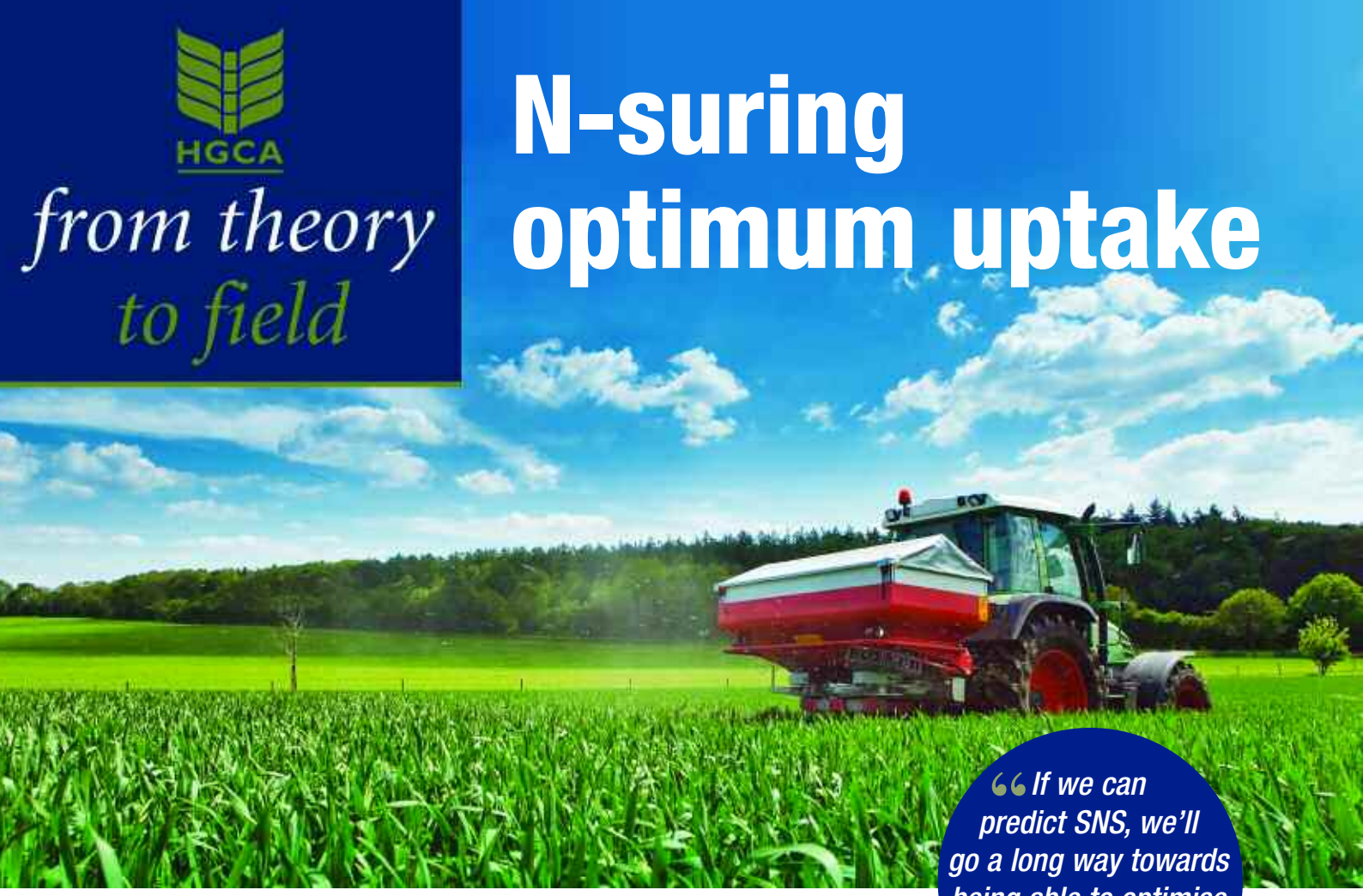
HGCA

from theory to field

N-suring optimum uptake



> *"If we can predict SNS, we'll go a long way towards being able to optimise the amount of applied N."*

A major HGCA-funded project has brought a step change in industry understanding of soil N supply. In the first of a new series, *CPM* finds out what the project has achieved for growers.

