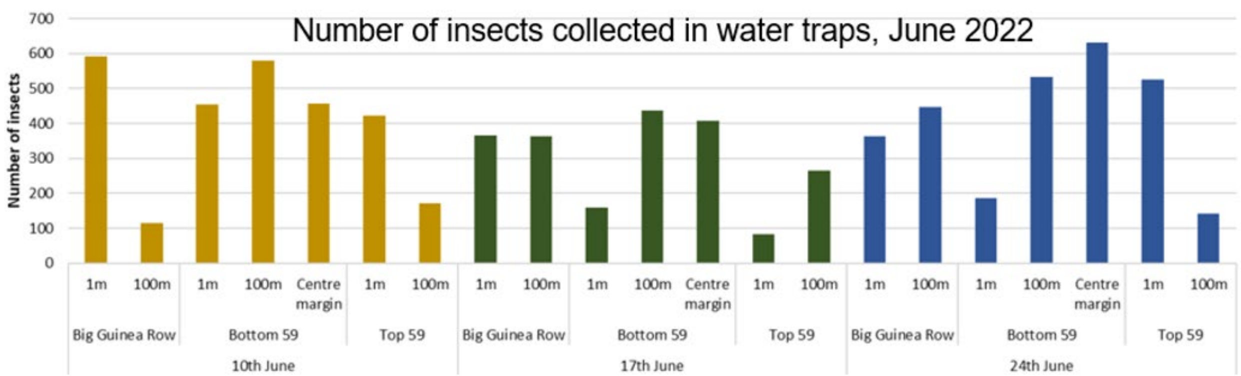
Season overview

- Slugs were found in all the fields, both close to the field margin and in the field centre; there was a slight trend for higher numbers in the field centre. The highest abundance was found at Big Guinea Row
- No two fields were alike in their composition of invertebrate pests and beneficials
- No two floral strips were alike in their plant species composition, although strips within each field were more similar than across fields reflecting the soil conditions, species selected, and date of drilling
- There was no clear evidence in this study of an impact of distance into the crop on pest or beneficial invertebrate abundance; though there is a lot of evidence from larger studies that the number of beneficials reduces further into the field

Spatial distribution of pests and natural enemies

The total number of insects recorded at three successive trapping periods in June 2022 shows variation between fields.





Slugs were present in all fields both close to the field margin and in the field centre. There was a slight trend for higher numbers in the field centre with the greatest number of slugs recorded at Big Guinea Row. This was a similar result to the two previous years of slug trapping.

The number of aphids and parasitised aphids (known as aphid mummies) was very low in 2022 with numbers recorded well below treatment thresholds in all fields monitored.

There was also a low number of aphid predators such as lacewing and hoverfly larvae across the farm), though numbers were higher than that recorded in summer 2021.

No mason or miner bees were observed in nests, however miner bees were found in water traps in June 2022.

The six nests placed across the farm all contained high numbers of leaf cutter bees and there were no observable differences between fields.

Weeds

A high number of perennial flower species were present across the margin edges in both fields:

- Bottom 59: 21 species
- Big Guinea Row: 18 species

12 different grass species were also recorded across the farm.

The most frequently occurring species were common knapweed, wild carrot, oxeye daisy, ribwort plantain, common sorrel and musk mallow.

Other non-sown species including ploughman's spikenard, birds foot trefoil, cut leaved cranesbill and smooth hawksbeard were found infrequently throughout the margins.

For both fields where floral margins were present there was a low level of encroachment of several grass species 5m into the main crop.

Cost of establishing flowering strips

Item cost	(£/ha)
Preparation of strips operation (4m discs/tines + power harrow + roll)	100
Seed	589.91
Broadcast operation	15
Rolling operation	10
Total cost of establishment	**714.19**

- Average loss of income (£) across the rotation is estimated at £241
- Average loss of income for wheat only is estimated at £370/ha based on wheat prices in November 2022 of £265/tonne
- Calculations were based on field averages from Harvest 2009–2022, using a flower strip area of 445m x 6m which was taken out of the centre of Bottom 59

Crop	Yield (t/ha)	Margin (£/ha)
Herbage Grass	1.1	511
Herbage Grass	1.3	1269
Herbage Grass	1.0	564
Herbage Grass	1.1	895
Hybrid Barley	9.7	652
Naked Oats	4.0	-111
OSR	5.3	306
Winter Wheat	10.4	597
Winter Wheat	12.9	780
Winter Wheat	8.6	51
Winter Wheat	10.5	691
Winter Wheat	9.8	1,674
Average	N/A	657
Area wildflowers (ha)	0.267	
Average loss income across the rotation (£)	**241**	
Average loss income-wheat only (£)	**370**	

