Nutrient management for field vegetables:

Focus on improving nutrient use efficiency

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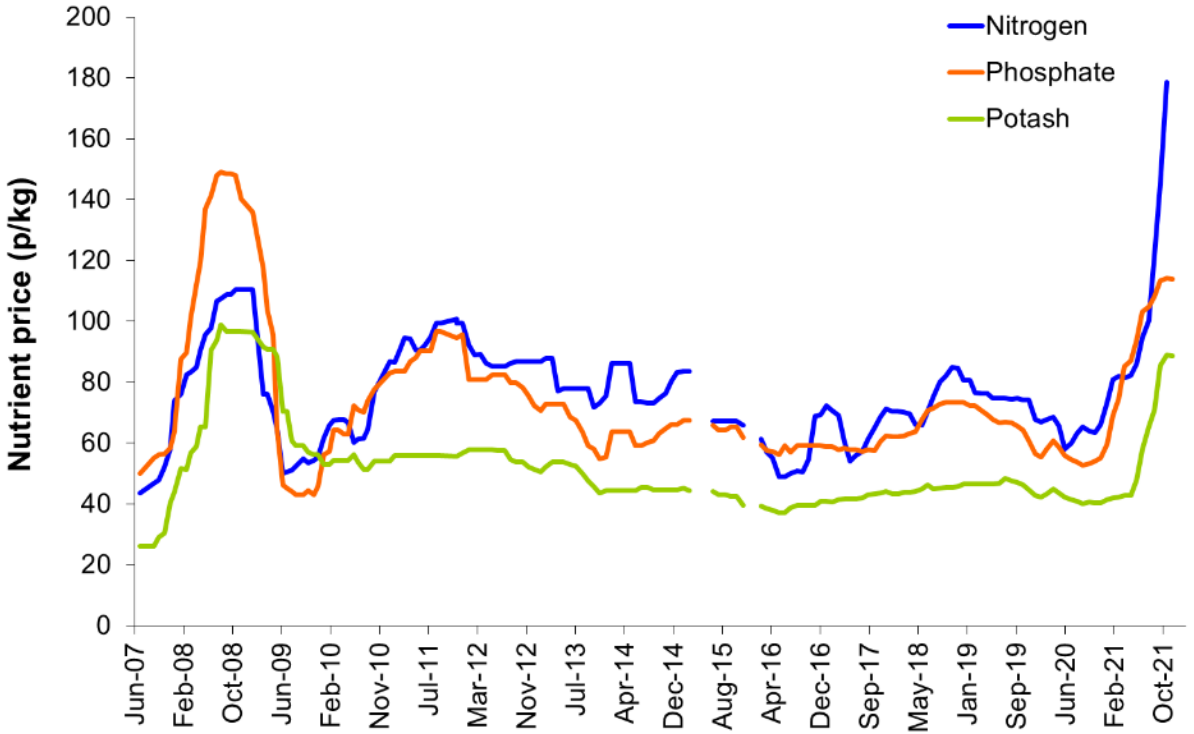
Teagasc webinar, 8th February 2022

www.adas.uk

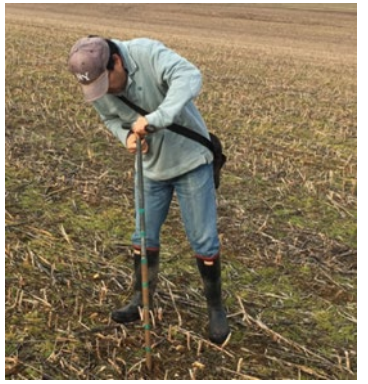
Drivers to improve nutrient use efficiency

- Increasing fertiliser costs
- Carbon from manufacture
- Potential pollutant
  - Nitrate leaching
  - Ammonia emissions
  - Nitrous oxide emission



Deciding what N rates are right for my farm

- Use a recommendation system
- Estimate, *or better measure*, soil mineral nitrogen
- Calculate nutrient supply from applications of organic materials
- Strategic decisions – use **experience** to judge past success to inform future decisions
  - Yields, crop quality, misses & overlaps
- Consider on validating N decisions with on-farm tests:
  - Apply 50kg N/ha more or less in alternate tramlines



