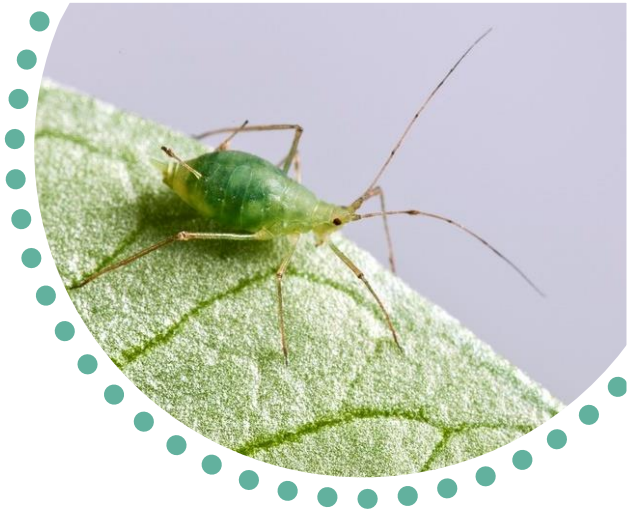
Lessons from Broadbalk

Getting the most out of wheat crops

Thankyou to the e-RA Curators for providing data and helping to put this teaching resource together.

Rothamsted Research

is a buzzing community of agricultural scientists all working to find answers to the question...



“How can we feed the world without harming the environment?”

ROTHAMSTED RESEARCH

History of Rothamsted Research

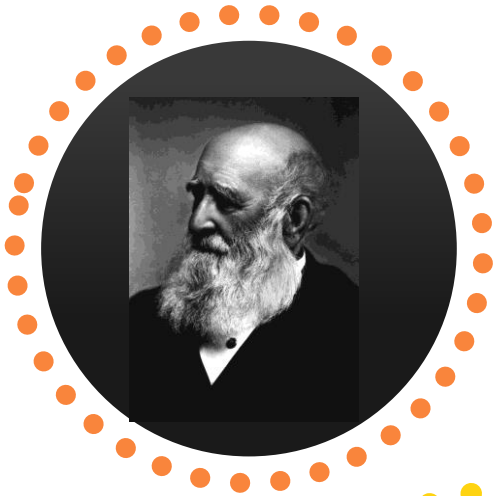
John Bennet Lawes, who was born in Rothamsted Manor, took over the Rothamsted estate in 1834.

Shortly after leaving University in 1834, turned a bedroom of the manor house into a chemistry lab and experimented with animal bones and sulphuric acid to increase yield of crops on the Manor farm.

He started a successful fertiliser business in 1842.

