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**Final report**

# Digestate distribution models

This project examined different organic material supply/distribution models which should enable AD companies to learn from and adopt/adapt existing practices for the benefit of their own businesses.

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**Written by:** ADAS UK Limited

**Front cover photography:** Anaerobic digestion plant; digestate storage; digestate transportation; land application using shallow injector.

# Executive summary

The UK government supports anaerobic digestion (AD) as one of the best ways to recover value from organic 'wastes' – primarily because energy in the form of biogas is naturally produced as part of the digestion process. In addition to the generation of biogas, the AD process provides digestate (or 'biofertiliser'), which is a particularly good source of crop available nitrogen. There are three main types of digestate (whole, liquid and fibre), with whole digestate being the most commonly available.

The objective of this project was to examine different organic recycling industry supply/distribution models (i.e. the manner in which materials move from where they are 'produced' to where they will be used) and to assess the advantages and disadvantages of each model. Experience gained from other more established sectors, such as the composting and water industries, should prove valuable to AD operators in the development of their own business models for the distribution and land application of digestate since this aspect may have a significant effect on the viability of a project. This knowledge should enable AD companies to learn from and adopt/adapt existing practices for the benefit of their own businesses.

**Distribution models in other sectors**

**Compost:** The majority of compost is sold directly to end-users, although *c.*20% is distributed without charge and around 10% is used on the composters' own land or sold to third parties. Agriculture is the largest market sector for compost which is mainly applied to combinable crop (e.g. cereals, oilseed rape) land and is a high volume, lower value market. In contrast, higher value horticultural markets represent a smaller percentage of the overall market by volume, but a significant percentage by value. Geography is the key driver of market strategy for compost suppliers; any marginal income is soon lost if substantial transport costs are incurred. Thus, compost producers need to be close to their markets, particularly if these are agricultural. Compliance with BSI PAS 100, the recognised standard for compost quality, is seen as a vital driver to develop and maintain (a range of) compost markets.

**Biosolids:** Treated sewage sludge (i.e. biosolids) can be produced in cake, granular/pellet or liquid forms; solid materials (e.g. digested cake, lime stabilised cake) are the most common products. Most water companies charge farmers for the delivery and spreading of biosolids, and may run this operation 'in-house' or 'out-sourced' from specialised contractors. Typically, the price of the biosolids product will include: soil analysis; delivery; spreading and nutrient management planning services. The product is often delivered to the farmer well in advance of the spreading operation and is stored in temporary field heaps. Notably, the cost of the product does not usually reflect its 'true' nutrient value (i.e. compared with manufactured fertiliser). This approach to product pricing means that the company underpins the costs associated with recycling, whilst seeking to ensure an available and long-term agricultural landbank for biosolids products.

**Current digestate distribution models**

The UK market for digestate is immature and as a consequence current distribution strategies are similarly under developed. Typically, each AD plant lives in its own geographic 'bubble' and market strategy varies from site to site dependent upon local circumstances; operators rarely look beyond a 10-20 mile radius distance for markets because of transport costs. Digestate is typically applied as a *liquid* to agricultural land, either on site or transported off-site for application to nearby land. Digestate is expensive to transport and

spread due to its high water content (whole or liquid digestates – typically >95% of weight is water) or bulky nature (fibre digestate – typically 60-80% of weight is water), so cost-effective transport distances are limited. There are considerable logistical (and financial) advantages in having an available landbank close to the AD plant. Moreover, access to an available local landbank, using umbilical (i.e. no tanker) spreading equipment, will significantly increase spreading opportunities and reduce transport costs. To optimise storage, handling and reduce transport costs digestate enhancement systems, such as separation or dewatering, may be used prior to land application, which will typically reduce the liquid volume by around 10%. However, significant quantities of digestate liquor (typically 90% of the whole digestate volume) will still remain and require management at the plant.

### Lessons from other organic material sectors

Whole digestate is a much 'wetter' material (*c.*4% dry matter-dm) than compost (*c.*60% dm) or biosolids (25-95% dm for solid materials), meaning that the costs of storage, transport and land spreading are higher than for other solid-based products. Despite this difference, the experience gained by established sectors such as the composting and water industries can be valuable to AD operators, particularly in understanding how they have addressed the needs of the market. Drawing on experience from other sectors the following lessons can be learnt:

- The storage, transport and land spreading costs associated with the recycling of whole digestate (or separated liquid) to agricultural land are (almost always) greater than the fertiliser value of the product. Choices about how digestate is distributed can be critical to the viability of an AD project.
- Distribution as a solid material allows greater market reach through reduced transportation costs. Digestate enhancement systems, such as separation, dewatering or thickening, may be used to separate the whole digestate prior to transportation into a fibre and liquor portion. Also, a stackable product can also be stored in temporary field heaps, rather than requiring investment in secure liquid storage facilities. However, typically 90% of the whole digestate volume remains as digestate liquor that requires management (e.g. via land recycling or permitted disposal to sewer).
- The land recycling of digestate is constrained by the crop growing seasons, Nitrate Vulnerable Zone regulations (and Codes of Good Agricultural Practice) in relation to field application rates and closed spreading periods, and the availability of agricultural land within economic transport distances. The provision of adequate and secure storage is *essential* to enable year round production to be matched to land access and availability.
- Access to the available local landbank using umbilical (i.e. no tanker) spreading equipment can increase spreading opportunities and reduce transportation costs.
- Charging the customer (farmer) for digestate supply, reflecting its value as a source of crop available N (plus phosphate, potash and sulphur) will help to off-set producer costs (i.e. storage, transport land spreading). However, this approach is very much dependent on the farmer being willing to take the digestate; competitive product pricing (relative to manufactured fertiliser use) will be required to obtain and retain a sustainable landbank. Many water companies initially supply biosolids free of charge, until the value of the product has been recognised by farmers so it is likely that some digestate producers will initially have to take this route to market. Importantly, a fertiliser marketing approach to digestate supply and use (not disposal) should be adequately supported by professionally qualified (i.e. FACTS) advice.

- Accreditation to BSI PAS110 will increase customer confidence in digestate as a product and help to increase market access.