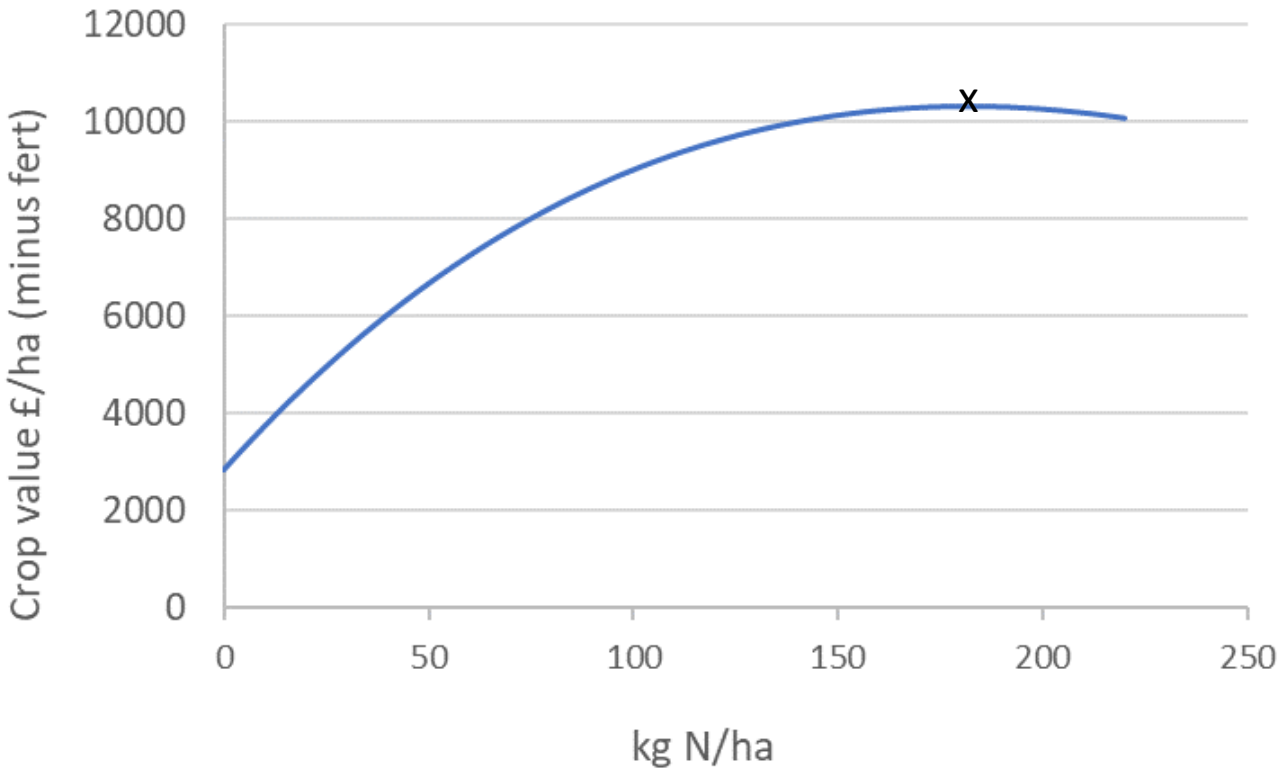
Economics of N response

- N requirement is the economic optimum N rate
  - Rate at which extra kg of N applied isn't paid for by value of additional marketable crop yield
- **Should we reduce N rates due to increase in fertiliser prices?**
  - Current recommendations to reduce N rates to cereals by 50 kg N/ha
  - Consider N cost as a percentage of crop value
  - With AN at €750/t a 200 kg N/ha application costs €435/ha
    - 25% value of wheat crop with wheat at €230/t and yielding 7 t/ha
    - 3% value of a broccoli crop with broccoli at €970/t and yielding 15 t/ha
    - 1.6% value of a leek crop with leeks at €1060/t and yielding 25 t/ha

Economics of N response - example

Broccoli, optimum N rate 182 kg/ha

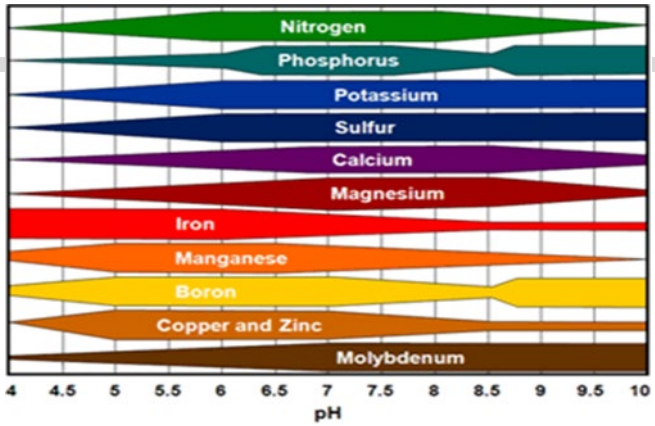
Based on N price £500/t AN



Impact of N price on economic optimum N rate

AN £/t	AN €/t	Opt N rate kg/ha
500	590	182
700	826	178
1000	1180	176

Steps to maximise N use efficiency



Get the basics right:

- Maintain soil at target pH
- Ensure sufficient supply of P, K, Mg, S
- Good soil structure
- Allow for nutrients from organic manures
- Assess soil nitrogen supply

What else?

