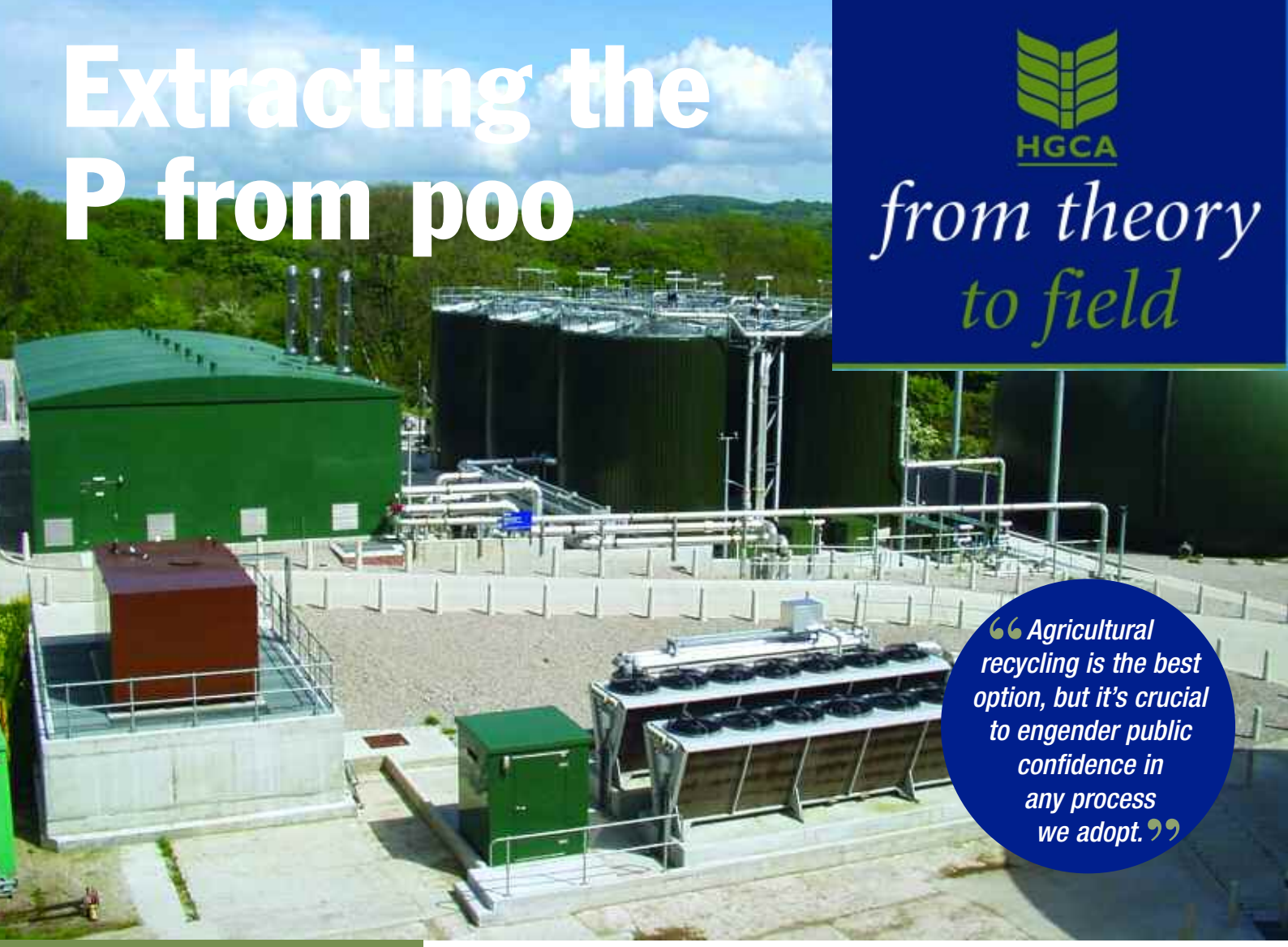
Extracting the P from poo

HGCA

from theory to field



> *"Agricultural recycling is the best option, but it's crucial to engender public confidence in any process we adopt."*

A major pan-European project is underway to develop new processes to turn sewage sludge into safer, more useful agricultural fertilisers. It also includes a crucial focus on changing public perception.