ROTHAMSTED RESEARCH

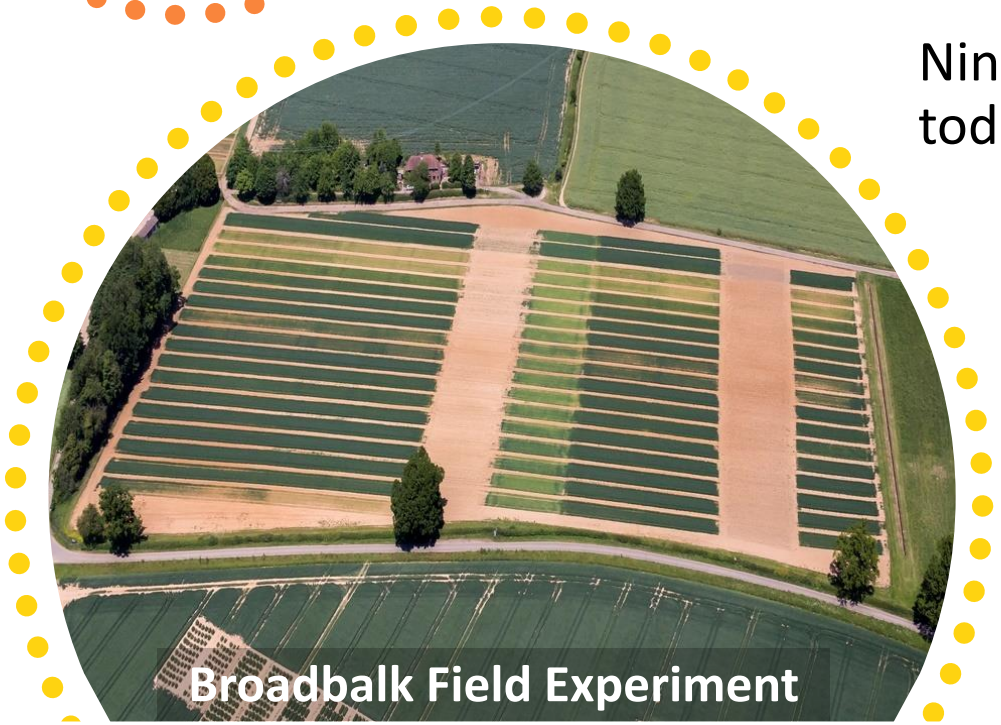
History of Rothamsted Research



He teamed up with the chemist Dr Joseph Henry Gilbert in 1843.

They started many long-term field experiments to investigate how farmers could increase the yields of their crops.

Nine of these experiments are still running today, now called the ‘Classical’ Experiments.



Data from these experiments are stored and managed in the electronic Rothamsted Archive (e-RA) where they can be accessed and used by scientists from around the world.

