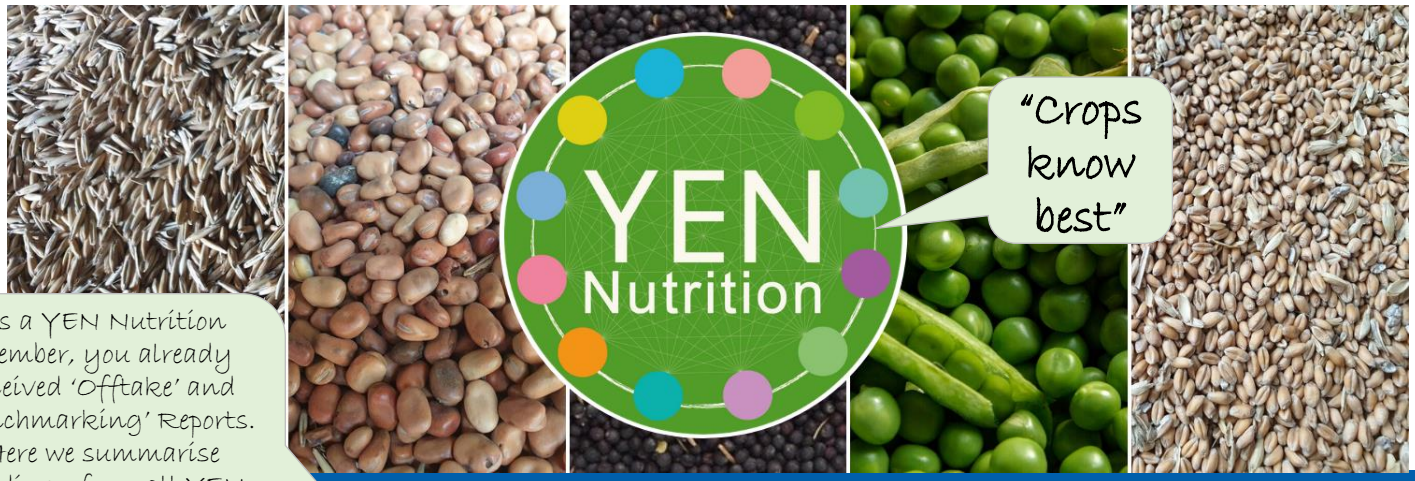


As a YEN Nutrition member, you already received 'Offtake' and 'Benchmarking' Reports. Here we summarise findings from all YEN Nutrition data from 2021.

Crop Nutrition Review 2021

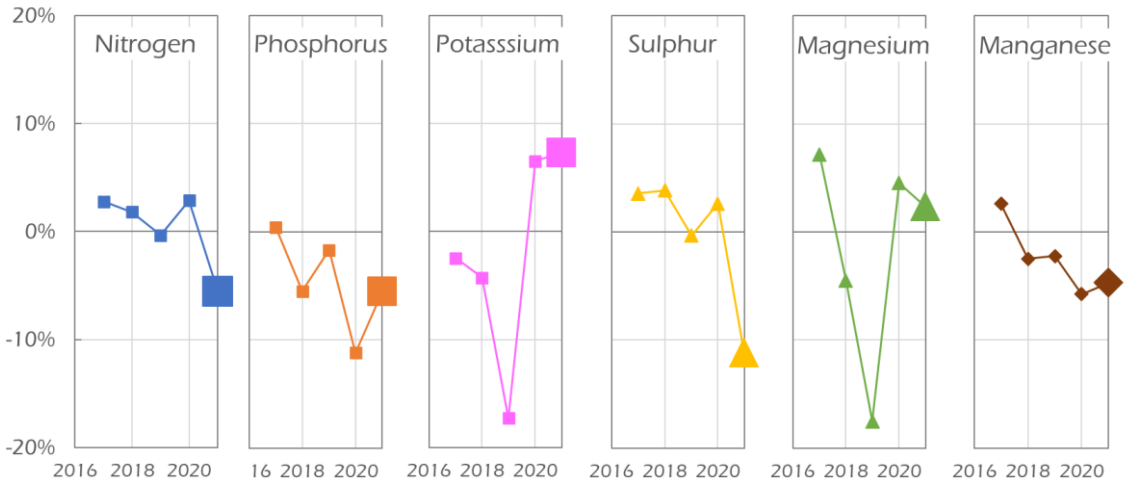
By ADAS's Crop Physiology Team, April 2022