- Measure soil mineral nitrogen (SMN)
- Placement of P fertiliser
- Fertiliser N efficiency products
- Variable rate application
- Match application timing to crop growth

Impact

Make the most of manure nutrients

What's it worth? Cattle FYM 40 t/ha

		Spring 2020 fertiliser prices		Current fertiliser prices	
	kg/ha	€/t	€/ha	€/t	€/ha
Crop available N	24	0.48	19	1.26	51
Total phosphate	128	2.30	92	4.31	172
Total potash	376	4.97	199	9.88	395
Total £		7.75	310	15.45	618

Assumes spring surface (broadcast) application

Spring 2020 £ value based on:

€278/t AN	N = 0.81 € /kg
€ 330/t TSP	P_2O_5 = 0.72 € /kg
€ 317/t MOP	K_2O = 0.53 € /kg

Current £ value based on:

€ 727/t AN	N = 2.11 € /kg
€ 620/t TSP	P_2O_5 = 1.35 € /kg
€ 630/t MOP	K_2O = 1.05 € /kg

Make the most of manure nutrients

What's it worth? Pig slurry 50 m^3/ha

		Spring 2020 fertiliser prices		Current fertiliser prices	
	kg/ha	€/t	€/ha	€/t	€/ha
Crop available N	99	1.59	80	4.18	209
Total phosphate	75	1.07	54	2.02	101
Total potash	110	1.17	58	2.31	116
Total £		3.84	192	8.51	425

Assumes spring surface (broadcast) application

Spring 2020 £ value based on:

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Key steps in making the most of manure nutrients

1. Know the nutrient content
2. Estimate crop available nitrogen supply
3. Minimise nitrogen losses
    - Avoid autumn/winter application to reduce nitrate leaching
    - Reduce ammonia loss by incorporating or apply using band-spread or shallow injection applicators
4. Spread accurately and evenly
5. Build into farm nutrient management plan

Assess soil nitrogen supply (SNS)

- Soil nitrogen that is available for crop uptake during it's growing season
- It comprises:
  - Soil Mineral Nitrogen (SMN) + N mineralization
- The SNS will directly reduce the need for fertiliser N
- Factors that affect SNS:
  - Soil type
  - Previous cropping (residues)
  - Overwinter rainfall
  - Regular use of organic manures
  - Take account of previous crop performance (e.g. reduced yields due to drought/weed pressures)

Consider *measuring* soil mineral nitrogen

- Target SMN measurements to fields where SMN is likely to be high or uncertain
  - Fields with a history of organic manures
  - Following high N residue crops
- Take samples as close to planting date as possible
- Do not sample within 2 months of manure or N fertiliser application
- Sample to 90 cm or rooting depth for shallow rooted crops
- Keep samples cool and send to the lab as soon as possible after sampling
- Consider analysis for Additionally Available Nitrogen (AAN)

Precision nutrition – strategies to improve nutrient use efficiency

- Fertiliser N efficiency products
- Variable rate application
  - P, K and lime
  - Nitrogen
- Placement - P
- Match application timing to crop growth
- On farm testing