By Tom Allen-Stevens

It builds organic matter, and provides a valuable and natural source of cheap crop nutrients. But there's no getting away from the fact that sewage sludge is human excrement. So while recycling to agricultural land may be the obvious solution, management of the waste that society flushes down the drain will always carry with it a host of issues that need to be addressed.

Many of these are being tackled through the END-O-SLUDG project. This is a pan-European collaborative research initiative involving 14 industry, government and academic partners. The three-year, €5.4M project, funded mostly by the European Commission, started in Jan 2011, and could radically change how sewage sludge is both perceived and used right across the EU.

Disseminate findings

"Sewage sludge is a fantastic resource, and the technology exists to bring it to farmers in a much more practical and effective form," notes James Holmes of HGCA. "Our role in the project is to disseminate findings to both farmers and end users. There's no cost to levy payers — the work is paid for by the European Union and the consortium of partners.

"At the heart of the project lie various new ways of treating the sludge, the derivatives and how the market for the products can be developed. At present, it's a resource available only to farms within a relatively short distance of a treatment works. But by developing new products, it will become more widely available."

Part of HGCA's role is to address end-user acceptability of sewage sludge. "Part of the industry still has concerns about the use of biosolids."

United Utilities new enzymic hydrolysis plant at Blackburn allows sewage sludge to be produced that is free from pathogens so that it can be used with confidence as a soil conditioner. It also produces 40% more biogas, used to generate power for the plant and to export.

In 1998 UK water companies and retailers made an agreement, known as the safe sludge matrix, on how sewage sludge could be safely applied to agricultural land. It involved phasing out the use of untreated sewage, and guidelines and limits for specified crops. Although it was a big step forward at the time, paving the way for most sludge in the UK to be disposed to agricultural land, a number of issues still remain, according to Dr Son Le, of United Utilities, who is leading the END-O-SLUDG project.

"In the UK alone, 1.5Mt of sewage sludge must be disposed of every year. Across Europe, this figure is 9.4Mt, which creates a real challenge. The option to dispose at sea was banned in 1998, while landfill stopped due to changes to the landfill regulations. 20% is incinerated at present, but that's not an attractive option to the general public.

"Agricultural recycling is therefore the best option, but it's crucial to engender public confidence in any process we adopt."

And on the public confidence scale, sludge is not a great material to work with, he acknowledges. "Firstly, it stinks. Often it's spread on urban fringes, and because it's an organic human waste, there's a risk of odour nuisance. So the industry has invested in digesters, that accelerate the breakdown of organic material. The biogas has an energy value that can be used for heating and electricity generation. So processed material now has a much lower odour."

There's then the perceived health risk, continues Son Le. "Again, this has now been addressed through the Safe Sludge Matrix. Pathogens such as *E. coli* and *Salmonella* can be spread through untreated sewage, and the 2001 foot-and-mouth outbreak highlighted the biosecurity aspect of material of food origin that's returned to agriculture. The industry now works to strict treatment standards to ensure sludge is safe to spread."

Heavy metals are another issue, he says. "This is down to material from industrial processes that can enter the waste stream through faulty systems, for example. Sometimes sludge can contain contaminates, such as PCB (polychlorinated biphenyl — a persistent organic pollutant used in the electrical industry, but now banned). In the past 20 years, the level of industrial pollutants has halved. But it's still high enough to cause concern, so we address this through a code of good practice.

The END-O-SLUDG project will help bring to market new organo-mineral fertilisers derived from sludge, says James Holmes.

"Soil samples must be taken where sludge is spread, and it's not applied where the pH is less than 5.5 — as this would tend to mobilise any heavy metals. Soils are then monitored to ensure the heavy metal content doesn't build above acceptable limits."