Crop monitoring is becoming *vital*

Whether you think it's a 'hike' (permanent) or a 'spike' (temporary), huge prices of nutrients (& grains) in 2022 are making careful nutrient management a 'must' and should transform attitudes this year. Soil analysis is not enough. It is now vital to know whether crops are getting what they need on each field and farm. Undoubtedly 'crops know best' and, as nutrients are invisible, crop nutrient benchmarking is a no-brainer. This summary shows many new lessons (and questions) that arose from analysis of crop nutrients at harvest 2021, which should help to build confidence in crop nutrition for 2022 and beyond.

Seasonal variation: High grain K again in 2021, but low N and S

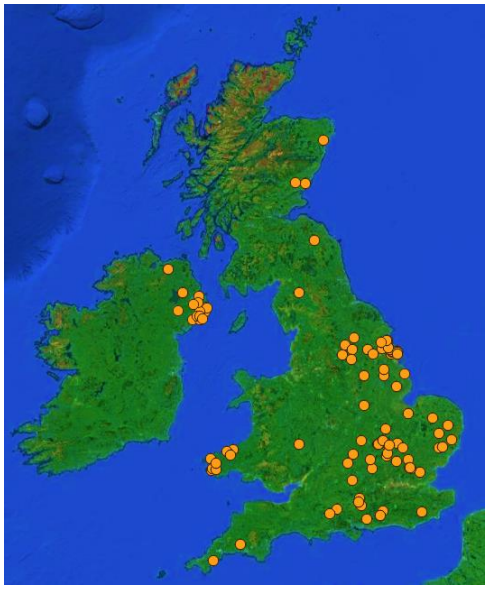
After five years of analysing grain nutrients in Cereal YEN, we can see how nutrient levels (of wheat crops) have varied over seasons. Potassium has been most striking; it was high again in 2021. But average potash offtakes (5.0 kg/t K_2O) were again variable and less than is assumed by RB209 (5.5 kg/t K_2O). Sulphur and nitrogen were low in Cereal YEN 2021, as was S in YEN Nutrition samples. However, the larger dataset of the AHDB Cereal Quality Survey shows only a minor change in grain N in 2021.



Analysis of all YEN Nutrition samples from 2021 shows us how benchmarking farm by farm pays ...

1. Benchmarking proves invaluable

In 2021, the 2nd year of YEN Nutrition, samples were analysed from farms spread widely across the UK and variation was again large. As with last year's YEN Nutrition results (and those from all YENs over years) farm-to-farm differences were again big, explaining >25% of the variation in grain N, grain P and grain K, as well as grain yield. Surprisingly, little variation was explained by soil factors (texture, pH, P, K) either this season, or last season.



From the 2021 harvest, 452 samples were analysed from 111 farms: 270 crops of wheat, 93 of barley, 17 oats, 40 oilseed rape, 11 beans and a few others including, linseed, triticale, and rye. This is a few less than in 2021, but sufficient to improve our understanding of how soils, crops and management are affecting crop nutrient status.

2. Learning more about nutrient 'norms'

We are learning more & more about normal nutrient levels in all the major UK grains (2021 averages are in the table below). N, P & K contents are well known in cereals. %N in feed barley was low this year, suggesting that it was under-supplied with N compared to feed wheat. We are now seeing that other nutrients (like Mn) differ between crops e.g. wheat has almost double the Mn level of barley, whilst wheat has only half of barley's Mo level. Milling wheat crops show greater N:S ratios than feed wheats; beans also have a much greater N:S ratio than other crops, even more than peas, begging the question of whether beans, or milling wheats, would generally have benefited from increased sulphur supplies.

Table showing average grain nutrient levels by crop type analysed in YEN Nutrition in 2021. Differences need to be about twice the SED to be considered 95% certain. Averages & SEDs produced using REML.