era.Rothamsted.ac.uk

ROTHAMSTED RESEARCH

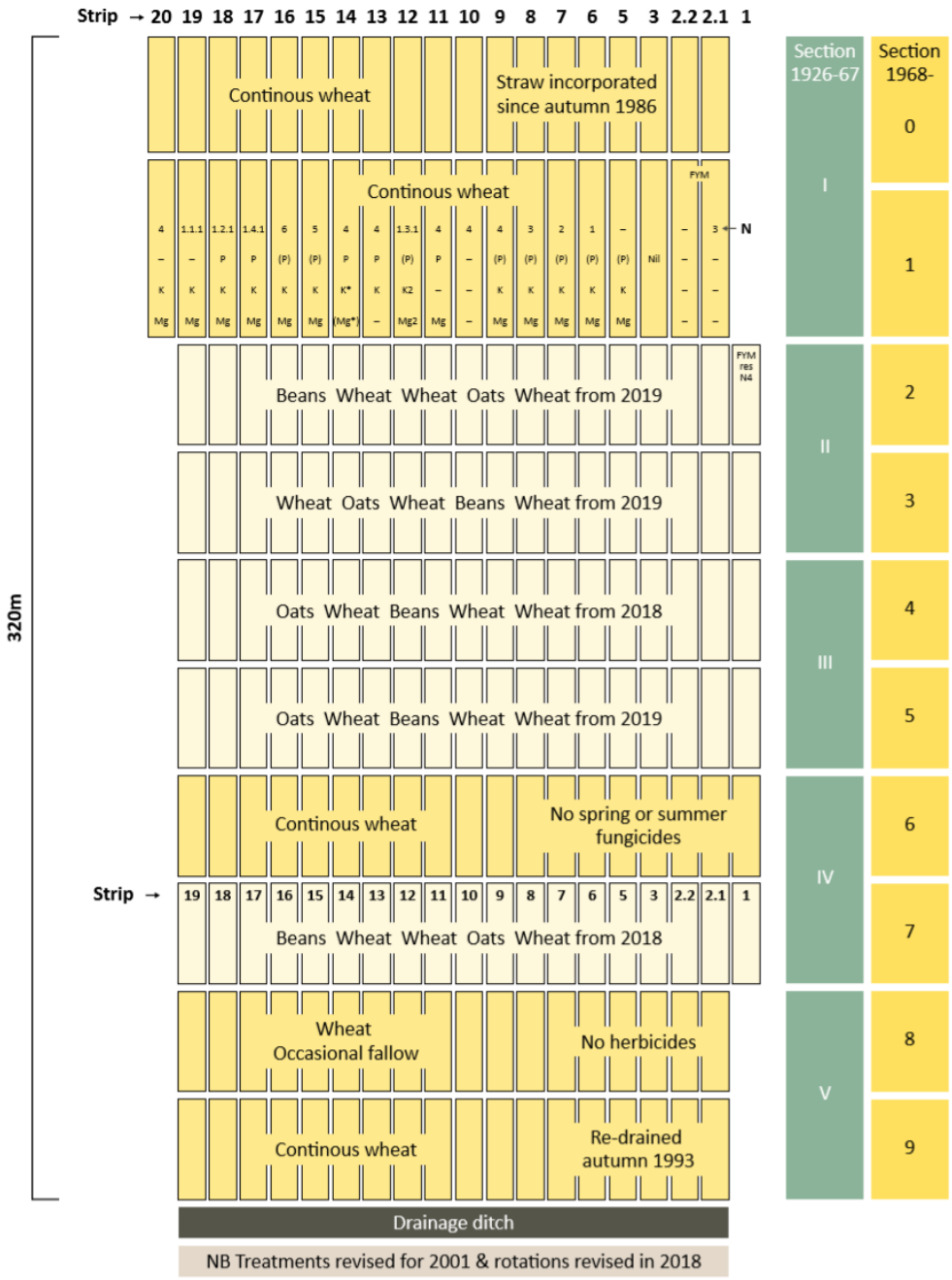
The Broadbalk Experiment

Set up in 1843 to compare different fertiliser and manure treatments on wheat yield.

The field was originally split into long strips with each strip receiving different fertiliser treatments.

The experiment has changed over time, to become more scientifically robust and to match modern farming practices, e.g. rotation of wheat with other crops and the use of pesticides.

This has resulted in the long strips being divided up and today the field is more like a grid of small plots.



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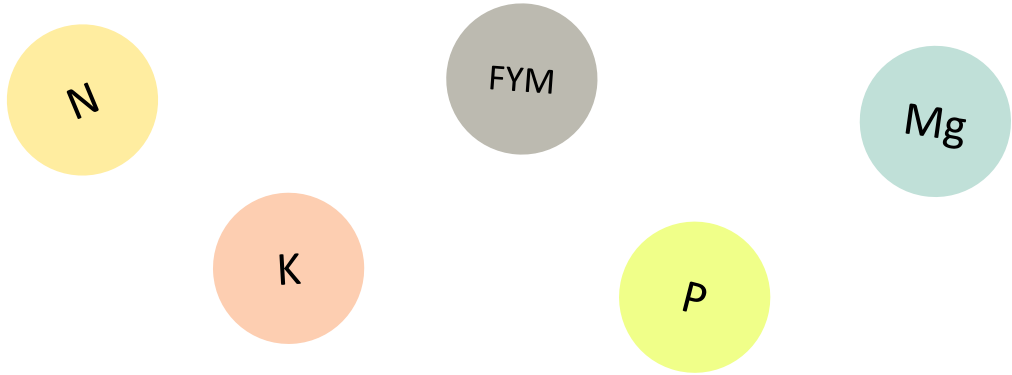
You are going to be using actual data from Broadbalk to:

1. Compare wheat yields from plots where different fertiliser treatments have been used.

2. Compare the results from plots where wheat is grown every year to plots where wheat is grown in rotation with other crops (called break crops).

Farmers use fertilisers to add nutrients to the soil



Some farmers rotate the crops that they grow each year on each field.

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The Broadbalk data

Fertiliser Treatments:

Nil = No fertiliser. This is the control.

FYM = Farmyard Manure, an organic fertiliser

N1 to N6 = In-organic fertilisers (man-made) with increasing levels of Nitrogen. They all have the same quantities of K, P and Mg.

All plots being studied here have been treated with the same herbicides, pesticides and fungicides.

Wheat Yield = the amount of wheat grain harvested

- Measured in tonnes per hectare (t/ha).
- The rotational dataset uses wheat yields from wheat grown in the first year of the rotation cycle.