Consider using N efficiency products

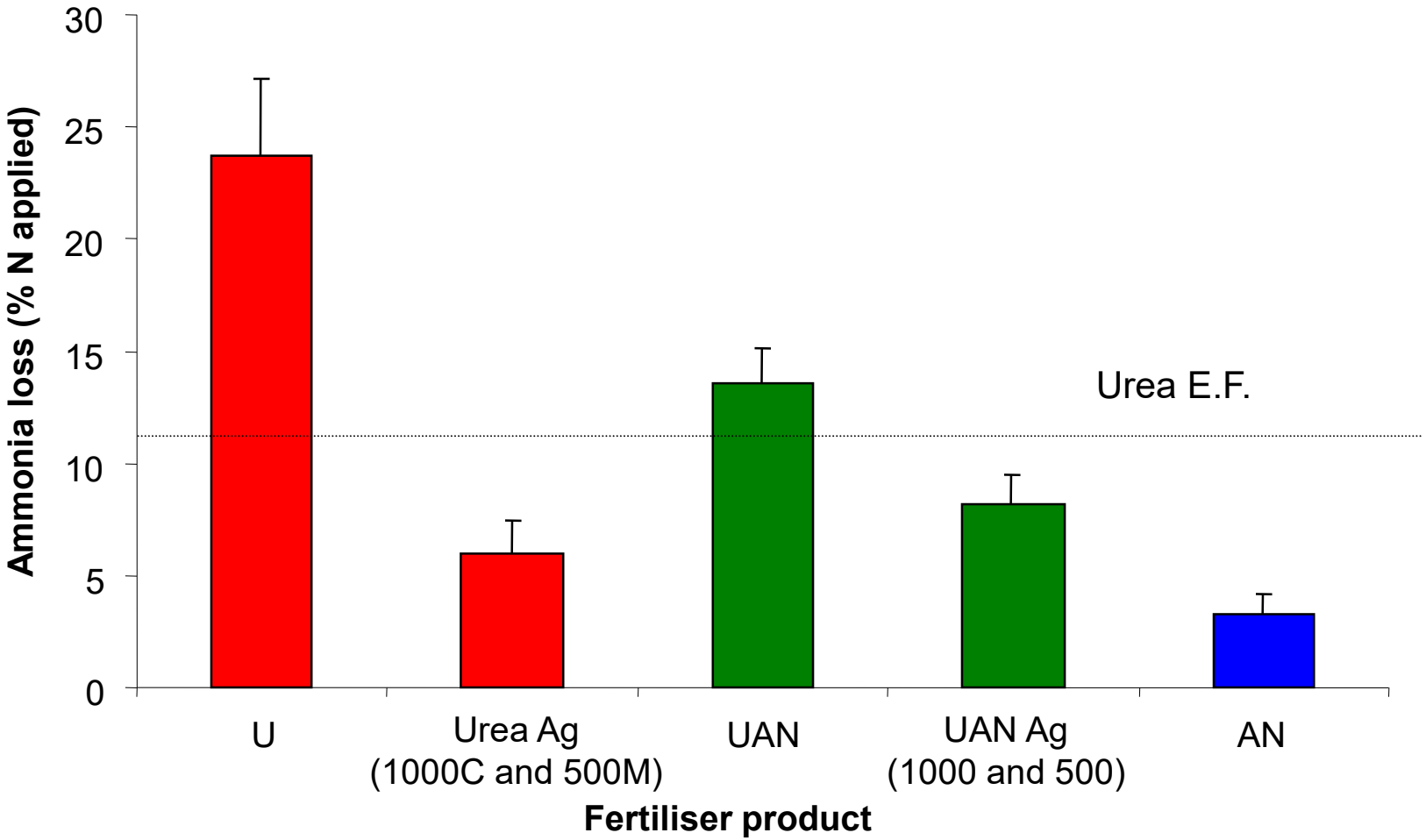
Department for Environment Food & Rural Affairs

ADAS

Type	Effect	Active Ingredients	Example Products
Urease Inhibitors	Slow conversion urea to ammonium **Reduce Ammonia losses** **Improve efficiency of urea & UAN**	nBTPT 1,2,4-triazole (2-NPT) NBTPT & NPPT	**SUSTAIN®** (**Agrotain®**) – Origin **YaraVera Amiplus® -** Yara **Piagran Pro® -** SKW Piesteritz **Limus®** BASF
Nitrification Inhibitors	Slow conversion ammonium to nitrate Reduce N_2O emissions Can reduce nitrate leaching	Nitrapyrin DCD DMPP	**N-Lock® -** Corteva **Didin** – Omex **ENTEC®** - Origin **Vizura®** - BASF
NI & UI	As above	MPA & 2-NPT DCD & ammonium thiosulphate	**Alzon-neo-N®** SKW Piesteritz **Didin®** - Omex
Slow or Control release	Physical or chemical barriers to release of nitrogen	Polymer Coated Polymers	**Nutrisphere® , Origin Enhanced-N®** **Efficie-N-t 28® Agrovital**

