End of 'averages' era

Crop nutrition

Making every bit of nutrition count is the name of the game. Results of a five-year study reveals some of the nutritional pitfalls when using averages to predict crop requirements. *CPM* finds out more.

By Lucy de la Pasture

The UK's soil has far greater variability in its structure, nutrient make-up and ability to utilise nitrogen than previously thought. That's the key finding of a major five-year study of nearly 50,000 individual fields carried out by independent agronomic and environmental analysis company NRM.

Many producers striving to boost productivity against a backdrop of greater environmental and sustainability demands are doing so with critically sub-optimal levels of basic nutrients and overall soil quality, says NRM's Dr Sajjad Awan.

"It's been a real eye opener just how variable our soils are and not just between different regions of the UK but also between neighbouring fields on the same farm. Some of this is undoubtedly being driven by climate change, with the wetter and milder winters and drier, hotter summers we're now experiencing affecting soil microflora and biology to a significant degree.

"This points to a reshaping of some aspects of current management thinking, but the analysis also shows following some simple steps can help address many of these issues."

Doing so could improve the soil considerably while making better use of resources, including nitrogen, says Sajjad, who was previously a crop nutrition scientist with the AHDB and responsible for updating RB209 fertiliser guidelines.

"The key is to know where you're starting from and base management decisions around own farm data and not assumptions or generalised information," he says.

"Testing, whether it be soil organic matter, soil nutrient status, nitrogen offtake in harvested crops or for a whole host of other analytics, has to become a routine part of future farm management. Only then will producers be able to make the necessary improvements across a range of management areas that together will combine to deliver real benefits to their business and the environment alike."

Sajjad identifies five key areas from the NRM analysis where growers could achieve significant gains.

"It's been a real eye opener just how variable our soils are and not just between different regions of the UK but also between neighbouring fields on the same farm."

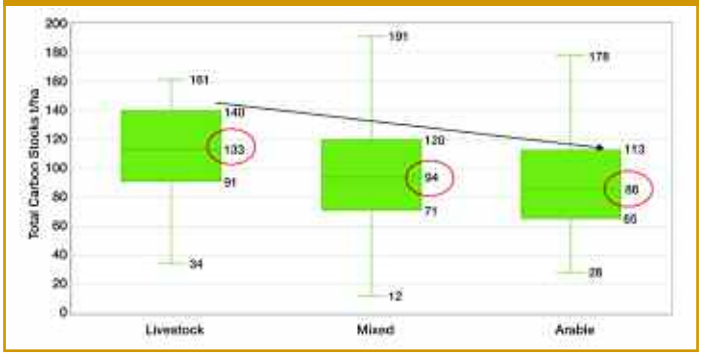
Know about soil carbon levels

Carbon content is a good guide to the overall organic matter of soils and there are so many beneficial aspects to improving this, such as higher resilience to rapidly changing weather conditions by increasing soil water holding capacity, aeration and soil microbial activity, he explains.

"Generally speaking, we're seeing arable land containing 24% less soil carbon than that used for livestock, but within all soils there is tremendous variation."

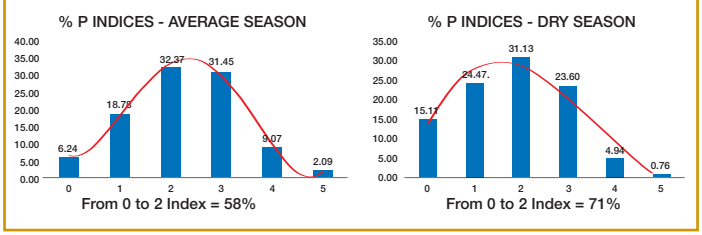
In arable soils, NRM CarbonCheck shows a range from 28-178t/ha for total carbon stock measured at 30cm, with the median being 86t/ha. For livestock, this is about 113t/ha which is close to that of horticultural ▸

Variation in soil carbon



Source: NRM, 2023

Seasonal variation in P indices



Source: NRM, 2023

Variation in organic amendments

	Nit (N) (kg/t)	Nit. (N) (£/t)	Phos (P) (kg/t)	Phos (P) (£/t)	Pot. (K) (kg/t)	Pot. (K) (K)	Total Value	20t/ha applic.
Mean	6.15	16	3.48	7	8.77	11	£34	£680
Max	32.6	82	21.88	42	35.04	45	£169	£3380
Min	1.34	3	0.54	1	0.24	1	£5	£100

Source: NRM, 2023

▶ soils at 122t/ha.

