# CPES Cover Crop Trials 2019-2022

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Catchment Sensitive Farming
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# Introduction:

**Overview:**

The aim of this study was to demonstrate the feasibility of cover crop establishment on shallow chalk soils ahead of a spring cash crop (Spring Barley) as a means of reducing over winter nitrate leaching within Portsmouth Water's Priority Zone. This work was undertaken across two commercial farms in West Sussex between 2019-2022.

**Key Findings:**

- There was clear evidence that cover crops can reduce nitrate leaching significantly compared to over wintered stubbles.
- Weed growth on over wintered stubbles can be useful, but in terms of nitrate leaching, their performance is poor.
- Early Autumnal conditions are key to cover crop establishment.
- Broadcasting cover crop seeds into a standing crop rather than drilling after harvest appears to reduce nitrate leaching through enhanced cover crop growth.
- Where cover crops are used there appears to be an increase in the available nitrogen to the spring crop. Further research is needed to determine what other additional N will become available from the destruction of the cover crops.
- There was no effect on yield of the following cash crop from the cover cops used in this trial.
- The cost of using cover crops resulted in reduced gross margins compared to over wintered stubble. When Portsmouth Water Financial Support was considered, the financial picture considerably improved.

# Cover Crop Assessment:

The trials were carried out on two farms in West Sussex. Chilgrove Farm, Chilgrove and 100 Acre Farm, Compton. The field changed each year following the cropping rotation and compared different cover crop establishment methods at Chilgrove. All cover crops at Compton were drilled after the wheat was harvested. Each cover crop was followed by spring barley and the plough was not used for establishment. Soil type was uniformly classified as shallow above chalk. Two cover crop mixes were picked for the trial (Table 1). Each cover crop was drilled/broadcast in a 100m run along an existing tramline. The exception being the N reduction mix which was broadcast prior to crop destruction in treatment 1 and drilled in treatment 3. The two cover crop mixes where specifically chosen to give a contrast between a diverse, expensive N reduction mix compared to a cheap and cheerful Farm standard mix. This was deemed important to help answer the question whether adding more species into a cover crop mix improves its performance in terms of nutrient retention.

### Table 1: Proposed Cover Crop Mixes and drilling methods:

| | | | |
|---|---|---|---|
| Control<br>Over wintered stubble | Tr 1 **(Mix 1):**<br>Nitrogen Removal Cover Crop broadcast before harvest.<br>Broadcast at 25 kg/ha | Tr 2 **(Mix 2):**<br>Host farms choice of cover crop seed broadcast before harvest. 25kg/ha | Tr 3 **(Mix 1):**<br>Nitrogen Removal Cover Crop Drilled into stubble at 25kg/ha |

| **Nitrogen Removal (Mix 1):** | **Farmers Seed (Mix 2):** |
|---|---|
| **Black Oats 45%**<br>**Forage Rye 30%**<br>**Berseem Clover 15%**<br>**Phacelia 10%** | **Phacelia 50%**<br>**Vetch 50%** |

