

**Crops grown for an anaerobic digester form the sole focus for one Oxon arable farm, that gets all its fertiliser for free.**

*By Tom Allen-Stevens*

# Food for the concrete cow

**Imagine the perfect arable farming system. There'd be a high wheat yield — say 11t/ha — and to sustain this would be the best rotation, perhaps including grassland and maize. The blackgrass burden would reduce year on year, without relying too much on chemicals, and there'd be a ready, reliable and well paying buyer for the produce.**

There'd be no livestock to muck up this perfect arable system, but how about if it produced enough slurry to eliminate bagged fertiliser inputs altogether? Oh, and there'd also be some big meaty kit to farm it.

Believe it or not, this set-up actually exists, but not a blade of grass nor single grain is grown for food. This 186ha farm at Cassington, near Oxford, feeds five concrete cows — anaerobic digesters (ADs) producing electricity for 4600 homes.

The 2.1MW, £10m plant is the jewel in the crown for Agrivert, a business which has grown from a firm of muck-spreaders. "Everything we do is geared around

what's going onto the land," says chief executive Alexander Maddan. "What's exciting about AD in my mind is the potential of the digestate."

This is the 5% dry-matter slurry produced as a by-product. With an NPK analysis of about 5:1:3, and 2kg/m<sup>3</sup> of sulphur, it's spread at a total rate of around 60m<sup>3</sup>/ha and forms the basis of this virtuous system.

"It's slightly low on phosphate, but about half of the N is ammoniacal and readily available to the crop. There's also 3% organic matter, which benefits the soil. It's applied in three splits to wheat, in the same way conventional fertiliser might be applied. But we do need a long spreading window as we only have 3 months' on-site storage capacity for the digestate at present."

Grassland is therefore a handy crop to have. The farm has 86ha in total, the same area as wheat, grown in three-year leys and rotated with the wheat, plus 14ha of maize. "We can start spreading from 15 Jan on the grassland, then after





(L to R) Chris Woolcock, Charlie Baker and Alexander Maddan in front of the engine house of the 2.1MW AD plant.

“What’s exciting about anaerobic digesters in my mind is the potential of the digestate.”

every silage cut — you get a magnificent response. We get silage yields of around 60t/ha — all this grass, yet there isn’t a cloven hoof in sight.”

This is actually quite a mindset shift to get your head around. With no crop grown for food, the whole equation on this farm feels odd. You have to be a firm supporter of growing crops for renewable energy for it to sit right, although this isn’t a problem for Alexander Maddan.

“In the mid-1800s, 40% of what we grew was fed to horses, essentially providing the transport and pulling power of the past. But then we took a 150-year hydrocarbon holiday.

### Sustainable source

“Now what we’re doing is capturing our only sustainable source of energy, the sun, through photosynthesis. Nature does it best after all, so agriculture has an essential role to play in energy production.”

And once you’ve balanced up the incongruity of farming for fuel, it’s actually quite a neat system, as local contractor Charlie Baker explains: “We grow and harvest the crops just as you would on any other commercial farm. The only differences are what you feed them, and the wheat is harvested whole crop.” ▶



30m<sup>3</sup> tankers ferry digestate from the plant to a nurse tank parked up on the headland.



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The 5% dry-matter slurry, spread at a total rate of around 60m<sup>3</sup>/ha, is the only nutrition crops need in this virtuous system.

► Taken off in early July, this removes most of the farm's problematic blackgrass too. A Gregoire Besson Discordon makes the first pass through the clay loam that Charlie Baker calls 12 o'clock ground — "if you miss it, you've missed it for good". There's then a long window before the autumn crop is established, allowing a

good chit for a stale seedbed, followed by the first dressing of digestate for the next crop — about 10m<sup>3</sup>/ha.

This is where it becomes apparent you need to be tooled up to farm for fuel. Charlie Baker manages around 1200ha of wheat, 400ha of maize and 2400ha of grass in total. "You've got to have the kit

— you can't mess about with small stuff. If anything, we're over-mechanised but it means we can do the job fast and do it well."