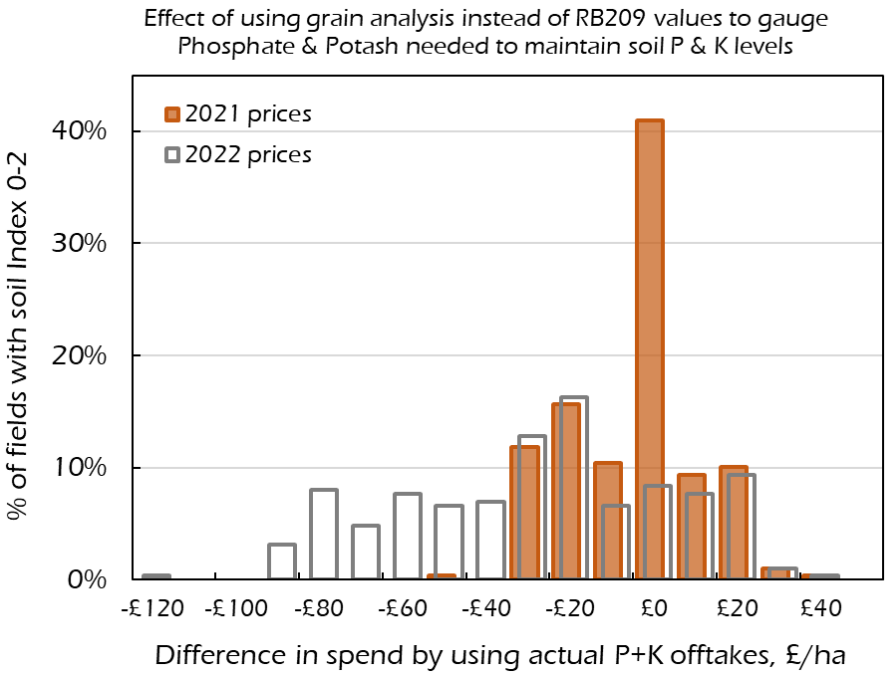
	No.	N[1]	P	K	S	Mg	Ca	Fe	Mn	Zn	Cu	B	Mo
		%	%	%	%	%	g/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Wheat	270	2.02	0.31	0.47	0.10	0.13	0.041	37	29	23	3.8	0.83	0.48
Bread	*102*	*2.21*	*0.33*	*0.45*	*0.10*	*0.13*	*0.046*	*39*	*30*	*25*	*3.7*	*0.86*	*0.44*
Feed	*158*	*1.89*	*0.30*	*0.48*	*0.09*	*0.12*	*0.038*	*36*	*28*	*21*	*3.8*	*0.81*	*0.50*
Barley	93	1.71	0.33	0.56	0.11	0.12	0.058	61	17	25	4.3	0.86	0.98
Feed	*22*	*1.80*	*0.35*	*0.57*	*0.11*	*0.13*	*0.058*	*58*	*17*	*24*	*4.2*	*0.84*	*0.82*
Malting	*39*	*1.65*	*0.33*	*0.55*	*0.11*	*0.12*	*0.058*	*65*	*16*	*26*	*4.7*	*0.89*	*1.10*
Oats	17	2.06	0.37	0.49	0.11	0.16	0.093	73	43	27	4.5	1.14	3.03
OSR	40	3.04	0.59	0.73	0.24	0.36	0.468	65	35	32	3.2	9.29	0.55
Beans	11	4.65	0.52	1.26	0.13	0.18	0.111	56	16	44	14.6	9.19	2.39
SED		0.061	0.013	0.018	0.007	0.005	0.010	4.51	1.75	1.16	0.263	0.202	0.188

3. Accurate P&K offtakes: 60% of entries saved over £100 per field

Average contents of phosphate and potash in YEN Nutrition grain samples have generally been less than standard assumptions (as in RB209), so YEN Nutrition Offtake Reports help to save on P_2O_5 & K_2O costs.

We estimate that the average benefit on land that needed maintenance dressings (soil P&K less than Index 3) exceeded £100 per field in 2021.