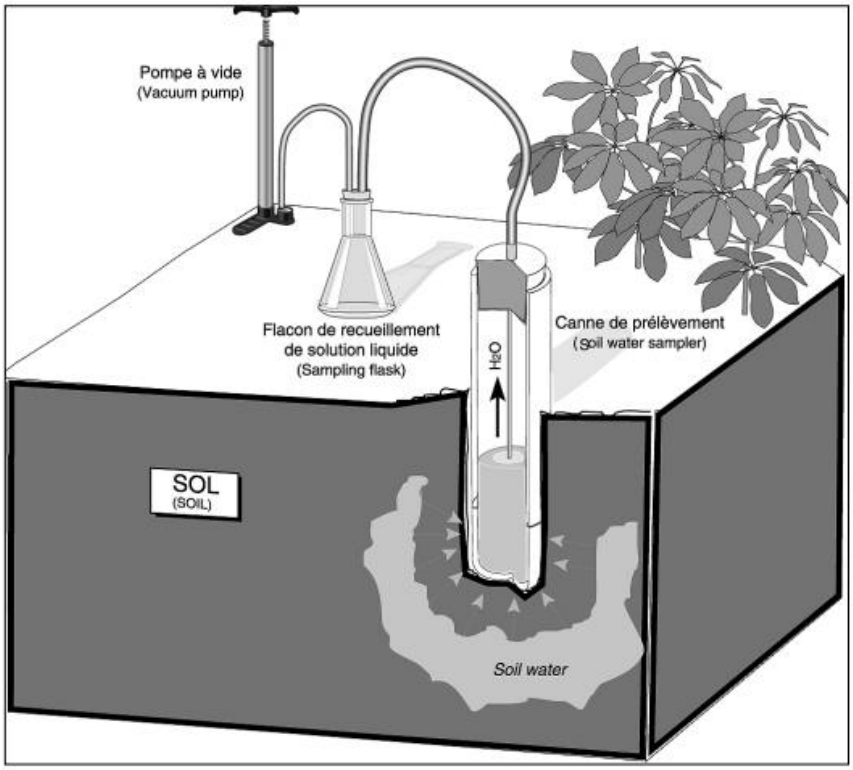
### Table 2: Demonstration Fields:

| Season | Field Name | Depth to chalk (cm) | Previous Crop | Cover Crop Drilled | Cover Crop Destroyed |
|---|---|---|---|---|---|
| 2019-20 | Bravins | 60 | Winter Wheat | 31/08/2019 | 10/02/2020 |
| 2020-21 | Pastures Piece | 40 | Winter Wheat | 15/08/2020 | 14/02/2021 |
| 2021-2022 | Compton | 60 | Winter Wheat | 06/09/2021 | 25/02/2022 |

# Methodology:

**Soil Sampling:**

Soil mineral nitrogen samples were carried out every twice in a 12-month growing season (before planting the cover crop and before drilling and the spring cash crop). SMN samples were taken at two depth, 0-30cm and 30-60cm as set by the RB209 guidance on shallow soils. P, K, Mg and OM samples were also taken before planting the cover crops in each field to understand the variability across the field.


**Porous Pots:**

Twelve porous pots were installed in each treatment, giving a total of 48 porous pots across the trial. Porous pots were sampled once every two weeks from the beginning of October through to the end of February. The water samples gathered from the porous pots were analyzed as fresh samples for nitrate levels (mg/l) which provided an excellent indication of the amount of nitrate leaching through the soil profile.

**Yield Measurements:**

Yield measurements were taken at the point of harvest each year to give a good on farm indication of yield variations between the different plots. Although this is not always the most accurate method, it was deemed appropriate for a on farm practical trial.

**Rainfall:**

Rainfall data was gathered directly from the Environment Agency to monitor how heavy rainfall events effect the potential nitrate leaching through the soil profile.