"So, if you're growing crops on land in the lower range on that scale, you'll be struggling. In fact, soil carbon level correlates highly with soil nitrogen content, meaning high carbon soils are likely to require less inorganic N and they will also process any N that is applied more effectively due to the greater activity of their soil bacteria."

Medium to heavy soils tend to have greater soil carbon content than lighter soils but there's much that can be done to lift levels, although this tends to be a long-term project, he points out.

"Using farmyard manure (FYM) and other organic materials can do much to help, as can reducing the number of cultivations, disturbing the soil less and avoiding soil compaction. There's a strong relationship between carbon content and the bulk density of soils, too. The higher the carbon level, the lower the bulk density of the soil and the better protection this gives against compaction," says Sajjad.

"Soils with low carbon content tend to compact more which damages their structure, makes them less water retentive and starves plant roots of oxygen. But you need to know where your fields sit on the soil carbon spectrum. Trying to farm in a manner based on an assumed high carbon content when this is actually significantly less, can not only reduce productivity, it'll damage soils and long-term sustainability too."

Implications of grain nutrient offtakes

While growing numbers are realising the importance of soil testing ahead of fertiliser applications, fewer appreciate the significance of testing nutrient offtake values in the grain post-harvest, believes Sajjad.

"Knowing how much N, P and K, is contained within grain can give you a vital early indication of fertiliser needs for the following season. Again, our analysis shows this varies considerably from year to year and the extent of these changes is highly significant.

"Grain N offtakes measured through NRM GrainCheck at harvest 2022 were around 4% less than in 2021, suggesting more of the applied N has been left in soil so this could be an early indication of less N being required in 2023," he notes.

"Factors during the winter, such as soil temperature and rainfall, can affect overall soil N level subsequently, so it's essential that this is tested at the start of the following year to give the most accurate picture.

"At a time when N prices are so high, understanding precisely how much N is in the soil — soil mineral nitrogen (SMN) and the total soil nitrogen supply (SNS) — can help save on fertiliser bills."

The analysis shows P offtakes were also considerably reduced in 2022, he says. "These were 8% less than in 2021, again suggesting more has been left in the soil than in previous years so soil indices could be higher than you would normally expect.

"There is no point adding more nutrients to crops than is necessary from both production and environmental viewpoints but equally, starving crops of vital yield-enhancing nutrients can adversely affect the economics of production too. With climate change making the factors that affect nutrient availability in the soil more complex than ever, getting an early indication of requirement for the next season through grain offtakes is vital," he says.

"You might consider using more FYM, slurries, and other organic sources than perhaps you would normally, or it could be that it has an impact on your decisions regarding rotations moving forward. But again, if you don't know the values you can't implement the right strategies."

Climate impacts on nutrient utilisation

The drier summer conditions experienced in recent years are creating a greater number of UK soils with indices below 2 for P and K, the analysis reveals.

"Distribution curves for years considered historically 'normal' look very different compared with those of recent years where summer droughts were experienced, with 13% more soils below index 2 in the drier years than in an average year," explains Sajjad.

Met office data for the past five years reveal a trend for drier, hotter summers with many climate change specialists predicting this will become the norm

The right soil pH

The NRM analysis suggests a soil pH of 5.8 to 6.5 is the optimum level for maximum soil respiration rate to take place in most soil types.

"Getting soil pH right is important because our results suggest soil respiration levels, which are a good proxy for soil microbial activity and overall soil health, could fall by 10-15% for every change in pH of 0.5 either side of the kas RB209 suggests the optimum is 6.0 for grassland and 6.5 for arable. The rate of decline in soil respiration if these guidelines are not adhered to has never really been documented before.

"The bottom line is that modern data collection and analysis can improve understanding of individual farming businesses more clearly than ever and contribute hugely, both to greater productivity and future sustainability.

"The era of 'farming by averages' is rapidly coming to an end as new individualised precision technology takes over," he concludes.

in the years ahead for the UK.

"If this is the case, we may well have to rethink key nutrient strategies. Water is essential to drive most chemical reactions, and this is certainly the case with soil microflora which do much of the work involved in making nutrients available to plants.

"Mineralisation of phosphorus in the soil is much reduced under drought conditions and this is reflected in our analysis, with the distribution curve visually skewed towards the lower indices."

Increasing soil organic matter helps soils retain moisture better and hold key nutrients more effectively whilst building vital resilience to future droughts, he explains. "But drier, hotter summers will also affect the time it takes to improve the carbon content of soils. Whereas it might have been possible to improve this by 1% in five years previously, this could take six or seven years under drier and hotter conditions.

"Again, minimising ploughing and disturbance of the soil will help get the biology working to its full potential, as will the use of FYM and other organic sources of nutrition," he comments.