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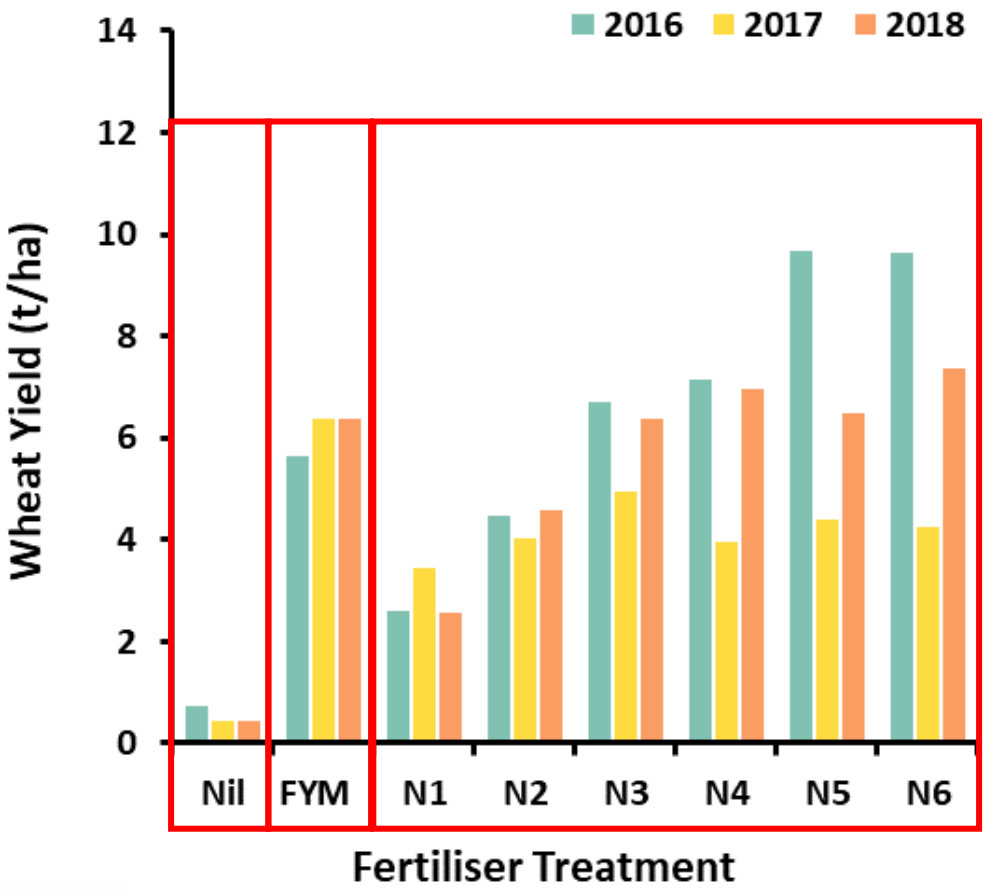
Results: Continuous Wheat