**Establishment Techniques:**

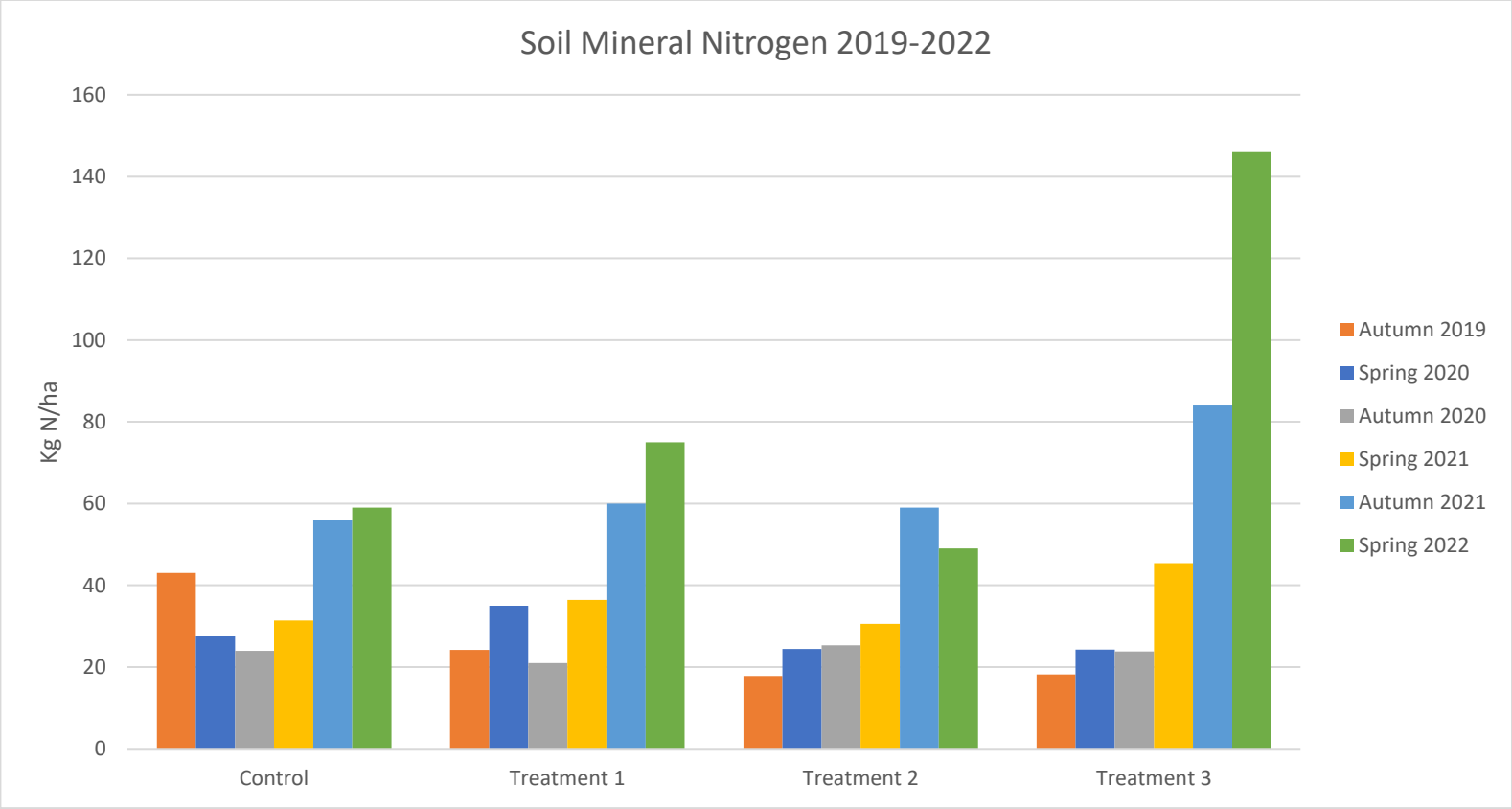
Two different establishment methods where used, broadcasting cover crop seed into a standing crop and conventionally drilling. The two options where deliberately chosen to add another comparison into the project. Broadcasting into a standing crop is cheap and efficient, but the availability of equipment in the South is limited. It can also pose issues if the straw is going to be removed from the field. Drilling cover crops is more expensive but can stand a better chance of having a successful cover crop. Placing the seed directly into moisture ensures a quick germination and rapid uptake of available nutrients.