As well as the effects of drought on P and K indices, the analysis also highlights the wide range of these nutrients in UK soils, he adds. "Overall, phosphorus ranges from 4mg/l to 57mg/l, Index 0 to Index 4 respectively. Potassium ranges from 19mg/l to 362mg/l, Index 0 to Index 3 respectively, so you just can't estimate these with any accuracy at all."

Organic manures are highly variable

The NRM analysis shows the contribution of FYM and slurry to farming systems is much more variable than previously thought, with some applications contributing just 3% of that from others.

"The differences are of a magnitude I don't think anybody was expecting," says Sajjad. "Focusing on N, P and K alone — all of which are roughly the same in terms of cost/kg at the moment — shows that a 20t/ha application ranges from £100 to £3300 in terms of nutrient value.

"It's another great example of how working with average values and making management decisions based on these can be so damaging to production and profitability," he says.

"With organic materials increasingly seen as an essential means of reducing the use of bought-in inorganic fertilisers and building soil carbon content, such variability makes getting the most out of them very challenging if you don't know exactly what you have."

The era of 'farming by averages' is rapidly coming to an end as new individualised precision technology takes over, believes Sajjad Awan.

Sajjad suggests relying on the average values in RB209 is rapidly becoming a thing of the past. "We're increasingly realising all farms are different and so too are the organic nutrient sources they produce. Underestimating nutrient content from these sources could result in significant ▸

▸ over-application, with potential impacts to the environment.

"On the other hand, over-estimating can lead to crops being left critically short of vital nutrition with neither situation being acceptable. Routine testing of organic nutrient sources is the only way to make the right decisions around how they can be integrated into crop production plans to the greatest effect."

Don't overlook magnesium

The NRM soil analysis shows 25% of UK arable land is below Index 2 for magnesium, which means many UK growers are trying to maximise production with a hugely important nutrient in limited supply.

"Magnesium is essential in the production of the chlorophyll that drives photosynthesis, enzymatic activation and protein synthesis. It's at least as important as P and K, yet all too often gets overlooked. Even if you have everything else spot on, low Mg will suppress plant metabolism, health and production."

The analysis shows Mg levels in UK soil ranging from 12mg/l to 210mg/l, Index 0 to Index 4 respectively, so similar variability as the other key nutrients.

"Excessive application or presence of potassium can result in low uptake of Mg. Similarly, high concentrations of ammonium in the soil can also reduce the uptake of magnesium. This affects lighter soils more than heavy, clay soils," explains Sajjad.

"FYM and other organic sources are a good source of Mg but should be checked to make sure you know what you have available and can amend your crop nutrition strategy accordingly." ■

New test unlocks importance of carbon

A new soil test for carbon has just been launched by Eurofins Agro UK, using near infrared spectroscopy (NIRS) to measure organic matter. According to Eurofins' Sophie Cath, the information it provides will help farmers make more accurate decisions to reduce CO_2 emissions and sequester more carbon.

"For the first time, farmers will be able to use accurate carbon data to chart soil health. This will help decide crop rotation, the use of nitrogen-fixing cover or break crops, and the quantity of organic and non-organic fertilisers."

The test will provide data on how much carbon is sequestered in the soil, how much organic matter is stable or dynamic, what inputs can be used to improve the carbon sequestration potential of the soil, and how those inputs are likely to impact on the crop.

"Carbon is a key indicator of soil stability and fertility. Understanding how carbon fluctuates is the key to balancing the amount of carbon, nitrogen, and other soil components. Understanding the carbon to nitrogen ratio is critical to soil stability because it helps to indicate what levels of nitrogen and other inputs are sustainable for the soil," she adds.

The speed at which organic matter degrades determines the nutrients released to a crop. The higher the breakdown, the more nutrients are made available. This data is captured in the tests to help indicate what inputs will benefit the crop and what needs to be put back into the soil to improve carbon sequestration.

Sophie explains that reaching this optimum level for a crop within a rotation can be better gauged by first understanding the active organic carbon content: "We know that adding N stimulates growth. However, the C to N ratio is crucial to accurately evaluating the stability of organic matter and the speed it's broken down. By better understanding this, we can manage soil carbon sequestration more accurately," she says.

"The new test is a powerful tool that can tell us how much carbon is being sequestered in soil, how stable that carbon is, and how we can improve carbon sequestration over time. This can help agriculture to meet carbon targets while also lowering costs and improving yields," she concludes.

By better understanding the C to N ratio, the stability of organic matter and the speed at which it's broken down, it's possible to manage soil carbon sequestration more accurately, says Sophie Cath.