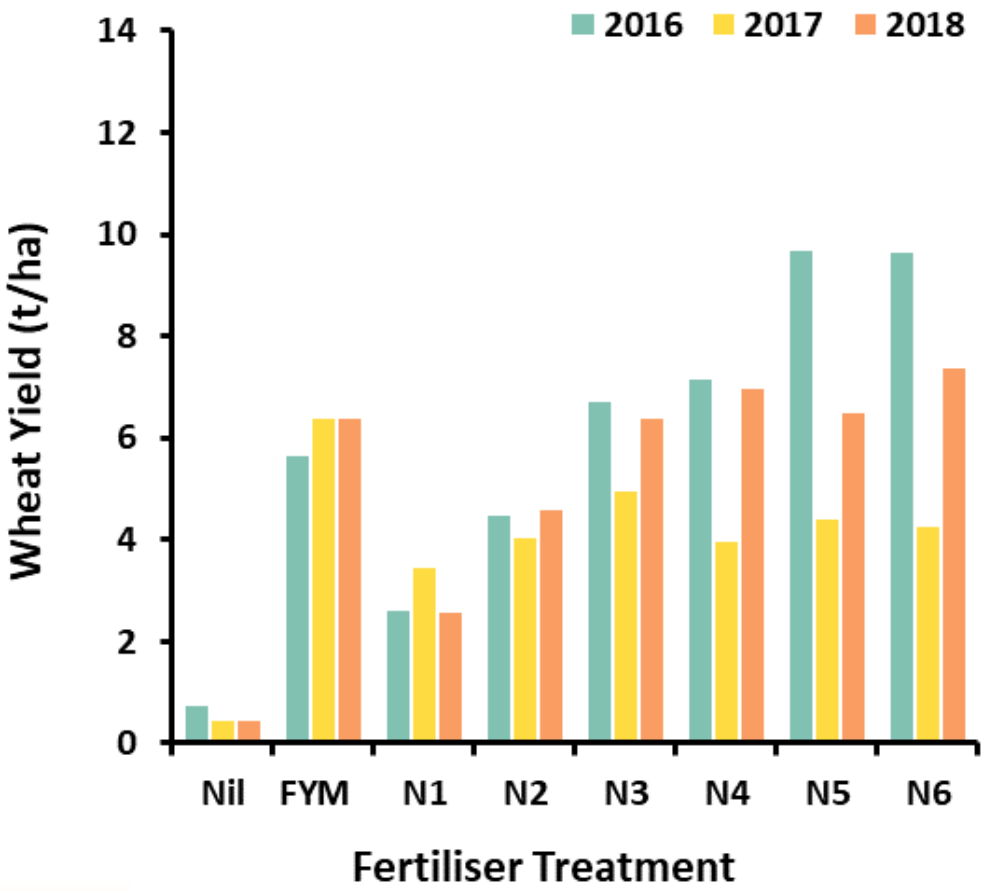


Treatment	Yield (t/ha) 2016	Yield (t/ha) 2017	Yield (t/ha) 2018	Average Yield (t/ha)
Nil	0.74	0.44	0.44	**0.54**
FYM	5.65	6.37	6.36	**6.13**
N1	2.59	3.43	2.56	**2.86**
N2	4.48	4.03	4.59	**4.37**
N3	6.7	4.96	6.38	**6.01**
N4	7.16	3.96	6.98	**6.03**
N5	9.67	4.39	6.49	**6.85**
N6	9.63	4.26	7.38	**7.09**

What did you notice about the data?

ROTHAMSTED RESEARCH

Results: Continuous Wheat



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- FYM and N fertiliser increased wheat yield (compared to the control).
- FYM increases wheat yields, but not as much as plots treated with N3-N6 fertiliser.
- Increasing N fertiliser results in greater yields but after N3 this seems to level out (except in 2016).
- Not every year is the same! For example, the N5 and N6 yields for 2016 are double the N5 and N6 yields for 2017.

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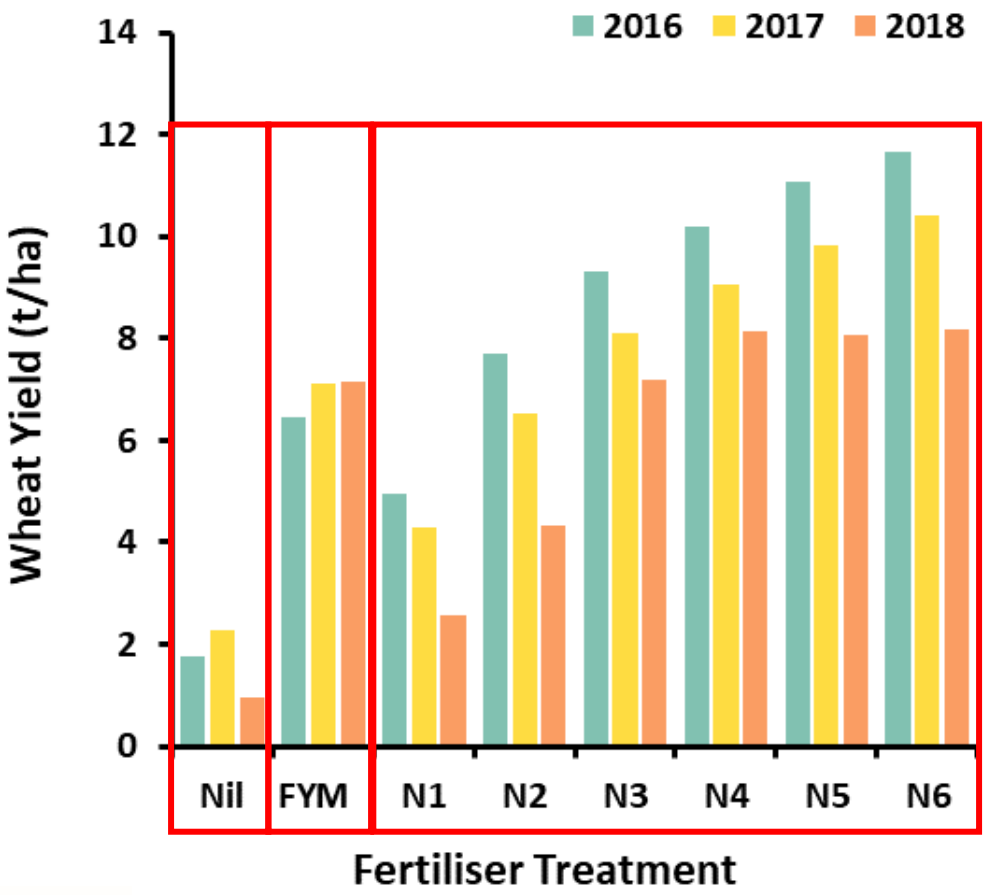
Results: Rotational Wheat