# Visual Differences:



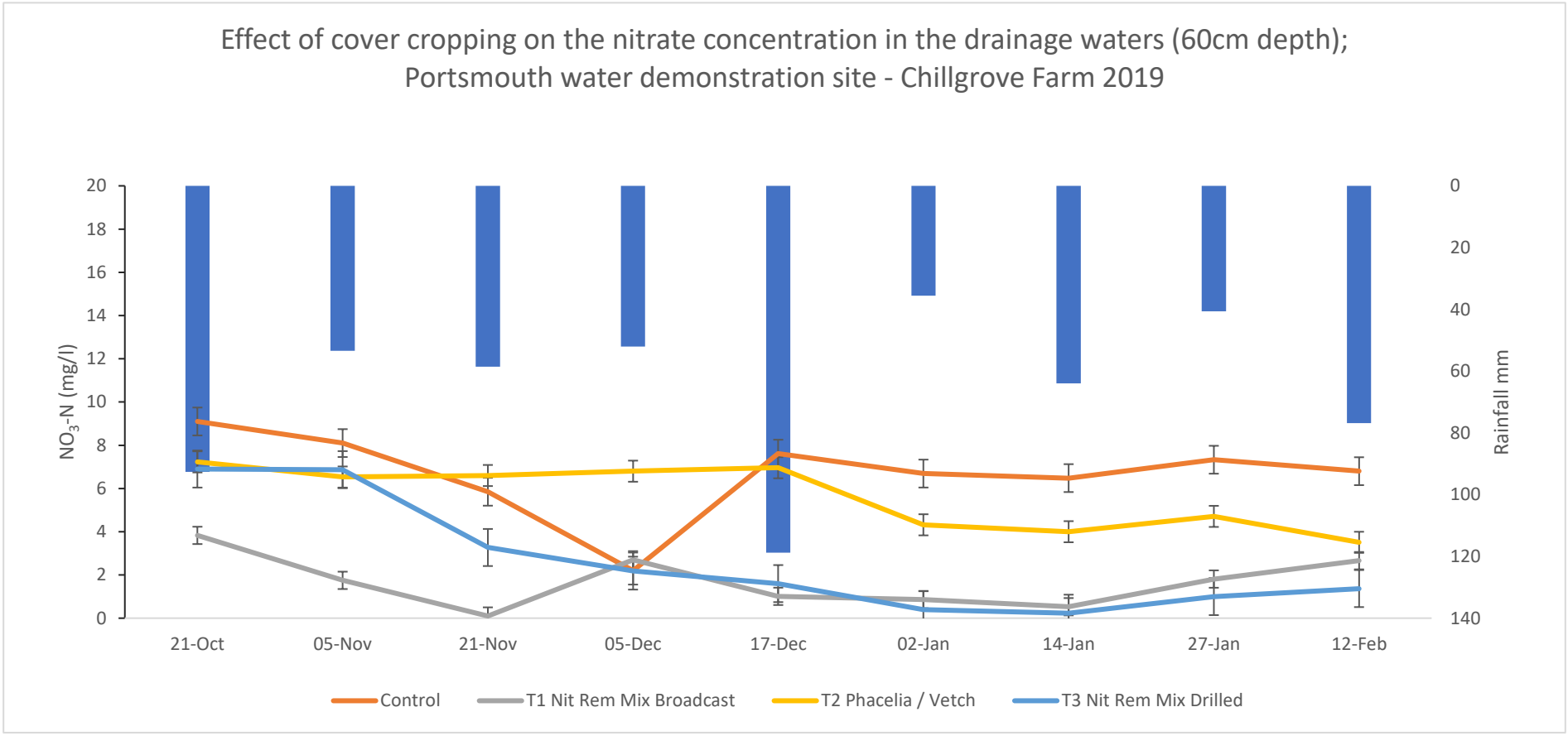
There are clear visual differences between the different plots across the three years. In 2019, T3 the only drilled plot, outperformed the other two plots that had seed broadcast after harvest. In contrast in 2020 the two plots which had the seed broadcast straight into a standing crop where the best performers in terms of ground cover. Unfortunately, in 2021, the option of broadcasting into a standing crop as taken away so all three cover crop plots had to be drilled. You can still see the differences in establishment between the different cover crop mixes!