Finally there's the issue of phosphates, he continues. "This is becoming an increasing problem for the water industry as EU standards on water quality tighten and the threat of NVZ-style restrictions loom. For its nitrogen content, sludge contains about twice as much phosphate ▸

Research round-up

END-O-SLUDG is a collaborative research project that runs from Jan 2011 to Dec 2013. It aims to reduce sludge volume through using innovative techniques in the sewage treatment processes; to develop processes that increase biogas yield and combat the resurgence of the pathogen indicator in the sludge products; to create a portfolio of high quality sludge products; and to develop energy-efficient techniques to support the move towards a low carbon economy. Total cost is €5,464,646 of which the EC contribution is €3,456,872.

The 14 partners are United Utilities Water, Nijhuis Water Technology, Waterleau, Teagasc, Hipsitec, Universidad de Oviedo, Cogersa, Cranfield University, Harper Adams University College, HGCA, Carrs Agriculture, Sustainable Resource Solutions, Valsave Engineered Solutions and Demeter Technology. For more information, go to www.end-o-sludg.eu.

Sewage sludge has nutrient and organic-matter value, but is bulky to transport and spread, and there are public perception issues with its use.

▸ as crops require, which raises the risk of phosphate pollution.

"The problem is worse in the non-arable areas of the UK, such as the north west of England. The high percentage of pasture land means the soils are already naturally high in P, and farms have their own manure and slurry to spread. So the area of suitable agricultural land on which to spread a high phosphate material is limited."

There are also practical issues to address, says Son Le. "As a fertiliser, it's inherently difficult to use because only about 25% of the N content is readily available — the rest is released over 10 years, and its release is unpredictable, making it very hard for farmers to judge how much N they're getting.

Transport cost

"Then there's the bulk itself — it's very costly to transport, and there's only a narrow window when you can spread it. For the rest of the year, it needs to be stored safely, in a way that poses no risk to the environment."

What the researchers have found, however, is that there's a host of new technologies that can address many of these practical and public confidence issues.

"The novel systems exist, and in some cases, these are already being used to good effect in some parts of Europe and elsewhere. We're evaluating these systems and refining them, so they're more widely adopted and bring value to the water companies who develop their processes. Farmers will also benefit through a better range of organo-mineral fertilisers on offer."

One example is a process that produces a cake that's a quarter of the volume of the traditional sludge that turns up on farm, he continues. There's also the Ostara process that produces Struvite from wastewater. This process removes up to 90% of the P and 40% of the ammonia from wastewater, into a granular fertiliser product, with a typical NPK content of 5:28:0.

"Pilot trials of these products have already shown results either equal to or better than conventional mineral fertilisers in terms of agricultural benefits. They just need refining to make them more available and commercially viable."

The real challenge, however, is better separation of sludge and nutrient particles from the waste stream, to deliver safe water back to the environment and useful products to farmers. "What's really exciting are some of the novel techniques the END-O-SLUDG scientists are working on."

These include Dissolved Air Flotation (DAF), a system which exploits the

Trials hope for new organo-mineral fertiliser

The product currently under investigation at Tile Farm, on the outskirts of Chester, is quite different from the treated sludge farm manager John Benson used to apply to his crops. There's a United Utilities sewage treatment works just four miles down the road, that previously supplied him with biosolids.

"It's good stuff, and we used to make regular applications. But the main reason we're not applying it now is that we're growing for a premium market."

There's 320ha of arable crops at Tile Farm, with winter wheat and oilseed rape rotated around the sandy clay loams, some of them shallow over sandstone. Gallant, Cordiale and JB Diego are grown, with the quality wheat going to a number of premium markets that lie on the doorstep. Contract restrictions mean biosolids haven't been applied to crops for around seven years.

But for many years previously, the farm had taken the waste stream from the treatment works, benefiting from its free nutrient value. Most recently this had arrived as treated sewage sludge, with much of the water and original odour, as well as any human and animal pathogens, removed.