4. Marginal land

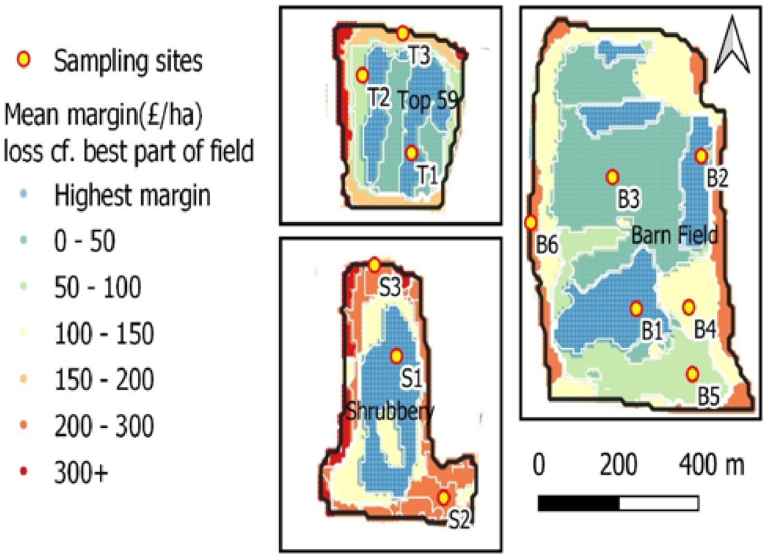
Objective: To locate areas of low productivity across the farm, identify the cause of variation, and assess whether alterations in management practice can improve economic performance in these areas.

Background – calculating marginal land

In 2021, ten years of yield maps were used to identify land most suitable for Environmental land management schemes. This approach used a statistical technique, called clustering, on ten years of yield maps and field level economic data from Strategic Cereal Farm East. Across the 35 fields, 154 clusters were identified, from this 38 ha of some of the lowest-performing areas will be entered into environmental schemes in 2023. However, of the area still in arable production, 300 ha was still identified as having an average annual mean net margin loss of over £100 ha, compared to the best performing part (zone/cluster) of the field. This raises several questions.

1. What are the causes of this variation in zone performance within fields?
2. Can management practices be altered to improve economic performance of lower performing zones?
3. Does the environmental risk change amongst zones?
4. Can management help deliver reduced environmental risk?

Across 3 fields and 8 management zones/clusters, some detailed soil and crop monitoring was carried out to help answer some of these questions.



Assessments

Soil and crop monitoring was carried out on the 6 winter barley sites in Barn field and 6 Winter Wheat sites across Shrubbery and Top 59.

Assessment	Timing
Spring Soil N	Feb-22
Soil nutrients, pH, OM and texture	Feb-22
PMN (Potentially Mineralisable N)	Feb-22
VESS, Earthworms, Bulk density	Mar-22
Tissue Nutrient Test	Apr-22
Tiller counts , GAI, Spad, Disease	Apr-22
Head counts, GAI, Spad, Disease	Jun-22
Grain Nutrients	Aug-22
Soil N Post Harvest	Aug-22
Yield (Yield maps)	Sep-22

What results has the project delivered?

Soil Nutrients

		Chemical				Biological			Physical
Field	**Site**	**pH (mg/l)**	**P (mg/l)**	**K (mg/l)**	**Mg (mg/l)**	**SOM (%)**	**Earthworms**	**PMN**	**VESS**
Barn	1	6.9	23.2	162	63	3.3	13	41	3
Barn	2	6.8	15.4	270	79	4.9	9	39	2
Barn	3	7.8	14	316	58	4.8	8	95	2
Barn	4	7.2	17.6	309	59	4.4	8	54	2
Barn	5	7.6	15	226	46	4.8	5	100	2
Barn	6	7.8	19.2	351	95	5.1	8	119	4
Shrub	1	8.1	15.2	224	61	4.3	6	68	2
Shrub	2	7.4	15.4	196	65	4.3	16	62	2
Shrub	3	8	18.6	288	63	5.1	15	123	4
Top 59	1	7.9	15.2	213	52	4.3	9	63	2
Top 59	2	7.7	16.6	192	56	4.4	10	47	2
Top 59	3	7.3	19.8	223	52	4.3	8	69	4

Thresholds set out in the AHDB Soil Biology and Soil Health Partnership (medium soil, low rainfall area). Soil nutrients sampled 0-23cm, Earthworms per 20x20cm spade, SOM by Loss on ignition, VESS scores of most limiting layer

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Key take-aways:

- pH varied across sites, although it showed little relation to yield historic yield performance
- Although P and K is higher on low-yielding sites, there is not significant indices build up, although some high yielding sites appear to have slightly low soil P levels
- VESS Scores identify plant limiting conditions on headlands – unlikely to be limiting factor on other lower-yielding sites