# SMN (Soil Mineral Nitrogen) Results: (graph 1)

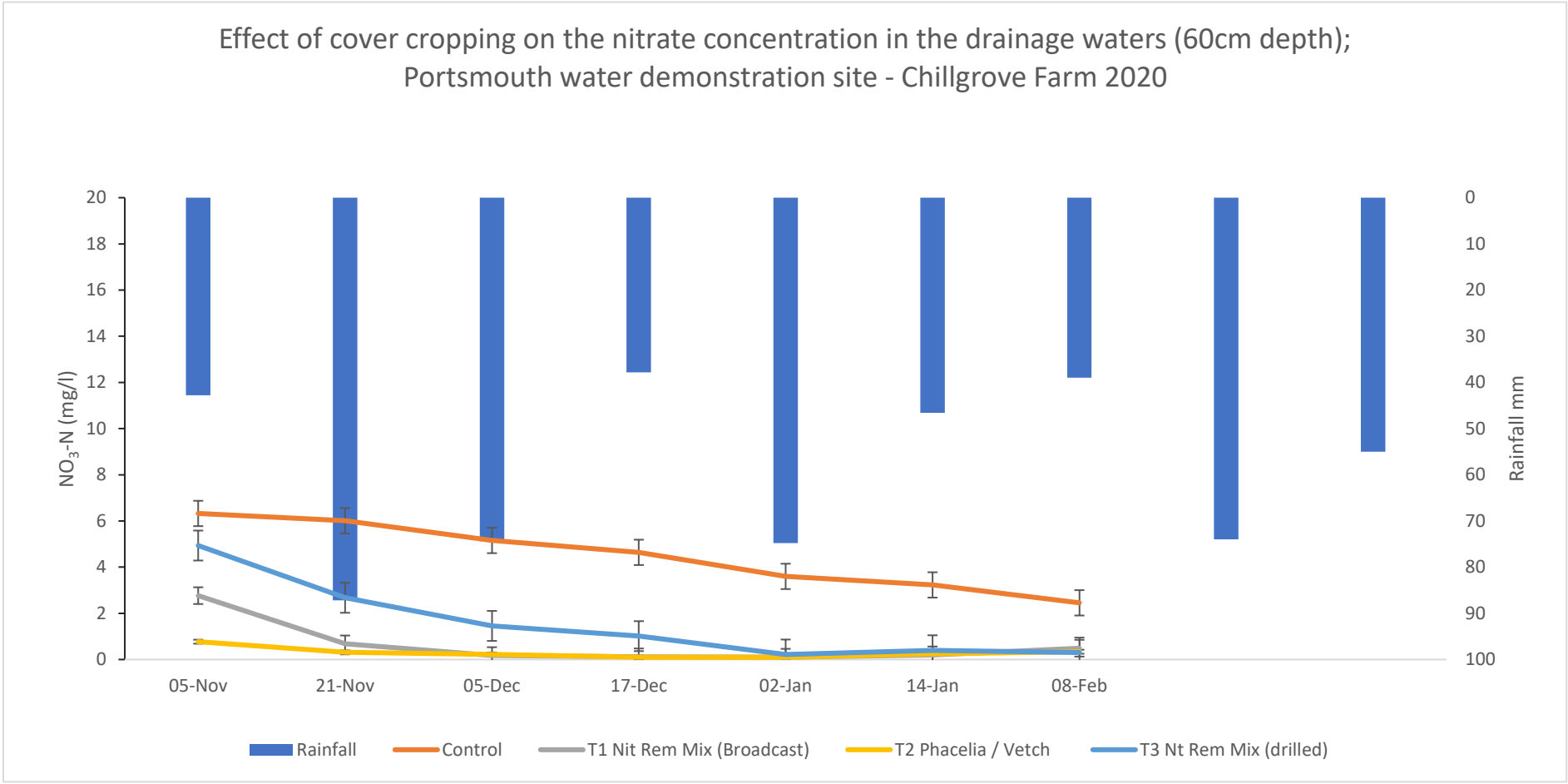



SMN levels varied between the three seasons followed. 2021-2022 stands out with an exceptional increase in SMN levels within the soil between Autumn and Spring. This is not a common trend, with the tendency for left over nitrates in the soil to be lost via leaching. That being said there has been a small increase in SMN over the autumn period in a number of the treatment plots. Statistically, the N uptake Mix in Treatment 1 has been the best performer with a SMN increase between Autumn and Spring every year of the trial.