By Tom Allen-Stevens

It is, perhaps, one of agriculture's ultimate questions: how much nitrogen fertiliser should growers apply to achieve the most profitable crop? All growers make a judgement on this, but they can rarely know whether these judgements are actually right.

Understanding the dynamics of what's happening in the crop and in the soil is what's really needed to judge how much N is required.

A key factor in this is soil nitrogen supply (SNS) — the N that's available to a crop from the soil through its lifetime. It's well documented that this varies between fields, cropping situations and years. But ensuring there's a reliable method to predict or measure SNS has been the subject of much debate within the industry recently.

Providing some confidence has been the main aim of a major four-year, HGCA-funded project (see panel). "The first step was to define what's the best ultimate measure of SNS," explains HGCA Research and Knowledge Transfer Manager, James Holmes.

"There's an amount of N that the crop needs to take up to reach its yield potential — the Crop N Demand. Of that, there's an amount that will be drawn from the soil — the SNS. The balance between Crop N Demand and SNS is the supply the crop needs from applied fertiliser.

"SNS explains a lot of the variation in N requirement between fields, situations and years, but won't explain all of it — it's part of the N story, but generally the most important part. So if we can predict SNS, we'll go a long way towards being able to optimise the amount of applied N."

The research team, led by Daniel Kindred, from ADAS, used measurement of the N that gets into an unfertilised crop by harvest as the ultimate measure of SNS, and has given this a new term — the harvested SNS. "This is the key figure we want to know because it's the amount of available N in the soil that the crop actually takes up during the course of the year, "explains Daniel Kindred. "But what's the best way of predicting this before fertiliser decisions are made in spring?"

Currently, there are two different approaches. The field assessment method (FAM) uses standard figures from RB209 to give you an estimate of SNS, based on soil type, over-winter rainfall and previous cropping. "Most people use FAM, and it's the standard way to assess SNS, whether you use software, such as PLANET, or a recommendation from a FACTS-qualified adviser. But this gives an average for a wide range of possible values."

Alternatively, the so-called "gold standard" approach is to use soil mineral nitrogen (SMN) testing, whereby cores are drawn from the soil in autumn or spring, up to 90cm depth, and tested in a laboratory for ammonium-N and nitrate-N content.

"The perception in the industry has been that SMN testing is unreliable, so we wanted to bring some confidence in the testing regime," explains Daniel Kindred. "Throughout the project, we were keen to achieve a best-practice consensus from across the industry."

Over the course of the project, new data was drawn from more than 180 ▸

Bringing confidence to the SNS testing regime has been one of the main aims, says Daniel Kindred.

▸ cereal sites across the UK, with a range of soil types, rainfall, previous cropping and manure histories. At each site, autumn and spring samples were taken and tested for SMN. The unfertilised crop was hand-harvested to determine its N uptake — the definitive harvested SNS. This allowed the research team to compare the measured SNS in autumn or spring with the harvested SNS.

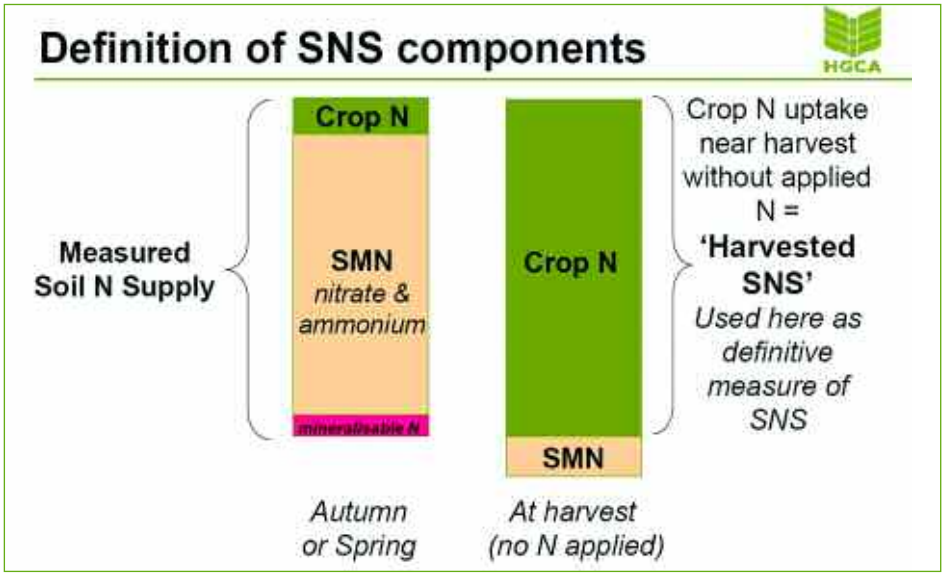
"What we found was that spring sampling generally gave better results than autumn sampling, although the differences were quite small. Overall, SMN measured in the spring tended to underestimate harvested SNS, while the autumn tended to be an overestimate."