Grain P and K

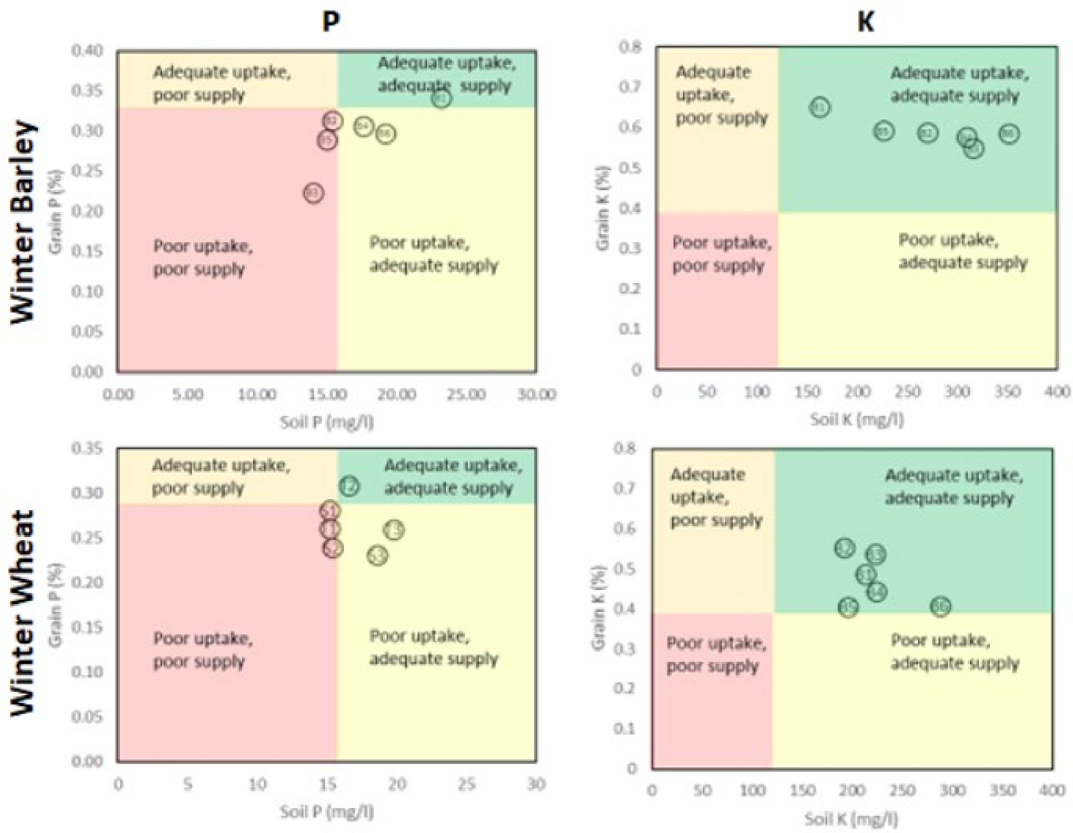

Figure 1 Grain P and Grain K compared to soil P and Soil K for 12 sites

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Key take-aways:

- All sites with Index 1 P showed lower than benchmark levels of grain P and might benefit from furth P additions
- 4 sites had adequate P in the soil however showed grain p levels below benchmark, 3 of these 4 sites are headland sites where VESS scores identify likely root limiting conditions
- 2 sites had optimal supply and uptake

Nitrogen management and yield

Yields were good across all fields, despite low spring and summer rainfall, and generally followed the clustering seen in the historic yield map analysis. Spring soil N - low levels of N prior to N application across the farm, with little variation across sites. Low-yielding sites (headlands) had the highest grain N levels. Based on RB209 recommendations, N rates could potentially be reduced on Top 59 if the pattern is consistently seen. The results broadly agree with the RB209 principle that lower yielding sites might benefit from reduced N rates and higher N rates on good yielding areas.

Field	Site	Crop	Applied N (kg N/ha)	Spring Soil N 0-90cm (kgN/ha)	PMN	Tissue N (GS 31)	Grain N (%)	Post Harvest Soil N 0-90cm (kg/ha)	Yield (t/ha)	Grain N oftake (kg N/ha)	Grain N RB209 recommendation
Barn	1	W Barley	180	37	41	5.05	1.7	76	9.8	166	NA
Barn	2	W Barley	180	26	39	4.93	1.7	117	10.2	175	NA
Barn	3	W Barley	180	22	95	4.86	1.8	119	9.6	171	NA
Barn	4	W Barley	180	23	54	4.85	1.7	87	9.6	165	NA
Barn	5	W Barley	180	35	100	5.12	1.8	129	9.8	175	NA
Barn	6 (H)	W Barley	180	35	119	4.86	1.9	133	8.8	168	NA
Shrub	1	W Wheat	212	44	68	4.91	1.8	106	12.4	225	30
Shrub	2	W Wheat	212	36	62	4.82	1.8	112	11.4	199	30
Shrub	3 (H)	W Wheat	212	23	123	5.35	1.9	195	12.1	234	0
Top	1	W Wheat	212	14	63	4.66	1.8	118	10.3	182	30
Top	2	W Wheat	212	8	47	4.28	1.8	128	10.0	184	30
Top	3 (H)	W Wheat	212	15	69	4.23	2.2	99	10.1	221	-60