Treatment	Yield (t/ha) 2016	Yield (t/ha) 2017	Yield (t/ha) 2018	Average Yield (t/ha)
Nil	1.75	2.27	0.95	**1.66**
FYM	6.45	7.1	7.16	**6.90**
N1	4.94	4.29	2.55	**3.93**
N2	7.71	6.53	4.34	**6.19**
N3	9.31	8.09	7.2	**8.20**
N4	10.2	9.06	8.14	**9.13**
N5	11.09	9.82	8.08	**9.66**
N6	11.66	10.41	8.16	**10.08**

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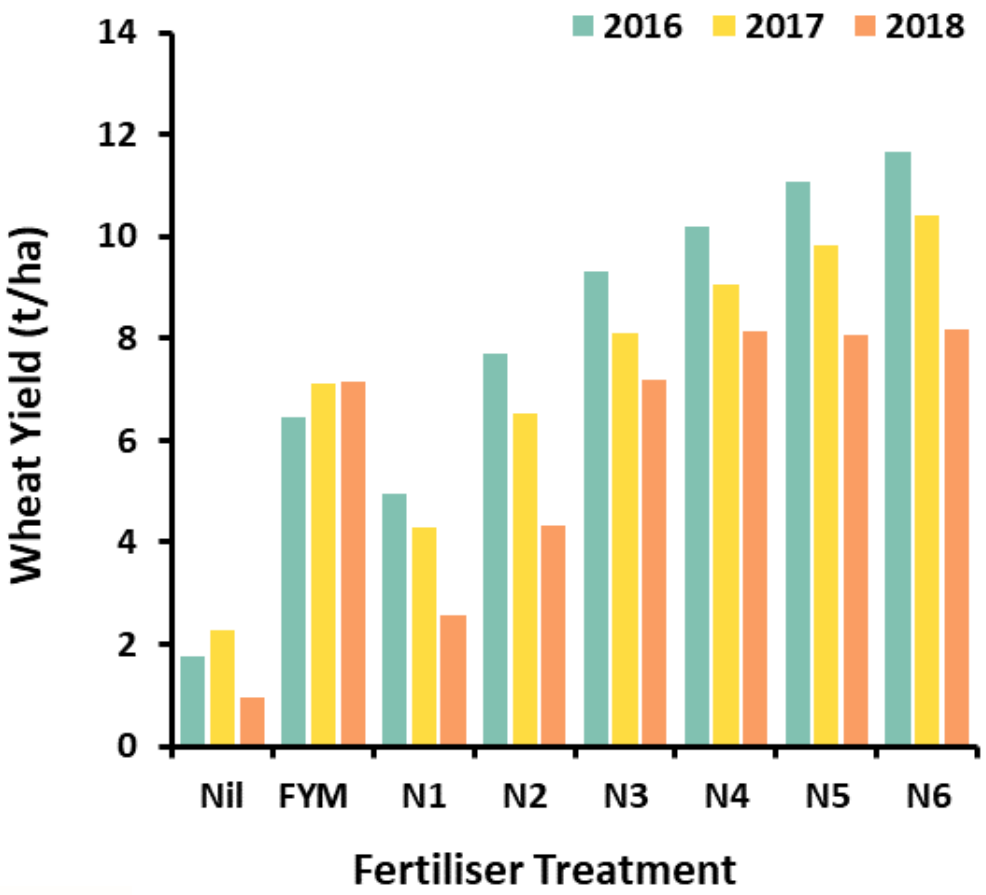
ROTHAMSTED RESEARCH

Results: Rotational Wheat



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- FYM and N fertiliser increased wheat yield (compared to the control).
- FYM increases wheat yields, but not as much as plots treated with N3-N6 fertiliser.
- Increasing N fertiliser results in greater yields in 2016 and 2017. In 2018 yields levelled out after N4.
- There were big differences between years in the plots given N fertiliser, with the highest yields in 2016 and the lowest in 2018.