"It would arrive anything up to six months before it was spread, and was stockpiled in the corners of fields," recalls John Benson.

"It was then applied by contractors in the narrow window between harvest and cultivations at a rate of about 15-20t/ha. Regulations required us to plough or deep cultivate within 24hrs, to incorporate it and minimise the odour."

The nitrogen content was very slow releasing with "negligible" available N, he says. But it did have a useful phosphorus content, which meant the farm didn't have to buy any triple super phosphate. There was also a useful amount of organic matter.

"It probably did improve the soils, but you've got to weigh that up with the downsides — sometimes the contractor would spread in less than ideal conditions, and then you get compaction issues as a result.

"There's also the smell — we're right on the outskirts of the city and have lots of footpaths. We used to get plenty of complaints from people, both about the material when it was spread and the large black heaps in our fields."

It's these issues which prompted United Utilities to develop new processing and treatment techniques and Tile Farm is now taking part in the trials as part of the END-O-SLUDG project. A small, 1.5ha plot of one of his wheat fields has received a number of different materials derived from sewage sludge.

"It's a granular material, just like a compound fertiliser, that's delivered in one-tonne bags and spread with an ordinary pneumatic spreader. It's a lot friendlier to use and practically odourless — you'd almost be happy to handle it with your bare hands."

The biogranules on trial at Tile Farm can be applied with an ordinary pneumatic spreader.

Its early days and there are no results from the trials yet, although work elsewhere has suggested the material is even more effective than standard compound fertiliser. "I think it would have to be priced very competitively, but I don't think there'll be much difficulty finding farms that would take it.

"The main issue will be with public perception. From an environmental and user-friendly point of view, this is the way to go, and I hope the research bears this out and helps these products come to market."

tendency of certain materials to bind to air bubbles. By injecting a flow of micro-bubbles into wastewater, up to 100% of the key components of sludge, known as Total Suspended Solids, can be removed, compared with a 65% reduction achieved through existing methods.

A second technique focuses on removing the dissolved organic material, which is the other main constituent of sludge, says Son Le. "The technique uses components which 'attract' these organic materials, in the same way magnets attract iron filings, which can then be physically removed. We're hoping this will replace the traditional biological method of using bacteria, that's extremely energy-intensive."

Another process uses ultrasonic waves or fine grinding to break down the sludge cell structures, which could release as much as 80% of the potential biogas. "Traditional treatments only release 45%, so this could unlock much more of the energy that sludge contains, which can then be used for heating and power."

The by-products of these processes can then be transformed into a range of safe, useful agricultural products that are easy to transport and spread, maintains Son Le. "This will solve the problems water companies currently face with land availability, haulage and spreading costs. It'll also ensure the sludge is spread over a wider geographic area, which means the rate of build-up of phosphorus will be reduced to a more sustainable level."

Waste material

But there's one objective of the project that remains a potential stumbling block, admits Son Le. "Sewage products are currently classified as a waste material, and until they're declassified, there'll always be restrictions and regulations which will limit their appeal to farmers."

Work is underway with Sustainable Resource Solutions to reassure the relevant authorities, such as the Environment Agency, that the products are an acceptable fertiliser replacement, and should be classified in a similar way to ordinary compound fertiliser.

But ultimately the consortium hopes the combination of properly researched new techniques and proven environmental benefits will reassure the wider public. "We need to ensure the public know that the final products used on farmland pose no extra risk to human health, and reduce a long-held fear that arises from a lack of understanding of the practice."

Son Le says there are novel techniques scientists are working on which can unlock more of the energy and nutrient value from wastewater.

Much of that will come down to successfully relaying the outcomes of the project, acknowledges James Holmes of HGCA. "There's a whole series of workshops and meetings planned at which we'll be showcasing the results of the work. It's a very positive story, so we're hopeful we can put to rest any stigma that may still exist." ■