The importance of gauging offtakes accurately has just increased massively with the hike in fertiliser prices. The value of P_2O_5 & K_2O taken off an average YEN field (of 12 ha yielding 8.3 t/ha cereal grain) has now reached £1,180, up from £640 at 2021 prices. Potential savings in fertiliser costs from using grain analysis instead of 'book' values are now greater, and much more variable: ***forecasting for 2022, YEN Nutrition now stands to save users over £300 per field just in P&K costs!***

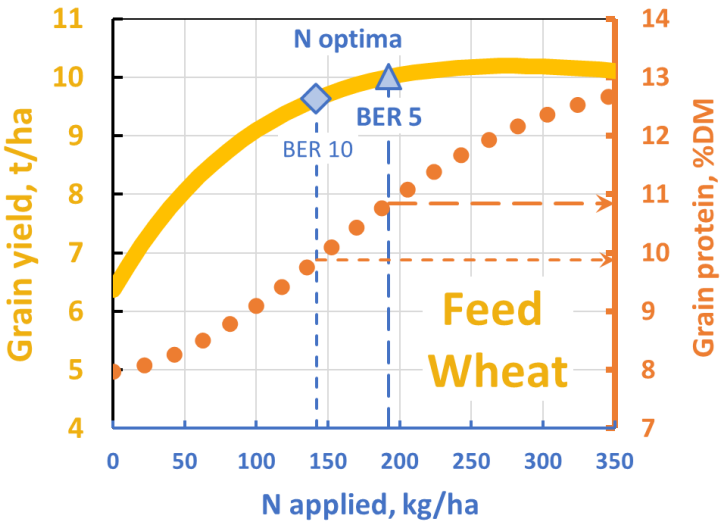


4. 'Thresholds of Concern' ('ToC's) to replace 'critical values'

In 2020, we judged nutrient sufficiencies according to 'critical' values taken from the worldwide literature. However, we could only find critical values for N, P, S, and Mn and only in cereals, plus some less certain values for K, Mg, Cu & Zn. But YEN measurements began in 2016, and we now have '00s of values for *all* nutrients in *all* major UK grain crops. So, in 2021 we have adopted a 'threshold of concern' or 'ToC' for each nutrient in each crop; these are the low quartiles[1] from all crops entered in all previous YENs. ToC values are similar to the previous 'critical thresholds' that we found for cereals, so we assume that these are equally meaningful for all nutrients in all crops, without being exactly the same. Note, these are not proven as indicators of yield limitations, so cannot yet be explicitly called 'critical'.

5. Diagnosing costs of Nitrogen errors

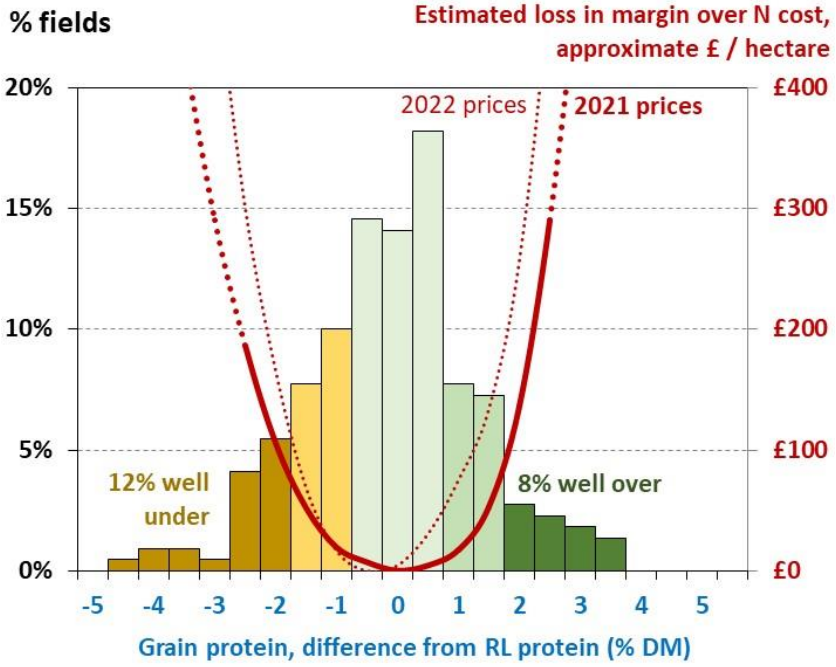
Grain N% (i.e. grain protein %) is very responsive to the crop's N supply; grain yield hardly changes as N supplies become super-optimal, but grain N% continues to respond. We therefore consider grain N% as much the best indicator of whether a crop's N supply was optimal. But protein optima depend on prices: in 2021 optimal N use was set by a break-even price ratio (BER) between fertiliser N and cereal grain of 5. It looks like the BER in 2022 is as much as ~10 for most farms, so protein optima will come down by ~1%.