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# Glossary

| | |
|---|---|
| **ADBA** | Anaerobic Digestion and Biogas Association |
| **AfOR** | Association for Organics Recycling (now the Organics Recycling Group; part of the Renewable Energy Association) |
| **Animal By-Products (ABPs)** | Products of animal origin. Low risk ABPs can be treated in AD facilities that comply with the Animal By-Products Regulations (ABPRs) |
| **AD** | Anaerobic Digestion |
| **ADQP** | Anaerobic Digestate Quality Protocol |
| **Biofertiliser** | The trade name for digestates certified under the Biofertiliser Certification Scheme (i.e. quality digestates that meet the ADQP and PAS110 specification) |
| **Biofertiliser Certification Scheme** | Waste-based digestates certified within this scheme are considered products. The scheme applies to the UK only |
| **Biogas** | Mixture of gases produced by anaerobic digestion |
| **Biomass** | Any living or recently dead plant or animal material |
| **Biosolids** | Treated sewage sludge |
| **Biomethane** | Methane produced as a result of upgrading biogas |
| **CHP** | Combined heat and power |
| **Co-digestion** | A process whereby one or more waste types are digested in a mixture, in order to enhance digester efficiency and increase biogas yield (normally include sewage sludge as a principal component) |
| **Co-digestate** | Digestates arising from co-digestion processes |
| **Digestate** | Material left following anaerobic digestion (often referred to as whole digestate) |
| **Digester** | The vessel in which anaerobic digestion takes place |
| **FACTS** | Fertiliser Advisers Certification and Training Scheme |
| **Feedstock** | The material that is put into the digester |
| **Fertiliser** | A substance added to soil to make it more fertile |
| **Fibre digestate** | The solid fraction of digestate, usually mechanically separated from the whole digestate |
| **Gate fee** | Charge levied upon a given quantity of waste received at a waste processing facility |
| **GHG** | Greenhouse gas |
| **Inorganic** | Material of mineral – rather than biological – origin such as metal or glass |
| **Liquor digestate** | The liquid fraction of digestate resulting from removal of solids (fibre) through processes such as mechanical separation or centrifugation |
| **Manures** | Mixture of bedding materials and livestock faecal matter, widely used as an organic fertiliser in agriculture |
| **MBT** | Mechanical biological treatment – combination of mechanical and biological treatments for extracting recyclables from mixed household waste |

| | |
|---|---|
| **MHT** | Mechanical heat treatment – combination of mechanical and heat treatments for extracting recyclables from mixed household waste |
| **Mesophilic** | Organisms for which the optimum growth temperature is between 30°C and 45°C |
| **Methane** | A colourless, odourless, flammable gas with the formula $CH_4$ |
| **MSW** | Municipal solid waste |
| **Organic** | Material deriving from biological sources |
| **Quality Protocol** | A standardised approach by which digestates derived from certain allowable inputs can be applied to certain allowable markets outside the waste regulatory regime |
| **REA** | Renewable Energy Association. Their subsidiary company – Renewable Energy Assurance Ltd – runs the Biofertiliser Certification Scheme |
| **Sludge** | Residual, semi-solid material left from sewage treatment processes |
| **SOM** | Separated organic material – stabilised material produced from an MBT/MHT facility (may also be referred to as compost like output, grey compost, BioCompost etc.) |

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## 1.0 Introduction

The UK government supports anaerobic digestion (AD) as one of the best ways to recover value from organic 'wastes' – primarily because energy in the form of biogas is naturally produced as part of the digestion process. Biogas can be used as a substitute for natural gas to produce green electricity or heat, it can be upgraded to biomethane for injection into the national gas grid or compressed for use as a transport biofuel. Anaerobic digestion is a key part of the UK government's strategy to increase the production of renewable energy and help combat climate change. In addition to the generation of renewable energy (via biogas), the AD process generates digestate (or 'biofertiliser'), which is a particularly good source of plant available nitrogen (Taylor *et al.*, 2010).

As part of the UK's commitment to meet EU Renewable Energy Targets by 2020, UK governments have put in place policies and strategies to increase the generation of renewable energy and treatment of food waste through AD. It is estimated that over one million tonnes of food-based digestate is currently produced in the UK, of which almost all is currently recycled to agricultural land (WRAP, 2012a). The production of digestate (biofertiliser) is set to significantly increase and developing sustainable markets and viable methods of beneficially utilising digestate is essential for the longevity of the AD industry. Indeed, it is predicted that there could be up to 5 million tonnes of food waste available for AD by 2020 (Defra/DECC, 2011) resulting in just under 5 million tonnes of digestate, in addition to digestate produced from livestock manures and purpose grown crops.

This project delivers against action 29 of the AD Strategy and Action Plan (Defra/DECC, 2011), aiming to examine different organics recycling industry supply/distribution models (i.e. the manner in which materials move from where they are 'produced' to where they will be used) and to assess the advantages and disadvantages of each model. Experience gained from other sectors, such as the water and composting industries should prove valuable to AD operators for the development of their own business models for the distribution and land application of digestate. This knowledge should enable AD companies to learn from and adopt/adapt existing practices for the benefit of their own businesses.