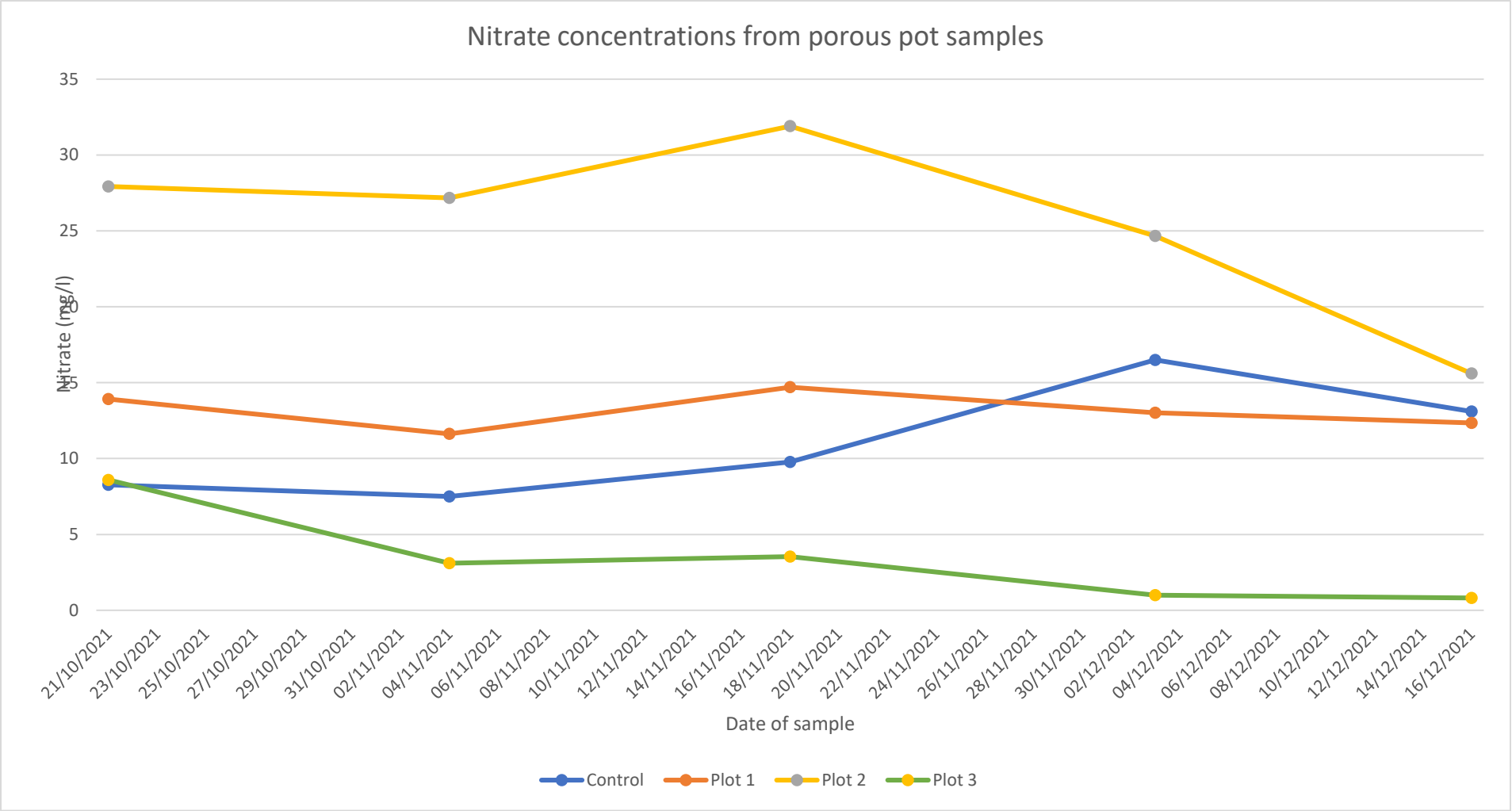
# Porous Pot Results Oct – Jan 2019-2020: (graph 2)



# Porous Pot Results Oct – Jan 2020-2021: (graph 3)



# Porous Pot Results Oct – Jan 2021-2022: (graph 4)



The amount of nitrogen lost through the soil profile because of leaching depends on several factors:

1. The SMN levels in the soil after harvest (graph 1). The higher the SMN levels recorded after harvest, the bigger the opportunity for nitrate leaching to occur over the winter period.
2. Soil depth seems to influence the level of leaching. But strangely in this trial the opposite occurs. In a normal scenario, you would expect the thicker the soil profile, the better nutrient retention would be. But in this case, higher levels of leaching occurred where the soil was over 60cm thick compared to Pastures piece which was only 40cm deep.
3. Cover crop type has a clear effect on the amount of N being lost through the soi profile. There is a clear difference between a simple oats and vetch mix versus a more diverse mix.
4. Cover crop establishment method seems to have an influence on the CC ability to take up nutrients. The early the CC can be established, the more effective it seems to be at taking up nutrients. Hence the broadcast plots in 2019 and 2020 where the best performers.