[1] The low quartile is the value that divides the top three quarters of values from the bottom quarter of values.

We consider that protein contents on the AHDB Recommended List provide the best reference for each cereal variety with optimal N supply (BER 5), because there are ~90 sites in each average and each RL trial should be fertilised according to best current RB209 advice. So, we can look at the deviation in % protein from the RL norm to gauge what the cost of that deviation was, either in unrealised yield (if protein was low) or in excess fertiliser use (if protein was high).

6. Costs of N errors in 2021 .. and 2022?



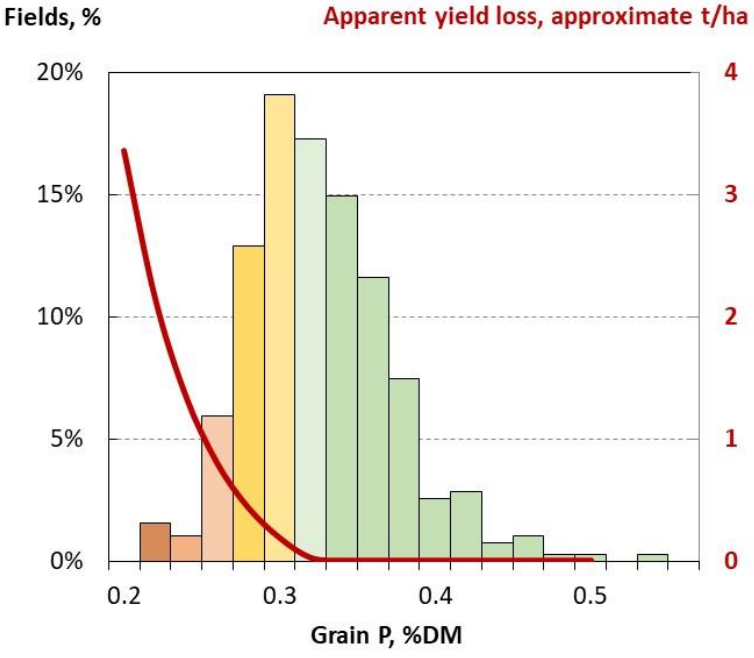
Normal protein responses of 1% relate to a change in total N applied of 50 kg/ha. Protein deviations of ±2% or more (i.e. relating to errors in total applied N of 100 kg/ha or more) cost ~£100/ha or more at 2021 prices.

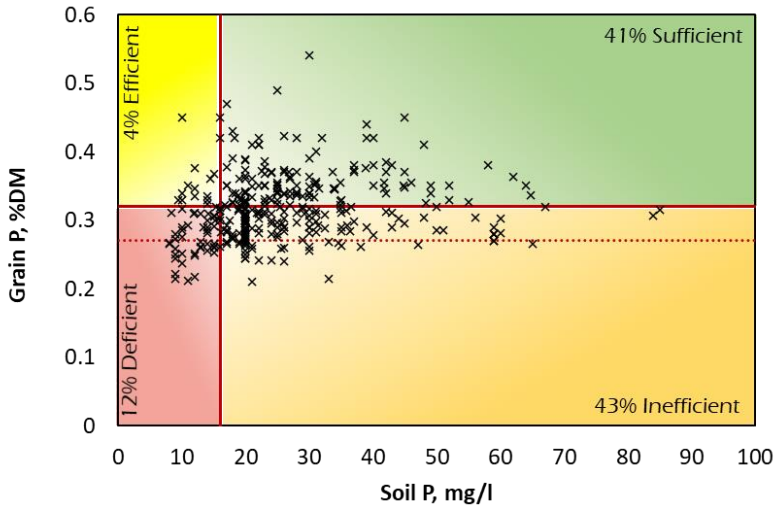
As in 2020, 2021 grain protein deviations were very variable and under-supply was more common than over-supply. Only ~50% of fields had protein levels within 1% of their RL target level, while 80% of fields were within 2% of their RL target; 12% of fields had an apparent N shortfall of more than 100 kg/ha whilst 8% appeared to have exceeded their optimal N supply by more than 100 kg/ha. Overall, this suggests that imprecise N management cost the average farm £63/ha in lost profit. The much higher prices in 2022 mean not only that optima will be less (by ~50 kg/ha) but that costs of N imprecision will be *doubled*! So, lessons learned from benchmarking grain protein levels have just doubled in value!