## 2.0 Digestate

### 2.1 Types of digestate

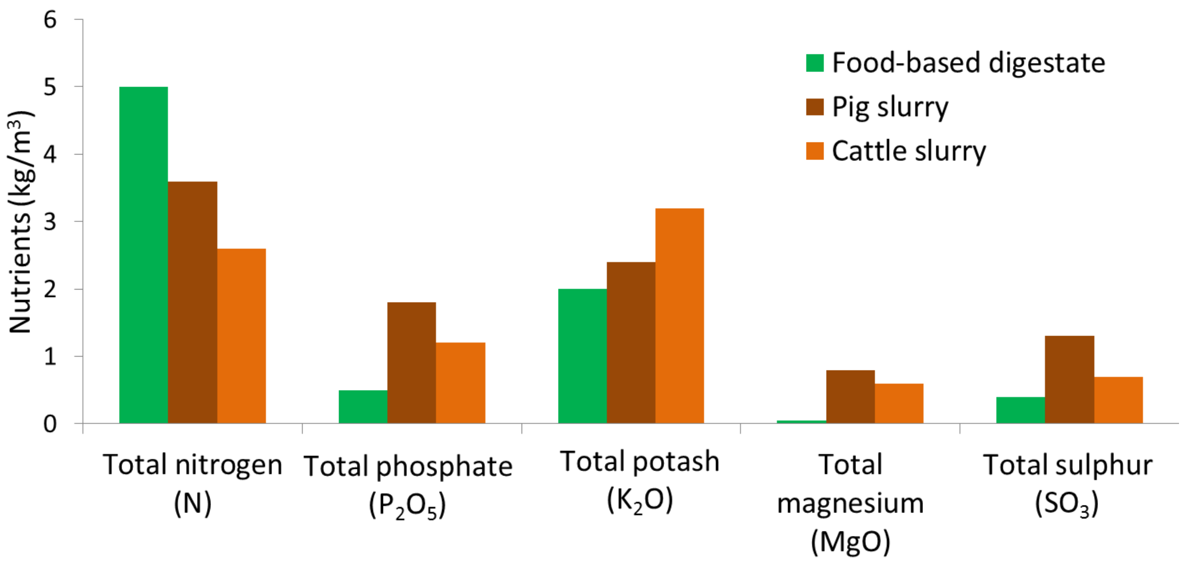
Digestate is a natural product that results from the controlled biological decomposition of biodegradable materials in the absence of oxygen, i.e. anaerobic digestion-AD. AD systems vary widely in terms of their design, however, the main types are either continuous wet or dry systems, that are run at either mesophilic (30-40°C) or thermophilic (50-60°C) temperatures. Most UK operators use mesophilic anaerobic digestion (MAD) systems. Suitable input materials include domestic and commercial food 'wastes', livestock manures and purpose-grown crops. The resultant digestate can be used as an alternative to manufactured fertilisers and by doing so, farmers and growers can improve the sustainability of their cropping systems, whilst potentially saving money on manufactured fertilisers.

There are three main types of digestate (whole, liquid and fibre), with whole digestate being the most commonly available. Some AD plant operators opt to separate digestate into liquid and fibre fractions for operational reasons. The fibre fraction typically has a dry matter content of between 20 and 40%, and the whole/liquid fraction between 1 and 6% of the total sample, although these proportions will vary depending upon the separation process or processes employed. There are also technologies that can be used to further enhance the properties of digestate (e.g. ultrafiltration and reverse osmosis), which process digestate into nutrient rich liquor, a solid fraction and 'clean' water.

### 2.2 Nutrient content of digestate

Digestate varies in its nutrient content, depending on the input materials (i.e. feedstocks), nature of the AD process and post-digestion processing. The 'typical' nitrogen, phosphate and potash contents of food-based digestate are illustrated in comparison with livestock slurries in Figure 1. Digestate is an excellent source of readily available nitrogen (RAN) (i.e. ammonium-N) which is potentially available for immediate crop uptake. Food-based digestate typically contains around 80% of its total N content as RAN (WRAP, 2012b) compared with around 70% for pig slurry and 45% for cattle slurry (Defra, 2010). The nutrient content of digestate determines its fertiliser replacement value and hence its financial value to farmers.

**Figure 1** 'Typical' nutrient content of food-based digestate and livestock slurries (WRAP, 2012b; Defra, 2010)



## 2.3 Current food-based digestate production and markets

The AD sector is growing rapidly; WRAP (2012a) reported an increase of 850,000 tonnes (fresh weight) in food-based digestate production between 2009 and 2010 from *c*.160,000 tonnes to over 1 million tonnes, respectively. In 2010, total 'waste' input to AD plants was 1.15m tonnes, however, it was estimated that the practical capacity (as opposed to the operational capacity) was 1.7 million tonnes, suggesting a 67% utilisation. Since then, the number of plants has increased to 63 operational waste-fed sites (WRAP market data August 2013), with a handling capacity of 7.5 million tonnes per annum (of this, 5.8million tonnes relates to on-site industrial, high liquid effluent capacity which produces less digestate). Plants accepting food waste (from municipal and commercial sources) total 36 plants with a handling capacity of 1.48 million tonnes per annum. WRAP (2012a) reported that agriculture was the dominant end-market for whole digestate, fibre and liquor; with all recorded outputs being used in agriculture, except a small fraction of whole digestate that went to land restoration. Around 38% of agricultural use was reported on the same site as the AD facility, with 62% going for off-site use. Later in 2013, WRAP will be publishing 'A Study of the UK Organics Recycling Industry in 2012' which will set out latest figures for end markets for digestate and is likely to show greater growth.

## 3.0 Recycling of other organic materials

In addition to digestate, the main (non-livestock) organic materials recycled to land include:

- *Compost* (i.e. solid particulate material that is the result of composting, which has been sanitised and stabilised, and which confers beneficial effects when it is added to soil).
- *Biosolids* (i.e. treated sewage sludge from waste water treatment plants).
- *Paper crumble* (i.e. paper waste arising from the reprocessing of paper at recovery/recycling plants which cannot be used to make recycled paper/cardboard; involving biological, chemical or physical treatments processes).
- *Separated organic materials* – SOMs (i.e. the stabilised organic material produced from mechanical biological treatment – MBT and mechanical heat treatment – MHT sites).

A number of these organic materials are also subject to further treatment ahead of recycling to land, including:

- de-watering of liquid digested biosolids to produce cake;
- de-watering of liquid paper fibre to produce paper crumble;
- de-watering and thermally drying of biosolids to produce granules/pellets; and
- de-watering of liquid digested SOMs to produce fibre.

The manner in which these organic materials are typically distributed also varies, for example:

- offered direct to customers at the site of production (e.g. bagged or loose compost);
- supplied direct to customers from the site of production utilising producer's or contractors' vehicles (e.g. compost, biosolids and paper crumble); and
- as a complete service, including soil testing, planning appropriate spreading rates and locations, arranging/overseeing haulage and application, and recording information that the land manager is obliged to make and keep (e.g. compost, biosolids and paper crumble).