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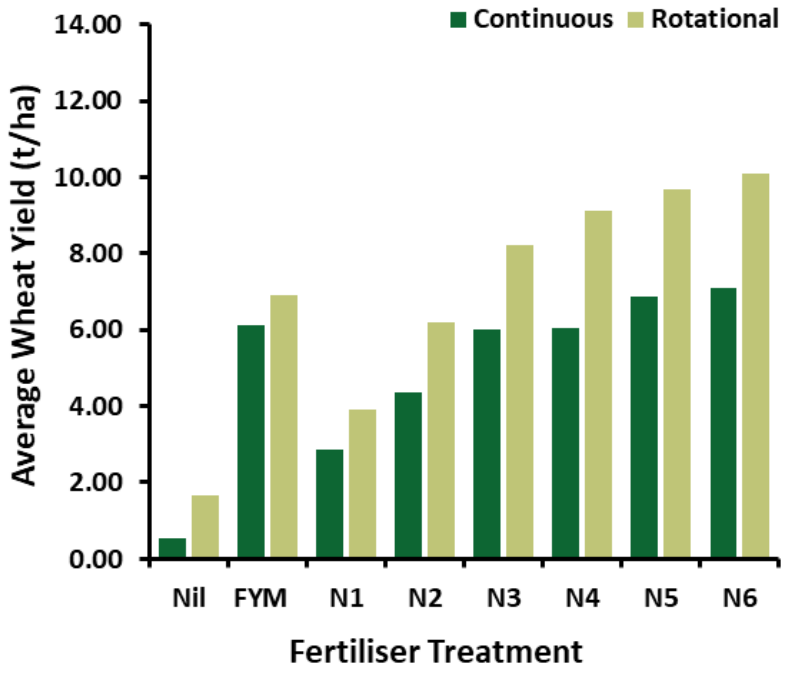
Results: Continual Or Rotational Wheat?

Wheat grown in rotation with other crops tends to have a higher yield.



Why do you think this might be?

ROTHAMSTED RESEARCH

Results: Continual Or Rotational Wheat?

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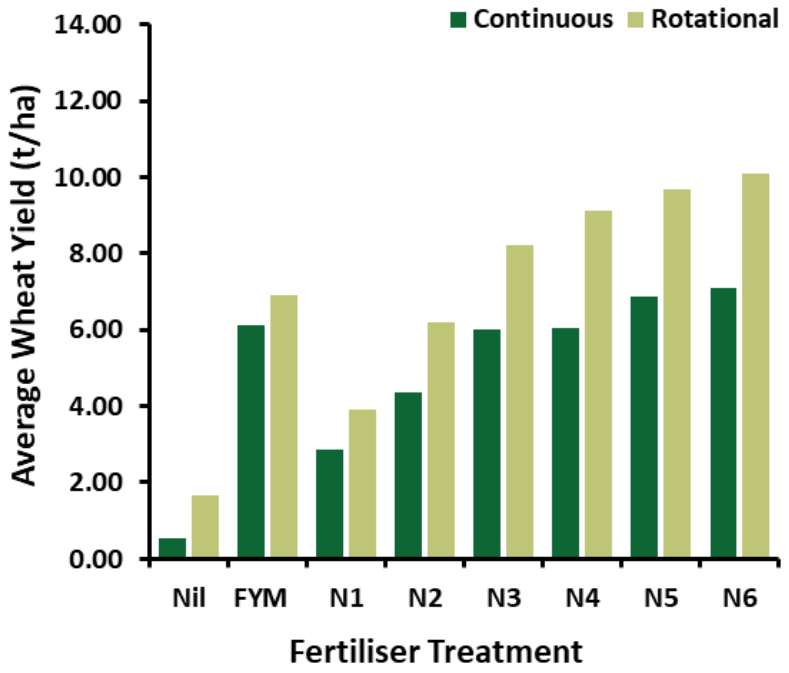

Deterring pests and breaking disease cycles

Specific pests attack specific crops. Rotating the crops force pests to move elsewhere, breaking the cycle and stopping them from becoming too destructive. Pests can be insects, fungi or weeds.

Soil nutrients are replenished

Different crops draw different nutrients out of the soil. Changing crops helps to stop the soil from becoming nutrient deficient. Some crops, like field beans, actually replenish nutrients as they fix N from the air.

Soil health and stability is increased

Different crops have different root systems helping to increase soil organic matter and reduce soil erosion.

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Conclusions

Different fertilisers give different results

Of the fertilisers looked at here FYM and N3-N6 fertilisers result in the greatest wheat yields.

Rotating crops is best

Farmers can increase crop yield in a field by changing the crops grown each year.

Long term data is important

Long running experiments give scientists lots of data helping them to see overall trends instead of year to year variations. This means that they can consider other factors that may affect the results they are seeing, like the weather.

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