7. Cost of phosphorus errors

Cereal grain P levels in 2021 varied from 0.2% to 0.5%, i.e., from 4 to 10 kg/t P_2O_5. Only ~50% of fields had grain P of 0.32% or more, indicating that they were adequately supplied with P.

Grain crops store almost all P in their seeds at harvest so P levels in grain are the most telling of all nutrients. YEN crops have commonly shown grain P less than critical level of 0.32% so the new Thresholds of Concern indicate significant yield losses (wheat's ToC at 0.28% suggests a 0.45 t/ha yield shortfall).





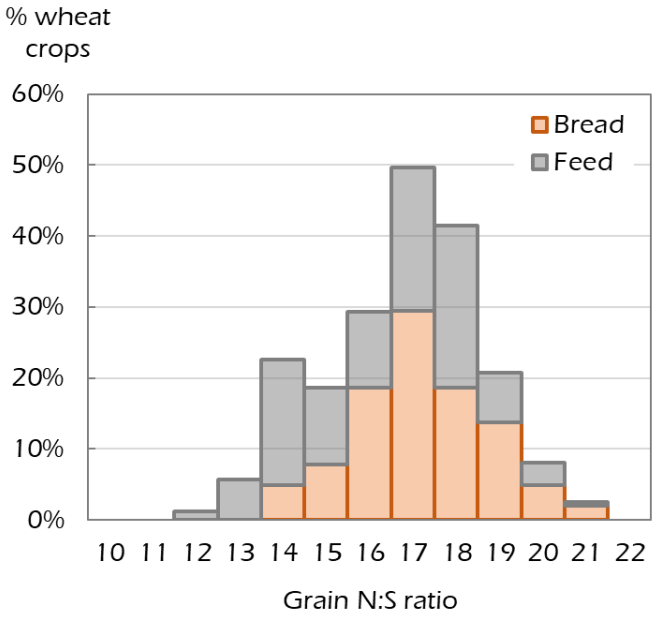
Soil P levels of Index 2 or more (>16 mg/l) increased chances of grain P being adequate but did not guarantee it in 2021 (or any previous year). Farms with low P levels in their latest soil analysis tended to apply more P_2O_5 but this was not associated with increased grain P. We are therefore keen to work with anyone interested in testing any other means of increasing grain P. In 2022 we will be working with several companies to test whether their foliar P products can help.

8. Sulphur

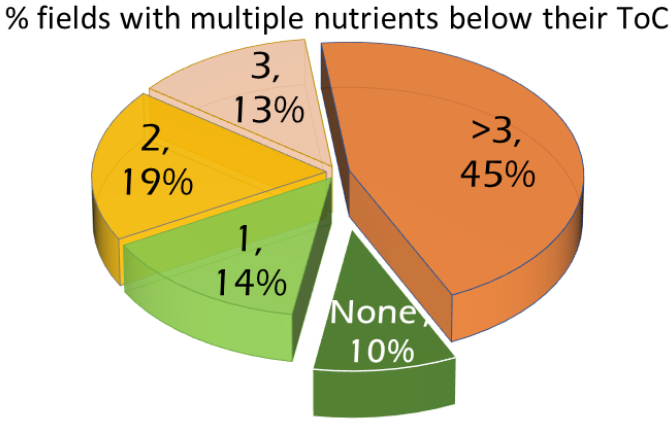
Grain sulphur tended to be low in 2021. Sulphur sufficiency in grain can be diagnosed directly by its S content, or by its N:S ratio – values exceeding 17 are of concern for wheat. Both approaches showed shortfalls in wheat to have been common in 2021, both in milling (40% of fields) and feed varieties (34% of fields).