Notably, compost, most biosolids and paper crumble are handled and applied to agricultural land as solid materials, whereas digestate is largely handled and applied to land as a liquid material with associated logistical challenges.

## 3.1 Source-segregated compost

### *3.1.1 Current compost production*

The total quantity of compost produced in the UK has more than doubled between 2003/04 and 2010; with the quantities used in agriculture mirroring this general increase. In 2010, the total quantity (on a fresh weight basis) of compost produced in the UK was 2.82 million tonnes (WRAP, 2012a). Agriculture was the largest market sector, accounting for 1.9 million tonnes (67% of the total), with applications most commonly made to arable (e.g. cereal, oilseed rape etc.) land. Notably, with the expansion of the composting industry in response to European and National policies encouraging the diversion of organic 'waste' from landfill (e.g. the Landfill Directive; the UK Waste Strategy), the amount of compost recycled to agricultural land may still increase further.

### *3.1.2 Nutrient content of source-segregated compost*

The nutrient content of compost products varies depending on the source materials and treatment processes; typical values are summarised in Table 1. The nutrient content of compost determines its fertiliser replacement value and hence its financial value as a source of nutrient to farmers. In addition to its nutrient replacement value, compost also offers other benefits such as its use as a soil improver to enhance soil structure for better workability, water management and crop establishment as well as acting to inhibit pests and diseases within the soil.

**Table 1** Typical total and crop available nutrient content of compost (kg/t fresh weight)

| Major nutrients | Green Compost | | Green/food Compost | |
|---|---|---|---|---|
| | Total | Crop available | Total | Crop available |
| Nitrogen (N) | 7.5 | Nil | 11 | 0.6 (5%) |
| Phosphate ($P_2O_5$) | 3.0 | 1.5 (50%) | 3.8 | 1.9 (50%) |
| Potash ($K_2O$) | 5.5 | 4.4 (80%) | 8.0 | 6.4 (80%) |
| Sulphur ($SO_3$) | 2.6 | n.d. | 3.4 | n.d. |
| Magnesium (MgO) | 3.4 | n.d. | 3.4 | n.d. |

n.d. = no data
Source: "Fertiliser Manual (RB209)" (Defra, 2010) and SRUC Technical Note 650 (SRUC, 2013)

### *3.1.3 Compost distribution model*

Sale prices to agriculture in 2010 were typically £0-5/t, to horticulture £6-18/t and to landscaping £9-15/t. WRAP (2012a) estimated that the total value of compost (manufactured at permitted composting sites) sold to the various market sectors was in the region of £9.2 million (i.e. agriculture £2.3 million; horticulture (professional) £1.3 million; horticulture (amateur) £1.7 million; landscaping £2.7 million and other sectors £1.2 million). Perceived reluctance by some farmers to embrace compost or attach a financial value to it, indicate that agriculture (in the short-term at least) is likely to remain a high volume, low value market; although increases in the price of manufactured fertilisers may encourage greater uptake in the future (WRAP, 2012a).

In contrast, higher value horticultural markets represent a smaller percentage of the overall market by volume (5% professional horticulture; 5% amateur horticulture; 10% landscaping and 0.5% sports turf sector), but a significant percentage by value (14% professional horticulture; 18% amateur horticulture; 29% landscaping and 2% sports turf sector). In addition, WRAP (2012) reported that even though composted products were sold, the revenue per tonne of product was low (generally in the region of 10-20% of gate fees).

WRAP Project OAV032-004 "Compost and Anaerobic Digestate Quality for Welsh Agriculture" (Taylor *et al.*, 2011) examined the current and likely future production of compost (and anaerobic digestate) in Wales, and the ability of Welsh agricultural markets to use the materials. Although this report looked specifically at the situation in Wales, the findings are relevant to the UK compost market as a whole. The report concluded that geography and topography were key drivers in determining the market strategy for compost suppliers. Most of the composters expected an increase in the agricultural market for compost, as confidence in material quality and knowledge of nutrient benefits increased. Arable farmers were acknowledged as the preferred agricultural market due to their perceived willingness (based on the relative profitability of their businesses) to pay more for compost than grassland farmers, and the higher nutrient balance requirements of arable crops, along with lower competition from livestock manures.

The main barrier to market expansion for compost was seen as the low price paid by farmers for the product compared with the relatively high transport cost; any marginal income was soon lost if substantial transport costs were incurred. Thus, compost producers need to be close to their agricultural markets. Also, Taylor *et al.* (2011) indicated that there were still some issues around the perception of compost as a waste, rather than a product; BSI PAS100 (BSI, 2011) compliance was seen as a vital driver to develop and maintain (a range of) compost markets. Similarly, WRAP (2012a) also recognised the importance of compost quality as a market driver, with producer feedback indicating that the main benefits of BSI PAS100 (BSI, 2011) and the Compost Quality Protocol (WRAP/EA, 2012) were the confidence they give to end-users about the quality of the material. Indeed, some composting industry respondents saw compliance with BSI PAS100 (BSI, 2011) as 'necessary to keep up with the market'; compliance was viewed to be difficult, but the best option. For some markets, PAS100 may be the baseline for required quality whilst for others, such as the growing media market, stricter guidelines would need to be followed. Box 1 contains a case study from a composting site (Jack Moody Ltd) which is producing a range of BSI PAS100 (BSI, 2011) accredited products for the horticultural sector.

## Box 1: Compost distribution model – Jack Moody Ltd

Jack Moody Ltd began as a landscaping company and diversified into commercial green waste composting; the company was the first to gain BSI PAS100 accreditation for its composting operation. With AD the Government's preferred treatment method for food industry and catering waste, the company has begun to develop the first of three planned AD facilities to produce digestate products that complement those already produced for the compost market.