The slurry spreader is a Kaweco 24m<sup>3</sup> tanker with 4m injector tines running behind. Pulled by a Claas Xerion 3800, it's the right tool for the job, believes operator Ian Souch. "It covers about 0.5ha to a tankful and empties in 4 minutes. It generally takes a little longer when you're cultivating, but it does a much better job than spreading and gets it into the soil beautifully."

The fast turnaround requires a nurse tank parked up on the headland, which is constantly topped up during spreading by a fleet of 30m<sup>3</sup> tankers running to and from the plant. To service this has meant a network of tracks were laid across the farm.

### Compaction conscious

"You could use umbilical lines, but it's better and faster with our system and we've never pulled a traction mark," maintains Charlie Baker. "The Xerion's on 710 tyres while the tanker's on 650s with a swan-neck coupling and all the slurry's held in the front of the tanker to spread the weight evenly. So we've little danger of causing compaction despite the heavy kit."

A Väderstad Rexius Twin makes the seedbed, and a 6m Väderstad Rapide drill establishes the wheat crop —

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A good, well balanced diet is essential for maximum gas production from the bacteria says Chris Woolcock.



*The biogas is fed to two huge V20 engines that generate enough electricity for 4600 homes.*

of gas, piped to two massive V20 engines that take 1000m<sup>3</sup>/hr of biogas and run 24hrs a day, each generating 1MW.

But the majority of the feedstock for the plant is food waste, and this is the secret to making the plant profitable, says Alexander Maddan. "The gate fee, charged for food waste deliveries, accounts for 30% of the profits. It's far more important to make sure we're using the waste for energy, rather than the silage, as we can always sell the silage on."

### Waste sweet spot

It took five years for Agrivert to win the Oxon County Council food waste contract, and there's a team of eight staff in the business whose sole task is to win these contracts. "In every county, there's a sweet spot where you can build a plant and waste gravitates to there. Find that sweet spot and you can get the waste contract.



*A specialist hammer mill takes in food deliveries, macerates the food and separates out the plastics with no manual intervention.*

"It's incredibly difficult and very expensive to bid for, but the reward is 15-25 years of guaranteed tonnages."

It's also expensive in capital terms — 60% of the plant's cost relates to handling food waste. There's a pasteurising plant, which is essential to ensure the by-product's safe to spread to land under Animal ▶

JB Diego is the variety chosen, but any feed variety will do, he says. Then autumn management is just as for a conventional crop. It's in the spring that nutrition is handled a little differently.

"The crop gets another 25m<sup>3</sup>/ha of slurry in March and then the final dose by GS27. We spread it into the spring canopy through drop pipes on a 15m boom on the back of the tanker this year. But I'm going to Germany to have a look at a 30m boom that'll fit with the tramlines for next year."

The digestate is relatively odour-free, so spreading on the surface isn't a problem. Care must be taken near watercourses, although the farm has 6m buffer strips, partly for this reason.

### Harvest handling

Harvest starts in May with the grassland, with three cuts taken over the season. Wholecrop wheat fits in the middle, and the maize is harvested in October. "You need a fine chop and then you need to crimp the corn. The wheat grain should be milky ripe — not too hard or it won't digest properly." These requirements are handled by Charlie Baker's Claas Jaguar 960 forage harvester with a 5.2m Direct Disc header.

The silage is worth in the region of £25/t to the AD plant, and makes a good feedstock. The digester acts in a very similar way to a cow's rumen — bacteria break down the feedstock to produce methane. At Cassington, there's 8500t of silage that produces between 160-180m<sup>3</sup>/t

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# AD for arable farms – does it stack up?

Yes it does, according to NFU's Jonathan Scurlock, but only as part of the overall picture. "You don't have to own your own AD plant — you can supply whole-crop fodder to a nearby unit, or you could be part of a joint-venture agreement with a developer. You can get a good rent from hosting a plant, and would then benefit from the digestate."



*Anaerobic digestions plants are a good fit with farming, says Jonathan Scurlock.*

The technology for such plants is now relatively developed, with systems available "off-the-shelf" from Denmark, Sweden, Austria and Germany. "The UK lags Europe — in Germany there are about 5000 operational AD plants, while there are only 60-70 currently in the UK, half of which are on farms."