Large SMN values can over-predict harvested SNS, the project team found. "Treat estimates greater than 160kg/ha as 160, unless field experience suggests otherwise," advises Daniel Kindred. The same is true of low SMN values, with 50kg/ha being the minimum predicted value.

"In autumn, you only need to sample to 60cm depth — any N in the deepest 30cm at that time is unlikely to reach the crop, so sampling to 90cm will give you an overestimate. In spring, sampling to the full 90cm depth gives best results. The relationship between SMN and harvested SNS was strongest on clay or silt soils, and worst on light and shallow soils."

Sampling methodology was also studied. Variation between labs was assessed through ring-testing, whereby identical samples are tested in different labs. "We concluded this was not a major source of variability in results."

But treatment of the samples themselves was found to be a potential problem. "As soon as the sample is



Research round-up

HGCA Project 3425, Establishing Best Practice for Estimation of Soil N Supply, ran from Nov 2007 to Nov 2011. Its aim was to achieve consensus across the industry on best practice for estimation of soil N supply (SNS), and its total cost is £390,000.Project partners are ADAS, NIAB-TAG, SAC, HDC, PGRO, GrowHow, Eurofins Laboratories, NRM and Hill Court Farm Research.

HGCA Project 3530, Automating nitrogen fertiliser management for winter cereals, runs from Jan 2010 to December 2014. Its aim is to develop validated, commercially viable systems for automated, fine-scale adjustment of fertiliser N use on autumn-sown cereals. Total cost is £1,440,000, of which HGCA is contributing £180,000. Project partners are Defra, Sustainable Arable LINK, ADAS, Rothamsted Research, NIAB-TAG, Soilessentials, SOYL, Yara, Masstock, Ag Leader, Zeltex, Hill Court Farm Research, BASF, FOSS, Precision Decisions and Farmade.

More information on all HGCA-funded crop nutrition research projects can be found at *www.hgca.com/research*.

taken, N mineralisation will accelerate, so speed and temperature in transit are very important."

On average the measured SMN increased by 2.5kg/ha for each day the test was delayed. If stored in ambient conditions, the variation was greater, but even when refrigerated, the apparent SMN of samples increased in just a few days.

"It's therefore crucial to keep samples cool during storage and transport, and to analyse them within three days. Put them straight into insulated packaging and use a reliable courier and analysis service. But don't freeze samples as the SMN still increases. And don't send in samples on a Thursday or Friday, as they may sit in the lab over the weekend."

Out in the field, the standard W pattern is adequate for sampling points for SMN, with 10-15 cores generally sufficient to represent a field, advises Daniel Kindred. "You may want to do more if SNS is expected to be high or very variable, or if the field is large. But try to avoid mixing the sample too much — we found this did little to improve the degree of accuracy and could actually accelerate mineralisation."

Oilseed rape crops were also analysed. "We wanted to assess the relationship between N stored in the crop and SMN. We know there can be up to 100kgN/ha stored in the crop by spring in some of these large, over-wintered canopies. So how efficiently is that N stored?"

Crops were set up with small and large canopies in the same field. Plants were hoed out or fleeces used to create the small and large crops, with 28 comparisons made over three seasons. SMN and crop N were measured and compared with harvested SNS.

"We found that N in the crop — whether cereal or OSR — is equivalent to N in the soil, so crop N should be estimated at the time of SMN sampling and included in the estimate of SNS. OSR is also quite efficient at remobilising N from dying leaves, with little N being lost." ▸

Sample to 60cm depth in autumn, but to the full 90cm in spring.

The research is building up a picture of how N monitoring can be used as an essential tool in managing N.

▸ When comparing SMN with FAM, the researchers looked at two criteria: how accurate the method tended to be on average, and how reliably it predicted a variation — a high or low SNS. This was assessed in terms of kg/ha and profit foregone through getting it wrong.