### Compost sales and distribution model

- All of the compost produced is delivered for landscaping/horticultural use where it commands a higher financial value (than in the agricultural sector) by competing with peat and other growing media. The company carries out market research and develops products to meet the market's requirements. The compost is size graded and if necessary blended with materials such as bark and livestock manures to create products to individual specifications.
- The bulk of the compost produced is used directly in the landscaping division of the company. Large quantities are used on civil engineering sites where it is delivered in bulk directly to site.
- Compost is also bagged into 40 litre sacks for retail sale as Care Composts™ which is sold directly to the public at two community recycling centres in Dudley and Sandwell, at three Jack Moody Ltd owned retail garden centres, two independent garden centres in the West Midlands and through the recently launched soilstogo website. This provides a higher return per $m^3$ of compost sold.
- Bagged multi-purpose compost (with added nutrients) is also produced in alliance with the Wildlife Trust and sold through their centres throughout the UK with profits going to the charity.

This distribution model was a success as Jack Moody clearly identified their target market and focused on product development to meet the specific needs of their customers.

### Plans for digestate distribution

- Digestate will be made into high value, environmentally sound products for use within the business, or that will meet the demand from the public for (peat-free) horticultural products.
- To meet market requirements and to ensure that the digestate produced fits with their established marketing strategy the company has planned for and selected a high solids AD process.
- Jack Moody intends to seek BSI PAS110 accreditation to market their digestate products for use in the landscaping industry.

## 3.2 Biosolids (treated sewage sludge)

### *3.2.1 Current biosolids production*

Around 1.1 million tonnes of biosolids dry solids (tds) were recycled to agriculture land in the UK in 2008 (Water UK, 2010), which represented 77% of UK sludge production. Additional outlets were incineration/energy recovery (16%), land reclamation (2%) and other (5%). Assuming an application rate of *c*.7 tds/ha, the area of agricultural land in Britain estimated to receive biosolids annually is over 150,000 ha.

In 2008, about 71% of biosolids recycled to agricultural land was *conventionally* treated; the other 29% was *enhanced* treated (EA, 2009). The water industry is moving towards the production of more enhanced treated products with higher levels of microbial pathogen kill, which fits with stakeholder preference for enhanced treated products. Additionally, advanced digestion gives greater biogas yields and dry solids destruction, and 'low' odour products.

### *3.2.2 Nutrient content of 'typical' biosolids*

The nutrient content of biosolids varies depending on the individual source and treatment processes; typical values for two biosolids products commonly applied to agricultural land are summarised in Table 2. Notably, most biosolids products are supplied by water companies with specific nutrient content data which determines its fertiliser replacement value and hence its financial value as a source of nutrients to farmers.

**Table 2** Typical nutrient contents of solid biosolids products: digestate cake and lime stabilised cake (kg/t fresh weight)

| Major nutrients | Digested cake | | Lime stabilised cake | |
|---|---|---|---|---|
| | Total | Crop available | Total | Crop available |
| Nitrogen (N) | 11 | 1.7 (15%)+ | 8.5 | 1.3 (15%)+ |
| Phosphate ($P_2O_5$) | 18 | 9.0 (50%) | 26 | 13 (50%) |
| Potash ($K_2O$) | 0.6 | 0.5 (90%) | 0.8 | 0.7 (90%) |
| Sulphur ($SO_3$) | 6.0 | n.d. | 8.5 | n.d. |
| Magnesium (MgO) | 1.6 | n.d. | 2.4 | n.d. |

n.d. = no data
+ Assumes spring surface application
Source: "Fertiliser Manual (RB209)" (Defra, 2010)

### *3.2.3 Biosolids distribution model*

Recycling biosolids to agricultural land is a long established, well researched and robustly regulated practice. Demand on-farm currently remains strong, as manufactured fertiliser prices are high. Water UK (which represents UK water and sewage operators) stakeholder engagement work highlighted that the majority of the food supply chain had a low understanding of biosolids recycling to agriculture. Whilst the majority of the food supply chain (excluding malting barley purchasers) currently do not reject the use of biosolids, they are also unlikely to openly endorse its use. Hence, market place acceptance beyond farmers (including farm quality assurance schemes) and those with current exclusion clauses is largely indeterminate.

Biosolids can be produced in cake, granular/pellet or liquid forms. Solid biosolids (e.g. digested cake, lime stabilised cake) are the most common products, with the majority of water companies charging farmers a fee as part of a product marketing approach (see Box 2). Proximity to treatment works (transport costs), the price of manufactured phosphate fertiliser, phosphate content and competition from other organic materials (e.g. compost) are the main factors that influences the price charged to farmers. Typically, where a fee is charged, the price of the biosolids product will include routine soil analysis (i.e. pH, extractable phosphorus, potassium and magnesium) delivery, spreading and nutrient management planning services. Solid biosolids products are typically delivered to the farmer well in advance of the spreading operation and are often stored in temporary field heaps. The fact that the solid product can be field-stored means that delivery can be spread throughout the year and does not have to be concentrated into the period just prior to land application. Typically the cost of the product (which typically ranges for biosolids cake between £<1-10/tonne delivered and spread) does not reflect its full nutrient value (i.e. compared with manufactured fertiliser); this approach to product pricing means that the water company helps contribute to the costs associated with recycling, whilst seeking to ensure an available and long-term agricultural landbank for biosolids products. Importantly to ensure farmer acceptance (and landbank security) from the beginning, product pricing was 'low' in relation to the full nutrient value of biosolids compared with manufactured fertilisers. Product pricing has gradually increased overtime.

## Box 2: Biosolids distribution model – Severn Trent Water

Following market research, which established that farmers were willing to pay for biosolids, a charge was introduced across the whole of the Severn Trent Water (STW) region for the supply and spreading of biosolids in 2009. To help STW change from a philosophy of 'giving it away' to 'charging', they retained the services of a specialist consultancy to retrain their staff and those of their two contractors who manage the transport, field storage and land spreading of biosolids. Importantly, to ensure farmer acceptance (and landbank security) from the beginning, product pricing was 'low' in relation to the full nutrient value of biosolids compared with manufactured fertilisers. Product pricing has gradually increased over time.