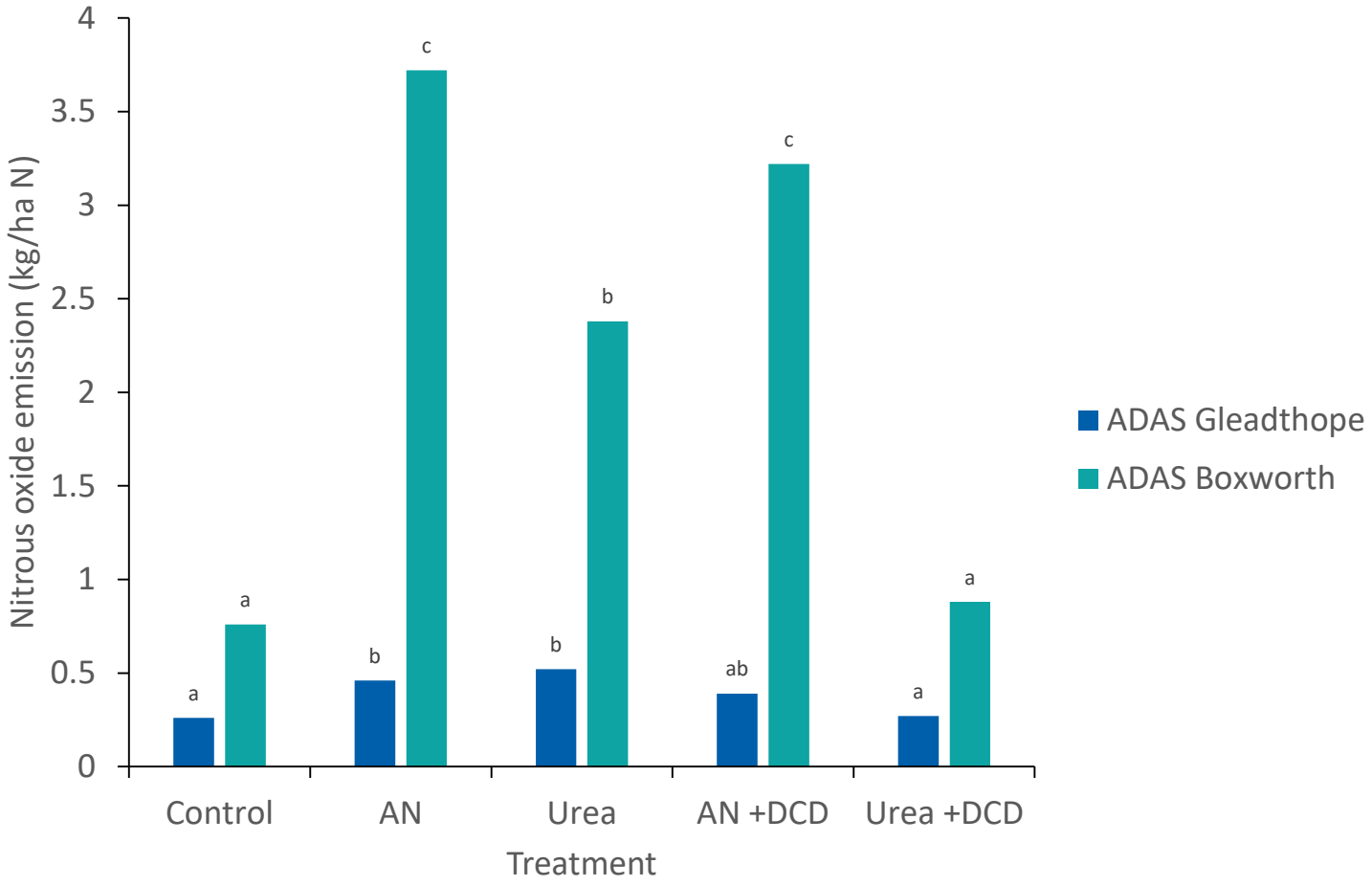
Defra review into Enhanced Efficiency Fertilisers – reporting spring 2022

Urease inhibitors reduce ammonia loss from urea based fertilisers



- Defra NT26 project
- Ammonia emissions from fertilisers applied to winter cereals
- Average of 10 sites

Nitrification inhibitors impact on N_2O emissions



- Nitrous oxide emissions reflect soil and weather conditions
- Effectiveness of NIs will vary according to soil and fertiliser type
- Average ~44% reduction

Misselbrook et al., 2014 Defra Project AC0112

P<0.01; letters indicate differences between treatments at each site

Variable rate P, K and lime

Systematic soil sampling and analysis

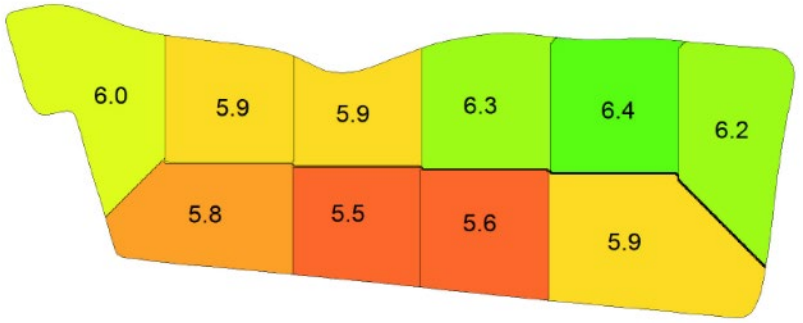
- Grid sample
- Targeted sampling (soil zoning)
  - *Using differences in soil type to direct sampling*

Generate field maps of soil nutrients or pH

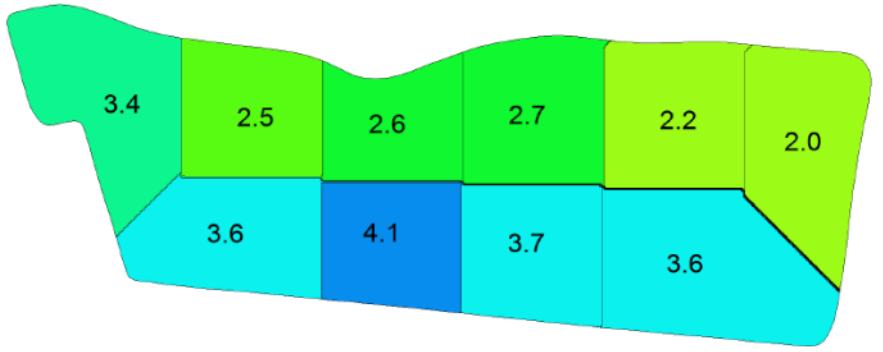
- Field nutrient recommendation map
- Variable rate fertiliser application