Improvement

Any method of assessing SNS was better than using none, the project concluded, although no method was perfect. With fertiliser use based on FAM, margins over N were within £10/ha of maximum on 69% of fields. This could be improved to 75% of fields by using SMN. But the costs of SMN testing are only likely to be repaid in situations where there is most uncertainty, and where SNS may be large.

"When using FAM, we found it was only accurate as long as the soil type, soil organic matter and field history were defined accurately. So those relying on this method need to know their fields fairly well," notes Daniel Kindred.

"It pays to underestimate SNS a bit — by about 10kg/ha — because lost yield costs more than wasted fertiliser. The accuracy of SMN can be improved by adjusting the results for additional available nitrogen (AAN), that may be released after soil analysis, and for leaching."

So over 'normal' arable sites where the cropping history is known, and on most mineral soils that have been in a long-standing arable rotation, SMN is unlikely to be worth the expense, advises Daniel Kindred, except perhaps on a few fields to gauge how SNS levels on the farm relate to the national picture.

"More benefit is likely where manures have been used, in fields coming out of grass or high-N vegetable crops, or where the cropping history is unclear. Here, the 'best' SMN method can bring an advantage of £8/ha over FAM, before sampling costs."

The conclusions from the project are being used to further develop understanding of crop N requirement. "We've shown that SNS is perhaps the most important component, but it's not the only one — crop N demand and fertiliser N recovery are the others."

Another five-year project, that started in January 2010, is getting a better handle on the relationship between these components, and how they vary within a field. The Auto-N project is using information from precision-farming technologies to work out how to predict SNS and crop N demand, and so help growers manage N fertiliser better between and within fields.

"We've shown in the Auto-N project that canopy sensing in early spring can relate closely to differences in SNS within a field, so this may give hope for better ways of predicting SNS for the future."

The research is building up a picture of how N monitoring can be used as an essential tool in managing N. "We have to accept that we won't get the N requirements precisely right in every field. The important thing is that we get it right on average across the farm over years and identify any fields that behave very differently.

"This is where N monitoring is important, and precision farming provides some excellent new ways of monitoring crops. Through the Auto-N project, we're working out how they can be put to best use," concludes Daniel Kindred. ■

Holding back on N could pay dividends

The mild and dry conditions this winter are prompting many growers to consider starting fertiliser applications early, with the perception being that this will improve the chances of crops withstanding prolonged periods of dry weather.

But holding off in large overwintered oilseed rape is a strategy that has paid dividends for Wilts grower James Stafford. He uses GrowHow's N-Min service to estimate SNS. This measures both the nitrogen in the soil at sampling and the AAN (Additionally Available Nitrogen) that will become available through mineralisation over the growing season. "We found our nitrogen bill could be cut substantially by taking account of all the nitrogen that will come from the soil. In this case we were able to halve applications to our oilseed rape crop."

With 145ha of arable crops on Cotswold brash and silty clay loams near Corsham in Wilts, James Stafford admits his previous policy on assessing crop N requirement was "really quite basic".

"We just used RB209 and didn't really take into account the manures we were using." With 250 beef cattle this was applied every year, while much of the farm receives biosolids.

Tightening legislation and a desire to get more value from the manure prompted him to take a closer look at SNS. "If there's no benefit, what's the point in putting the manure on?"

In the first year, he was sceptical and didn't make any adjustments. But in year two, testing revealed an N reservoir of 97-132kgN/ha. "We dropped the level of applied N on the oilseed rape down from 180kgN/ha to 100kgN/ha and it still yielded 4t/ha."

In 2011, his Eiffel and Cabernet OSR received just 80kgN/ha. "We left it as late as we could, just going at the green bud stage to get the yield."

This year, his wheats, Conqueror and Santiago, won't receive the early March dose of 40kgN/ha. The 160-180kgN/ha total dose will be split between the early April and early May doses. "If we needed a late dressing, we could apply that instead of the early one."

James Stafford halved N applications to his oilseed crop as a result of N-Min testing.

N-Min sampling is now carried out annually, with samples taken from land that has received manure compared to a reference sample. "It's important that it's done properly and that the results are interpreted correctly. Ours were taken by GrowHow and then despatched straight off to the lab. It's vital to get a consistent method, too, so that you can get a reasonable year-on-year comparison."