### Biosolids distribution model

- The biosolids service is managed by STW who, through retained contractors, supply and apply biosolids.
- It is the contractor's responsibility to identify farmers with suitable fields that would benefit from biosolids application and secure the sale. STW prefer that their contractor's source land with low soil phosphorus (P) indices and thereby allow maximum benefit from the P content of the biosolids to be realised.
- Management of the landbank is key to the whole process of biosolids recycling. To assess the suitability of land for spreading biosolids, the contractor will undertake a detailed risk assessment to identify areas to avoid spreading on, assess the physical limitations for lorry deliveries and identify areas where biosolids can be stored in temporary field heaps until spreading.
- Contractors are required to identify land within an acceptable travelling distance, generally within a 20 mile radius, of the sewage treatment works supplying the biosolids in order to minimise transport costs.
- The contractor is responsible for the day to day liaison with the farmer regarding temporary field storage heaps and timing of spreading. Once a contractual agreement for the supply and spreading of the biosolids is secured with the farmer, the biosolids are transported to the designated field for storage. The timing of spreading is by agreement between the farmer and the contractor.
- STW manage the soil sampling and provision of specialist back-up, such as independent technical consultancy to answer more in depth technical issues, and the financial process of invoicing farmers and securing payment.
- This distribution model is a success as Severn Trent Water researched the needs of their farmer customers and the financial value of their biosolids products to produce a pricing model that continued to secure a sustainable agricultural landbank, whilst deriving a return from biosolids sales that helps to offset treatment, transportation and application costs.

## 3.3 Paper crumble

### *3.3.1 Current paper crumble production*

The liming value and organic matter content of paper crumble make it a valuable liming agent and soil conditioner, particularly on low organic matter status arable land. To support the reuse of paper crumble on agricultural land, the paper industry produced a "Code of Practice for Landspreading Paper Mill Sludges" (Paper Federation of Great Britain, 1998). A 2005 study on the production and land spreading of paper crumble (Gibbs *et al.*, 2005a) estimated that *c.*0.7 million tonnes (fresh weight) was recycled annually to agricultural land and 85,000 tonnes (fresh weight) was used in land restoration. Similarly, EA (2012) estimated that 680,000 tonnes (fresh weight) of paper crumble was spread on land for agricultural or ecological improvement in 2010.

### *3.3.2 Nutrient content of 'typical' paper crumble*

The nutrient content of paper crumble varies depending on the treatment process; typical values for chemically/physically and biologically treated paper crumble are summarised in Table 3. The liming value (common range 2-10% neutralising value on a dry matter basis) and nutrient content of paper crumble determines its financial value to farmers as a liming material and nutrient source (Gibbs *et al.*, 2005b). Following the application of chemically/physically treated paper crumble nitrogen 'lock-up' commonly occurs due to the wide carbon:nitrogen ratio of paper crumble which immobilises soil nitrogen. As a general rule, around 0.8kg of inorganic nitrogen is required per tonne (fresh weight) of paper crumble applied to compensate for nitrogen 'lock-up' in the soil. As biologically treated paper crumble has a lower carbon:nitrogen ratio, nitrogen 'lock-up' is not usually experienced following land spreading (Defra, 2010)

**Table 3** Typical nutrient content of two types of paper crumble: chemically/physically and biologically treated solids (kg/t fresh weight)

| | Total N | Total $P_2O_5$ | Total $K_2O$ | Total $SO_3$ | Total MgO |
|---|---|---|---|---|---|
| Chemically/physically treated | 2.0 | 0.4 | 0.2 | 0.6 | 1.4 |
| Biologically treated | 7.5 | 3.8 | 0.4 | 2.4 | 1.0 |

Source: "Fertiliser Manual (RB209)" (Defra, 2010)

### *3.3.3 Paper crumble distribution model*

The majority of paper crumble applied to agricultural land is supplied in a 'cake' form (i.e. as a stackable solid material), as opposed to a liquid. Typically, storage of paper crumble at the site of production is not feasible or practical and material will be either stored in temporary field heaps on or adjacent to the designated field for spreading, or in some cases (mainly in high rainfall areas) stored on 'hard standings' for ease of access. The land spreading of dewatered paper crumble, rather than recycling in a liquid form, is related to the cost of transportation (less water means less mass) and the ease of handling/storage.

Paper crumble is recycled to land as a waste under Standard Rule Permits for Mobile Plant (for landspreading and for the reclamation, restoration or improvement of land) – SR2010 No.4 and SR2010 No.5 (SI, 2010) in England and Wales; and the Waste Management Licensing Regulations – Paragraph 7 and 9 Exemptions in Scotland (SSI, 2010). Paper crumble recycling services to agricultural outlets include routine soil (i.e. pH, extractable phosphorus, potassium and magnesium) and heavy metal analysis prior to delivery, spreading and nutrient planning services. Where the paper crumble 'locks-up' nitrogen farmers can receive a compensation payment.

## 3.4 Separated Organic Materials (SOMs)

### *3.4.1 Current SOM production*

Mechanical biological treatment (MBT)/mechanical heat treatment (MHT) processes are commonly used for the treatment of non-source segregated municipal solid waste (MSW). Biodegradable organic materials that have been mechanically extracted from mixed municipal waste, can be stabilised (typically via anaerobic digestion and/or composting) to produce a separated organic material (SOM) output (these materials are also commonly called compost-like outputs-CLOs, grey compost, BioCompost etc.). SOMs represent a valuable source of organic matter and major plant nutrients that can be used on reclaimed/restored land to create a manufactured soil. Purchase (2009) estimated that 650,000 tonnes (fresh weight) of SOMs was produced in the UK, of which the majority was destined for land restoration use or landfill. More recently, WRAP (2012a) estimated that 273,400 tonnes (fresh weight) of SOMs was produced in 2010 and the BioCompost Alliance 465,000 tonnes (fresh weight) in 2011 (BioCompost Alliance, 2011). The apparent discrepancy between these numbers is most likely due to the Purchase (2009) estimate being based on anticipated production, whereas the WRAP (2012a) and BioCompost Alliance (2011) numbers represent best estimates of actual production.

### *3.4.2 SOMs distribution model*

Companies producing SOMs find it difficult to develop outlets, as current regulations are highly restrictive on how and where they can be used. Under the Environmental Permitting Regulations (SI, 2010), the application of SOMs to land used for food production (or land to be restored for agricultural use) is not permitted, because it is not source-segregated prior to treatment. SOMs are classified as mixed waste and thus can only be used for land restoration/reclamation, and not for application to agricultural land growing food crops.