Potential advantages of VR fertiliser/lime

- Potential yield increases from low pH/soil nutrient are
- Cost savings from not over-applying



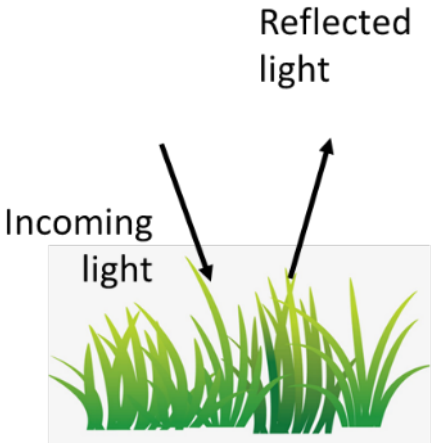
Soil pH



Soil P index

Variable rate nitrogen

- Canopy sensors can provide a rapid assessment of canopy size/crop N content/biomass
- Easily linked to VR control
- Apply less N to areas of the field with larger canopy
- Limitations
  - Assumes variation in crop N content/biomass is due to N supply
  - How much to vary the N rate by



Variable rate N experiment on Savoy cabbage

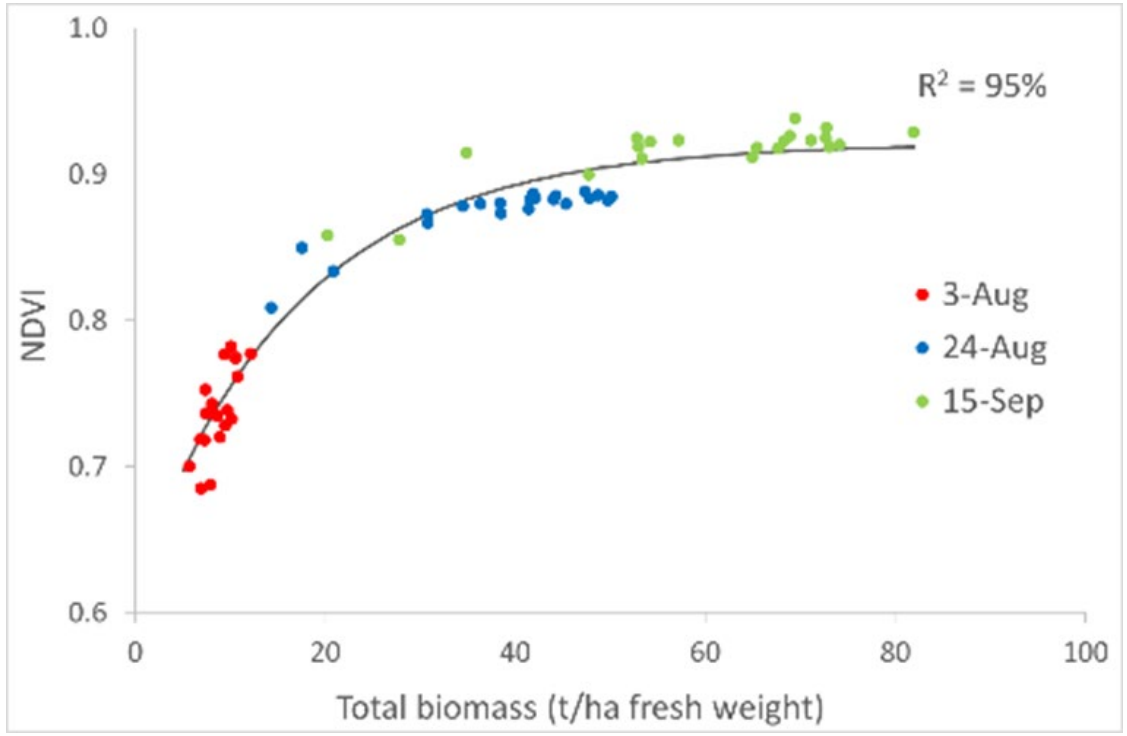
Aim: Demonstrate the potential to use canopy sensing to vary N application rate