SO_3 applications (which averaged 50 kg/ha) were not associated with any yield increase although on average crops with S applied showed slightly better S offtake (but only by ~1 kg/ha).

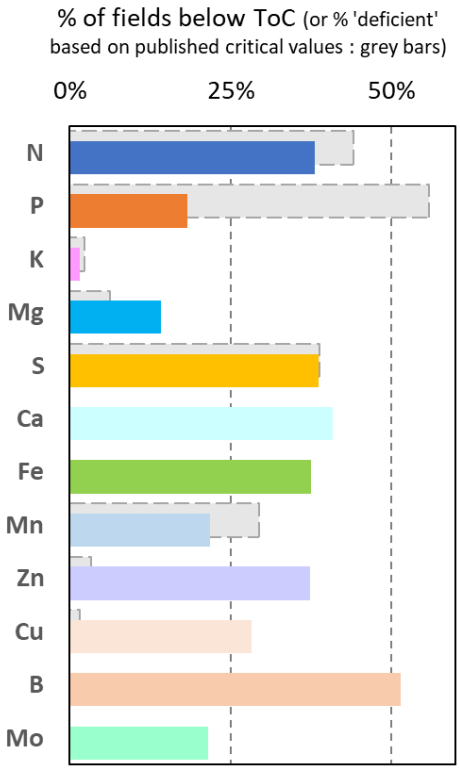
We are learning about S levels in non-cereals now. Sulphur in beans appears remarkably low, with N:S being always >18, and averaging 27 over the last two seasons. It seems that sulphur for beans deserves our closer attention.



9. Multiple deficiencies



Previous YEN reports have showed the prevalence of 'deficiencies' just for cereals and just for the eight nutrients with known 'critical' levels; with 2021 data this approach shows only 23% of fields with no known 'deficiencies'. However, now that we have 'ToCs' for all nutrients in each crop we can see a more comprehensive picture. This shows only 10% of fields had no nutrients below their ToC in 2021 … and more than half of fields had more than two nutrients below their ToC.



Macro-nutrients showing the most commonly low levels were N, P & S. Of the micro-nutrients, iron (38% of fields), zinc (37% of fields) and particularly boron (52% of fields) were most commonly low. As we have little or no idea by how much yield is affected by nutrient shortfalls other than of N & P, we cannot yet say what the costs of these low nutrient levels are, but clearly, they are to be avoided if possible.

Grain analysis results must be interpreted not only by thinking about soil availability but also about nutrient transport to the roots in topsoil moisture and then root capture. Where crops show multiple nutrient shortfalls, it seems most likely that root capture will have been responsible, rather than soil availability.

Crops primarily require nutrients through April and May, when leaf canopies are expanding, and then through June and July (to allow grain nutrient storage without causing premature withdrawal of nutrients hence senescence of the canopy). Dry spring conditions in 2021 are likely to have been responsible where many nutrients showed shortfalls from their ToCs.

10. Let's address our nutrient challenges with more urgency

Lost profits through imprecise nutrient management have been large and are due to double in 2022. With huge prices and new nutrient 'visibility' though grain analysis we must, and now can, refocus. Grain nutrient analysis can now identify whether any particular nutrient has limited the performance of any crop on any farm, so could transform crop nutrition.

Next steps are to confirm farm-specific conclusions and optimise farm nutrition for the future by:

i) testing more fields & crops through all seasons
ii) assessing how grain results fit with soil & leaf analyses and applications of manures, fertilisers, and nutrient sprays,
iii) testing what changes in management practices serve to increase nutrient capture, and whether these also increase crop yields.

'Nutrition Clubs' are now forming to share these steps and test some puzzles, and we are keen to support these initiatives. Please let us know if you wish to find a local group, or to start one of your own.

Contact:

For further information about YEN Nutrition or joining Nutrition Clubs, click here.
And please direct any enquiries to yen@adas.co.uk