In terms of end-use outlets for SOMs, all are used in land restoration/reclamation. WRAP (2012a) reported that typically producers pay to have SOMs removed rather than generating revenue, even though some of the output is being used by companies restoring or remediating land. This indicates that there is a limited market for SOMs, which is further corroborated by the fact that haulage distances to third party users are high (up to 80-100 miles), WRAP (2012a).

## 4.0 Current digestate distribution models

The UK market for food-based digestate is still relatively immature and as a consequence current distribution strategies are similarly under-developed. Digestate is typically spread to agricultural land either on site (land owned by the AD operator) or transported off-site for application to nearby land. The vast majority is recycled 'whole' (*c.*4% dry matter) and as such is expensive to transport, store and spread due to its high water content. There are considerable logistical (and financial) advantages in having an available landbank close to the AD plant. Furthermore, access to available nearby land using umbilical (i.e. no tanker) spreading equipment will increase spreading opportunities and reduce transport costs.

To optimise storage, handling and reduce transport costs digestate enhancement systems, such as de-watering, thickening or drying, can be used prior to land application. However, enhancement systems generally still produce significant quantities of digestate liquor which requires management at the plant. Given the relatively low value of digestate products, the costs of installing enhancement systems (along with operation costs) are currently a significant barrier to widespread adoption.

To identify examples of successful digestate distribution models that AD companies can learn from and adopt/adapt existing practices for the benefit of their own businesses, a telephone survey was undertaken.

### 4.1 Telephone survey

Telephone contact was made with AD industry representatives (identified from WRAP, AfOR, ADBA and REA databases, and through ADAS contacts in the industry). For a description of the method and information sought, and detailed feedback, see Appendix 1.

The telephone survey identified the following distribution models that are currently used by the AD Industry:

- **Category A** – The AD company use a contractor to take whole digestate on a subcontract agreement; the contractor is responsible for finding land to recycle the digestate. Revenue derived from the land recycling of digestate remains with the subcontractor.
- **Category B** – The AD company use contractors to take different digestate products on subcontract agreements e.g. subcontractor A takes the separated liquid which is disposed of to sewer; subcontractor B takes the fibre and is responsible for finding agricultural land to recycle the digestate (see example in Box 3).
- **Category C** - The AD company manage and spread whole digestate on their own agricultural land (see example in Box 4).
- **Category D** - The AD company manage and spread digestate fibre and liquid on their own agricultural land.
- **Category E** – The AD company have a partnership agreement with the AD plant, which is operated on the AD companies own land. The AD company (i.e. the land owner) takes responsibility for spreading digestate on their own agricultural land.
- **Category F** - The AD company actively market and distribute their products – whole digestate, liquid fraction and/or fibre fraction to farmers.

## Box 3: Digestate distribution model – Biffa

Biffa plan to develop a series of AD plants across the country. Their first source-segregated AD plant, which has the capacity to take 120,000 tonnes per year of commercial, industrial, household or other source segregated food waste, opened near Cannock (Staffordshire) in 2011.

### Digestate distribution model - Cannock

- Digestate at the Cannock site is dewatered; the liquid fraction is sent to the onsite leachate treatment facility which treats and refines before discharge to sewer. The separated digestate fibre is recycled to both land restoration sites and agricultural land; although, agricultural land is the preferred market where it is locally available.
- Biffa, like many other large national waste management companies, does not have access to their own agricultural landbank. As a result, a specialist management company has been employed to manage the landbank where the digestate is recycled. Biffa pays the management company for this service on a per tonne recycled basis.
- To access the maximum number of markets and optimise management of the digestate products, digestate is being produced to BSI PAS110 and Anaerobic Digestion Quality Protocol requirements; at the time of writing Biffa was in the process of gaining certification. Once certified, the digestate would no longer be classified as a waste and farmers would be able to spread the material to land without the need for an environmental permit.
- The contractor has responsibility for finding suitable land for recycling and undertaking regulatory compliance for handling and recycling of the fibre product. This includes responsibility for maintaining BSI PAS110 compliance records and procedures. Where necessary, the contractor also prepares agricultural or ecological benefit statements, according to the end use of the material.
- The contractor enters into arrangements with the receiving farmers, which can involve selling and deriving revenue for the digestate. Registered haulage and spreading contractors are employed to apply the fibre digestate to fields identified for spreading and also take on responsibility for managing waste transfer documentation, animal-by products compliance and due diligence.
- As part of the agronomy service, the contractor also undertakes soil sampling to ensure that agricultural application rates are matched with crop nutrient requirements.

This distribution model was a success as Biffa assessed the logistics of digestate management and developed a strategy that was appropriate for the Cannock site.

## Box 4: Digestate distribution – Agrivert

The Agrivert AD facility at Cassington (Oxfordshire) processes over 35,000 tonnes of solid and 15,000 tonnes of liquid waste per year. It was developed around a 20-year contract with Oxfordshire County Council, which required a waste management solution to divert 22,000 tonnes of kerbside collected, source segregated food waste each year from landfill. The facility produces *c.*45,000 tonnes of whole digestate (dry matter 4-5%) which is recycled onto *c.*1,200 hectares of agricultural land adjacent to the site.

### Digestate distribution model – Cassington

- A proportion of the AD feedstock is kerbside collected food waste and commercial food waste, which can contain physical contaminants. To deal with these contaminants the feedstock material is processed using a hammer mill and extraction equipment. The digestate product has physical contamination levels well below the BSI PAS110 threshold.
- For crops to make optimum use of the readily available nitrogen content of digestate, there is a relatively narrow application window. The plant has a designated transfer building where digestate tankers can connect quickly and easily to the storage tanks, without interference from other on-site activities. The digestate is transported up to 8km from the site, within an average transport 'round trip' of 15 minutes.
- Accurate digestate application, with minimal damage to soils and crops, is obviously important to farmers. A long-term partnership with an agricultural contractor, who has a separate contract for the spreading operation, has enabled the contractor to invest in specialist precision application equipment.
- The plant is certified under the Biofertiliser Certification Scheme, which sets a high standard of processing, and in turn provides a consistent product for recycling to agricultural land.
- Agrivert often exchange digestate as part of a rental agreement with host farmers. Also, Agrivert is 'selling' the product at up to £2.50/$m^3$ on a delivered and spread basis. Agrivert are finding that farmers are increasingly willing to pay more for the material, as user experience has developed. The plant is now oversubscribed with farmers wishing to purchase digestate.
- The company is interested in building a robust market for digestate by retaining a group of farmers and growers who will use digestate year on year. Installing digestate storage on partner farms is a planned part of this strategy. This will improve the timeliness and flexibility of digestate application to land, and optimise nitrogen use efficiency by applying digestate when arable crops are actually growing (i.e. in spring/summer).