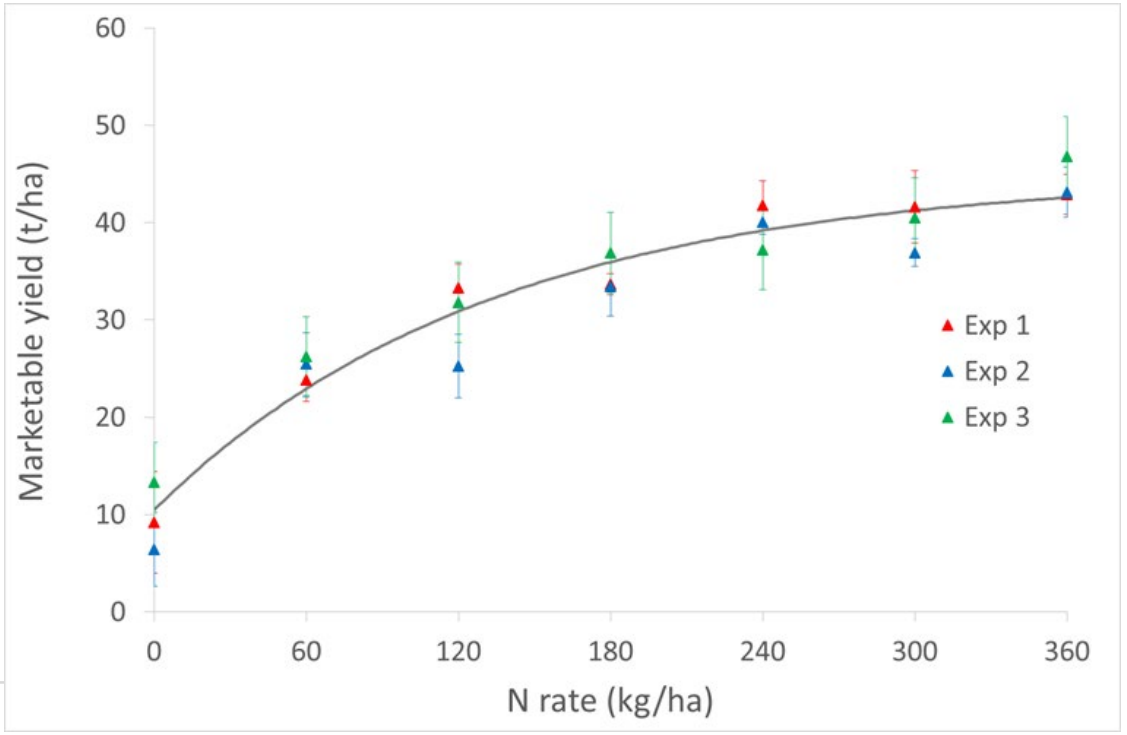
- Does the optimum N rate vary across the field ?
- Can we relate canopy information to biomass/N uptake during the season?
- Does it work – can we measure a yield response to varying the N rate?

N response plots

Tramline comparisons

N response experiments – *Savoy cabbage*



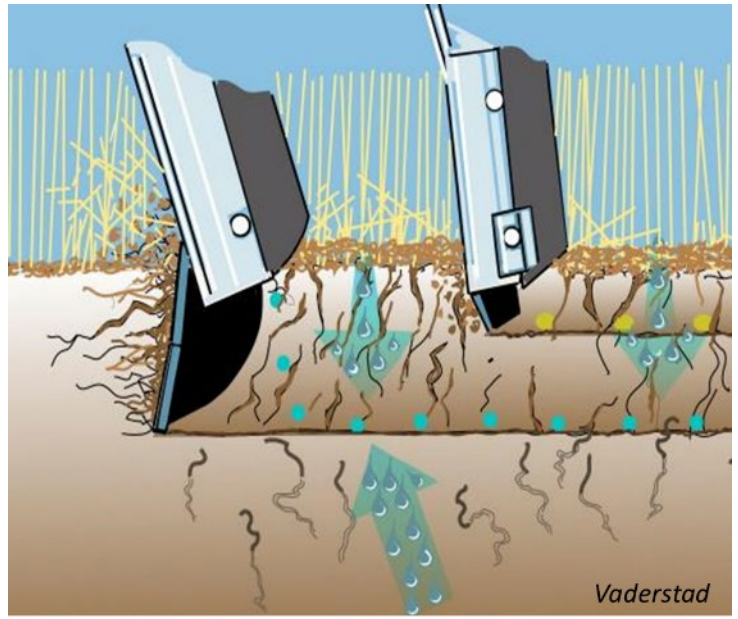


Tramline comparisons – *Savoy cabbage*

- Comparison of uniform N rate to variable N rate
- Three N applications
  - 4th July 80 kg N/ha at planting
  - 4th Aug 100 kg/ha (varied from 60-140 kg N/ha)
  - 24th Aug 60 kg/ha

Targeting P fertiliser

- Phosphorus moves slowly in soil
- Placement can improve P use efficiency & increase yields
- LINK Targeted P project showed that placing P increased potatoes yields compared to broadcast application



Site & Year	Broadcast	Placed	Effect	LSD	Prob.
Tamw'th-12	36.60	33.40	-3.20	2.84	**0.03**
O Rayne-12	23.70	26.00	2.30	1.84	**0.02**
Tamw'th-14	39.70	43.10	3.40	2.35	**0.01**