It's a good fit with farms, especially if there's a waste stream. "Field vegetable and potato growers can use it for waste produce. If there's a dairy unit that needs to upgrade manure and slurry facilities, rather than spend a fortune on storage tanks, go that bit further with an AD plant and get extra value from the waste stream."

It was the need to process manure and slurry in the light of nitrate restrictions that first brought about the technology. In the UK alone farmers produce 90Mt. "It's not the best feedstock because much of the energy value has already been removed. Food waste is better — 12-20Mt still goes to landfill. But these contracts are very hard to win and are getting rarer."

It's the ability to get value from waste that puts AD plants in a very favourable light with Defra — just capturing the methane and using it for energy production makes for large greenhouse-gas savings. This is reflected in the Feed-In Tariff (FIT), a premium for renewable energy generated

from AD plants. For typical farm-scale plants, smaller than 500kW, this brings in 13-14p/kWhr produced for 20 years. This is income in addition to electricity sold to the grid at a minimum of 3.1p/kWhr.

"It works out best financially if there's a large energy user on the farm you can supply — a potato store, pig or broiler unit, or business units, for example. You can also use the excess heat, although this is harder and requires careful planning. The carbon dioxide can be used to enrich the environment of protected crops."

The downsides of AD are high capital expenditure, plus overhead and maintenance costs. "This isn't like a simple photovoltaic system you stick on your grain-store roof and forget about. There are high maintenance costs, and these don't scale down very well for smaller units. This is on top of typical capital expenditure of £1-3M. Inevitably this makes banks more nervous when they're approached for funding, so AD has become the Cinderella of the renewable options."

Funding problems could paralyse the opportunity for many farmers, points out Roger Hellawell from Agrii Consultancy Services. "Banks won't lend such large sums on a return on investment of 8%. You'd need 15-16%. But this is quite feasible for farms that generate their own waste — it could be

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*Having a waste stream is the key to an AD plant's profitability.*

a profitable venture for a group of vegetable farms in Lincolnshire, for example. A market could even open up for food waste."

The chief benefits for the arable enterprise are the digestate fertiliser and a ready market for whole-crop produce. But there are spin-off benefits, too. "One of the biggest issues on arable farms, especially in eastern counties, is closer rotations. AD provides the opportunity to build in other crops, and reduce a blackgrass burden — without relying too heavily on chemicals."

► Byproduct regulations. An almost unique hammer mill takes in deliveries, macerates the food and separates out the plastics with no manual intervention.

The reward is 18,000t of feedstock from Oxon alone, with a further 10,000t coming in from Pembrokeshire and Essex and 1000t from local retailers. Another 10,000m<sup>3</sup> of liquid waste is taken in. "As long as it has energy value and they'll pay to get rid of it, we'll take it."

### Calorific value

But the calorific value, averaging 120m<sup>3</sup>/t of methane, varies. "You've very little say over what Mrs Smith puts in her waste. Christmas is the boom time. You get fatty food and lots of it — we thought we'd never have to feed silage again. But then everyone switches to a salad-based diet in summer and you have to bulk it up."

It's up to the site manager Chris Woolcock to get the balance right and feed the digester a healthy diet. "Modern, processed foods and preservatives are bad — we had to reject a batch of mayonnaise recently. You have to be very careful with anything that may contain antibiotics. But if it needs a boost we can put in some glycerine — it acts a bit like Lucozade and gives it a sugar rush."



*Farming for energy, rather than food, may not feel right, but it's what was done 150 years ago before the world came to rely on fossil fuels, points out Alexander Maddan.*

Just like any ruminant, a digester can suffer from bloat, he notes. "The digestate needs regular agitation or a crust forms on top, making a viscous layer. Then you get bubbles that don't pop and it starts to foam."

But this isn't the only similarity to looking after livestock, he says. "The digester's a living thing. You can't neglect it or stop feeding it or it'll die. You need to monitor volatile fatty acids and buffering capacity. But the bacteria gets used to what you feed it. Give it the temperature and the pH it likes and it'll eat whatever you choose to give it." ■

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