The nitrogen removal mix has performed well across all three seasons providing excellent ground cover and nitrate reduction between 60-85% compared to the weedy stubbles (control plot). It fixed nitrogen levels within the soil between 15-40kgN/ha, potentially reducing the requirement of artificial fertiliser to the following cash crop (spring barley). The phacelia & vetch mixes only performed well in 2020 (graph 3), with an 80% nitrate levels reduction in the porous pots. The other two years it did not perform particularly well, so this data is inconclusive.

2021 through up some strange results. The control outperformed the cover crops. The stubble was not particularly dirty, so reasons behind this are inconclusive.

# Cost/Benefit analysis

A cost assessment has been produced to compare each treatment in terms of the variable and operational costs. The farm solely relies on contractors for all field operations, so although they may be higher compared to the field operations being done in house, they are accurate in terms of budgeting. A single grain yield of 7.1t/ha has been used as yield mapping was not fitted to the combine.
Cover crop establishment costs have been different between the three plots as was the cover crop seed cost.

| Nitrogen Removal Mix: | Farmers Seed Mix: |
|---|---|
| Black Oats 50%<br>Forage Rye 30%<br>Berseem Clover 15%<br>Phacelia 5% | Phacelia 50%<br><br>Vetch 50% |

| Treatment | Over Wintered Stubble | Nitrogen Removal Mix (broadcast) | Farmers Seed Mix (broadcast) | Nitrogen Removal Mix (drilled) |
|---|---|---|---|---|
| Yield (t/Ha) | 7.1 | 7.1 | 7.1 | 7.1 |
| Price (£/t) | 141 | 141 | 141 | 141 |
| OUTPUT (£/Ha) | 1001 | 1001 | 1001 | 1001 |
| Cover crop seed (£/ha) | | 45 | 30 | 45 |
| Fertiliser – N, P & K | 202 | 202 | 202 | 202 |
| Sprays | 107 | 107 | 107 | 107 |
| Total variable costs | 309 | 354 | 339 | 354 |
| **GROSS MARGIN (£/Ha)** | **692** | **647** | **662** | **647** |
| **FIELD OPERATIONAL COSTS (£/ha)** | | | | |
| Broadcast / Drill covers | | 17.44 | 17.44 | 52.5 |
| Field Operations | 321 | 321 | 321 | 321 |
| Total Operational Costs (£/ha) | 321 | 338 | 338 | 374 |
| **NET MARGIN (£/Ha)** | **371** | **309** | **313** | **273** |

# Conclusions:

This field-based study has clearly demonstrated the advantages that using cover crops within a rotation can bring in terms of reducing nitrate losses, potentially reducing artificial fertiliser requirements for the following crop and the advantages of broadcasting a CC into a standing crop rather than drilling it. Establishing a cover crop of any sort early is critical to its effectiveness. Monitoring the effect of cover crops on the following crop is difficult and unfortunately, in this project's scenario the following crop each year was different (spring barley, beans, maize). This unfortunately meant that performing an accurate cost-based analysis between the years could not be performed. The calculations from 2019 did demonstrate the reduced gross margin from using cover crops down to the seed and operational costs of installing them. This gap is currently being filled by support from Portsmouth Water.

The real unknown is when the nitrogen taken up by the cover crops will become available (if at all) to the following crop. This poses challenges when an agronomist is working out the N requirements for the following crop. If we gain a greater understanding of this and have confidence in modifying N requirements following cover crops, the with current nitrogen prices there will be a clear financial advantage to growing CC in the rotation.

**Any questions then please contact Stephen Woodley (stephen@swoodleycropservices.co.uk)**