Match nutrient applications to crop demand

- Avoid high N applications at planting
  - Risk of N leaching if followed by heavy rainfall
- Controlled/slow release fertilisers
  - Nutrient release is controlled & nutrient availability spread over a period of time
  - Manufactures may recommend reducing the number of split N-applications compared to conventional practice
  - *Limited evidence of benefit*
- 'Little and often fertiliser' applicatio
  - Recent work on wheat compared N applied in 3 and 6 splits
  - *Limited evidence of benefit*

Test fertiliser decisions on farm – tramline trials

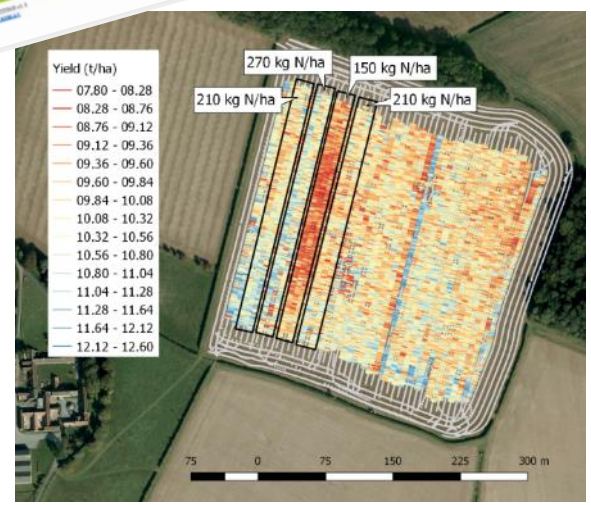
AHDB **LearN** Project 2014-2017 demonstrated the value of on-farm comparisons for cereal crops

- Simple tests of +/- 60 kg N/ha on alternate tramlines
- Obtained yields from yield maps … & protein

But, we don't have yield maps for most vegetable crops

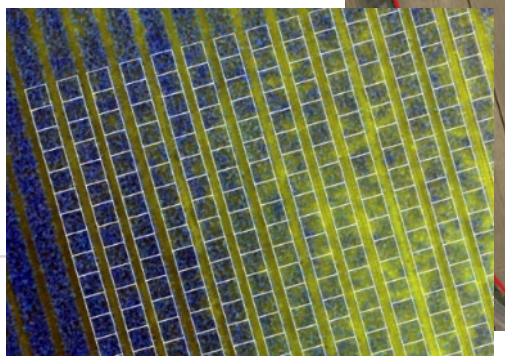
- Weigh crop from individual beds/tramlines
- Use canopy sensing as a proxy for yield to assess treatment difference

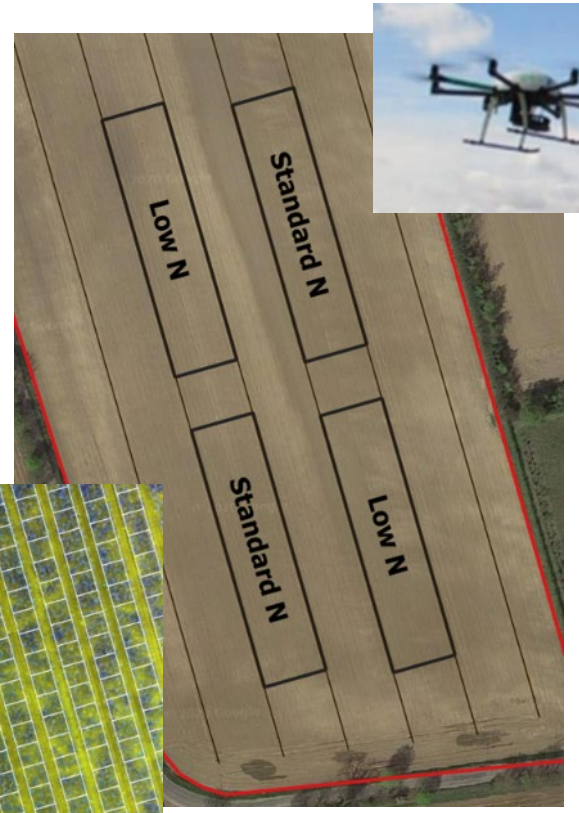
LearN



INNO-VEG – Increasing speed & uptake of innovation in field vegetable and potato sectors

- Demonstrated use of canopy sensing to assess treatment differences from field scale experiments in field vegetables & potatoes
- **Case study**: impact of N rate on yield of onions
- Protocol on use of crop sensing data in experiments
  - www.inno-veg.org





Conclusions

- Focus on nutrient use efficiency
- Get the basics right first
  - Maintain soil at target pH
  - Ensure sufficient supply of P, K, Mg, S
  - Good soil structure
  - Maximize efficiency of any organic manure applications
  - Assess soil nitrogen supply
- Precision nutrition strategies offer potential to improve nutrient use efficiency, but evidence for some is limited
- Consider on farm testing to validate nutrient management decisions

Acknowledgements

ADAS colleagues

Funding by Defra, AHDB and others

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