Technology-driven soil insights

New technology-driven tools are emerging to help improve understanding of what's happening beyond immediate sight, to reveal more about the behaviour of agricultural soils. *CPM* takes a closer look at two of these innovative solutions.

By Janine Adamson

Widely acknowledged as a topic where human understanding remains somewhat limited, means soils have become an obvious target for technology developers looking to innovative and make an impact.

And while not all of these solutions will successfully land in the hands of farmers, some, with a little assistance from those willing to screen and provide practical input, have every chance of being available in the near distant future.

One such prospect promises to help farmers fine-tune in-season fertiliser applications by sensing nitrate levels in the soil. However, what makes this different from other comparable solutions is two-fold, comments James Waltham of PlentySense.

"The sensor works at three depths linked to the crop root zone – 10cm, 20cm and 40cm – to understand how nitrate moves through the soil profile.

Greater understanding

By quantifying nitrates as they travel through the soil profile, there's the potential to optimise fertiliser applications and improve efficiency, says PlentySense's James Waltham.

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JAMES WALTHAM

Equally, because this is a continuous measurement, we can provide real-time data which can be used by farmers and agronomists to inform in-season fertiliser programmes," he says.

A spin-out from the John Innes Centre, PlentySense was initiated following a research project to screen different cultivars for nutrient use efficiency, but the team soon realised it had applications beyond research.

While undertaking the research, it became apparent that it was difficult to gain real-time measurements of nitrate in soil. This then led to the development of the solid-state sensor, based on a 'chemical cocktail' which identifies nitrate ions, explains James.

"This is then converted and expressed as nitrate availability, before being amplified via Internet of Things (IoT) technology to a dashboard which can be accessed for live monitoring."

By working at three depths, the sensor probe can indicate whether soil-applied fertiliser has moved beyond the crop's root zone and is therefore wasted. This information is valuable because a lot of plant nutrition isn't utilised by the crop, highlights James.

"But by quantifying nitrates as they travel through the soil profile, there's the potential to optimise fertiliser applications and improve efficiency. Not only does this avoid waste and maximise crop profit, it can also help to reduce the environmental impact of synthetic fertilisers."

However, optimising doesn't always mean a reduction in applications, suggests Agrii's Jonathan Trotter. Following six years of Agrii trialling the PlentySense technology, he believes its place is to inform decision making.

"Optimising could in fact mean increasing fertiliser applications; it's about what's best for that individual crop in that specific scenario," says Jonathan.

During the trial process, Agrii has been working with PlentySense to ground-truth the data, tweak the technology and iron out any problems. The aim has been to prepare the sensor for commercialisation by making it 'farm fit', he adds.

PlentySense has also been showcased at recent Agrii Digital Technology Farms open days, garnering positive feedback thus far.

In terms of next steps, official launch is pending but should be during 2026, says James. "The plan is to offer a ▶

E-nano penetrometer
This sits on the back of a quad bike and spears down to a depth of 60cm, measuring the pressure as it travels through the soil profile, explains Rhiza's Ben Foster.

subscription service where users pay an annual fee and receive continual support. Not only will this ensure the technology is working and being used, but that the data is utilised effectively.

"Data collected will remain secure, used only to inform the system and perhaps in the future, train AI as the technology develops further into the realm of predictive monitoring."

He believes innovation is key when it comes to helping farmers to make more of crop nutrition. "Ultimately, the way fertiliser is applied hasn't really changed for many years, but the technology to monitor it has.

"PlentySense presents an opportunity to go beyond RB209 to truly meet crop needs while targeting input use more effectively."

While PlentySense could be on-farm within months, a solution taking its first steps into the world of agriculture is a quad bike-mounted soil penetrometer from robotics company, E-nano. Originally developed for sports surfaces such as golf courses and football pitches, the company spotted an opportunity to branch out by working with agronomists.

This led to a new relationship with Agrii, explains Rhiza product manager, Ben Foster. "E-nano offers a range of autonomous robotic solutions for the amenity sector, to help paint a picture of field health and condition.

"Where we come in is by helping E-nano to develop its soil penetrometer technology. Within an agricultural setting, the penetrometer sits on the back of a quad bike and spears down to a depth of 60cm, measuring the pressure as it travels through the soil profile," he says.

"Using a GPS receiver, this is then uploaded to a platform. As that process is repeated across a field, a map is produced which indicates compaction levels from worst (red) through to best (green)."

As well as providing a top-line summary of field compaction, the penetrometer also records several data points during each reading, which are banded against soil depths. "For example, the data could suggest at 20cm compaction really ramps up, we can then interpret that accordingly and take appropriate action at the relevant soil depth," adds Ben.

Compared with conventional penetrometer methodologies, there are various benefits, he believes. "The E-nano system provides a significantly greater number of data points, and importantly, these are consistent because it's electronically-driven, thus removing any human variance. Furthermore, the automatic data upload means reduced admin and time at a computer."

In terms of technology readiness level, it's still early days, he raises. "This is the first time it's been used in agriculture; the technology is ready as proven in the amenity sector, but the delivery mechanism to make it effective within an agricultural scenario still requires more work.

"If we can get this right, it would mean growers can target cultivations better and be more efficient in time and fuel useage, by mitigating equipment breakdowns and of course improving rooting conditions for the crop. There's also the potential to link to developments within the machinery industry, as manufacturers strive to make variable depth cultivations a reality."

Drone-applied pod sealant

First UK trial sees Pod-Stik applied to beans by autonomous drone

A trial has demonstrated that drone technology can successfully deliver pod sealant in field beans. The work, conducted on 16 July at Park Hill Farm in Cambridgeshire, saw Pod-Stik applied to a 10ha crop of Tundra winter beans.

Host grower, Richard Cobbald, says he's impressed with the results. "This is the best bean crop we've grown in more than a decade – we've set pods all the way from the top down to 15cm above the ground. With that kind of potential, I'm keen to keep every kilo in the combine."

The trial is a collaboration between De Sangosse and AutoSpray Systems. De Sangosse's Rob Suckling believes in beans, pod shatter is often underestimated. "Pods become brittle in hot, dry conditions and losses can be extreme – up to 50% in some cases. Combines hitting ripe pods can scatter beans that are impossible to recover.

"Unlike oilseed rape where pod sealants are increasingly routine, beans haven't had the same attention. But in fact, pod protection is vital to safeguard yield."

Using UV tracer dye to assess droplet deposition, the field trial demonstrates that drone application at 100 l/ha achieved deep penetration – including the lower pod zone where ripening begins and shatter risk is highest.

But what sets this apart is not just depth of coverage, but the precision, believes Rob. "We saw droplet deposits on the undersides of pods, especially those lower down – a target that conventional boom sprayers struggle to reach due to their horizontal spray angle and lack of directed airflow."

He adds that boom sprayers may need 150 l/ha or more to push spray into the lower canopy, but even then, they can't lift droplets underneath the pods where the seam requires sealing. "The drone achieved that at 100 l/ha," he points out.

It's understood this is because the drone's rotor-induced downwash creates a vortex effect, swirling droplets under the pods.

Equally, coverage quality wasn't compromised by speed neither was there an increased drift risk, states Robert Pearson of AutoSpray Systems. "The rotor downwash forms a stable column of air that reduces drift and improves droplet placement, even at speed."