This distribution model was a success as Agrivert clearly identified agriculture as the target market for their (liquid) digestate products and worked closely with a contractor to invest in precision application equipment that would apply digestate accurately and at the right time to make best use of its nitrogen content. As a result, a revenue stream from digestate sales and a secure agricultural landbank have been achieved.

## 4.2 Constraints to distribution models

The constraints on different digestate distribution models, in terms of transport and spreading costs, are considered in the following sections.

### *4.2.1 Transport costs*

The costs of transporting digestate are dependent on a number of variables, the main ones being transport distance, digestate type, geographical location and vehicle type (Table 4). Transporting whole digestate or separated liquor is considerably more expensive than transporting fibre digestate; this is due to liquid transport being more expensive than the bulk transport of solid materials.

**Table 4** Typical transport costs for organic materials

| Organic material type | Cost (£/hr) | Cost for 10 mile delivery (£ per t/$m^3$)* |
|---|---|---|
| Liquid organic materials (e.g. whole digestate or separated liquor) | £60-80 | £3-4 |
| Solid organic materials (e.g. fibre digestate, biosolids, compost) | £40-60 | £2-3 |

*Costs adapted from Nix (2012)

### *4.2.2 Spreading costs*

The costs of applying whole digestate (or separated liquor) are generally similar to those for solid materials (e.g. fibre digestate, biosolids, compost) per cubic meter/tonne spread.

**Table 5** Typical spreading costs for applying different digestate materials

| Vehicle type (load size) | £t/$m^3$ spread* |
|---|---|
| Broadcast – whole digestate | £2-3 |
| Bandspread – whole digestate | £3-4 |
| Shallow injected – whole digestate | £3.5-4.5 |
| Fibre digestate application | £2-4 |

*Costs adapted from Nix (2012)

The amount of crop available N will be reduced if the digestate is applied in the autumn due to over-winter nitrate leaching losses. A typical fertiliser replacement value of whole digestate is summarised in Table 6.

**Table 6** Typical financial value of whole digestate

| Determinand | Food-based digestate (kg/$m^3$ fresh weight)+ | Financial value food-based digestate* (£/$m^3$ fresh weight) |
|---|---|---|
| Total Nitrogen (N) | 5.0 | - |
| Readily available N (RAN) | 4.0 | - |
| Crop available N** | 3.0 | £2.70 |
| Total Phosphate ($P_2O_5$) | 0.5 | £0.40 |
| Total Potash ($K_2O$) | 2.0 | £1.20 |
| Fertiliser Replacement Value | | £4.30 |

\+ WRAP (2012b); www.planet4farmers.co.uk/manner
* N=90 p/kg; $P_2O_5$=80 p/kg; $K_2O$=60 p/kg
** Assuming spring bandspread application

Based on a fertiliser replacement value for whole digestate of £4.30/$m^3$, transport and spreading costs are a significant part of the economic picture and in most situations are higher than the financial value of the N, P and K in the digestate.

### 4.2.3 Digestate storage

Digestate storage is generally the responsibility of the AD operator. More recently partnership approaches between AD operators and end users have developed; such arrangements can include shared financial and operational management of stored digestate away from the AD plant and close to the agricultural landbank for recycling. Typically, the capital costs of liquid organic material storage are in the range £25-£50/$m^3$ (Nix, 2012); the lower end of the range being for an earth banked lagoon and the higher end for a concrete or steel structure. Where storage takes place on the site of the AD plant, it is a requirement of the ADQP (WRAP/EA, 2009) that on-site storage is covered. By way of comparison, stackable materials (e.g. fibre digestate, biosolids cake, compost) can be temporarily field heaped prior to land spreading, which is effectively 'free' storage.

## 5.0 Lessons for the digestate industry from other sectors

The processing and marketing logistics associated with digestate (liquid) management are only now being recognised by some AD operators. These issues are not unique from the challenges faced by their forebears in the wider organics recycling industry (e.g. the water and composting industries). Importantly, the digestate industry can learn from the experience and advances of these more established industries, using the lessons learned to more rapidly find (financially and environmentally) sustainable solutions that best meet their specific needs and requirements.

From the telephone interviews, and in particular during production of the case-studies, it was evident that distribution models for biosolids and compost were well established. Similarly, product development and marketing was further forward than was evident from discussions with most AD operators. A key factor in the distribution of biosolids and compost, in contrast with whole digestate/digestate liquor, is that they are stackable products that can be more easily stored, transported and applied. Whole digestate (and separated liquor) are liquid materials and have associated greater challenges in their storage, transport and land application practices.

Although digestate can be separated into liquid and fibre fractions, such processes have an associated cost (typically in the range of £0.5-1.0$m^3$). The fibre typically has a dry matter content between 20-40%. The volume of the whole digestate is typically reduced by 10%, leaving 90% by volume as digestate liquor that still requires management. Newer processes (e.g. Bucher Press or Hydro Cell) can further reduce the water content of the solid fraction to <50%, but these technologies have not been widely used with digestate to date.

### 5.1 Supply material direct to customers from the site of production

**Advantages**
- producer has control over where the material is recycled;
- material can be moved off-site when it is convenient for the producer (assuming adequate storage);
- supplying whole digestate or separated liquor via a pipeline from the AD plant reduces haulage costs; and
- where customers are prepared to pay for the product this will generate revenue.

**Disadvantages**
- on-site storage will be required (or storage off-site near the receiving landbank);
- the AD plant operator has to identify and secure a recycling landbank; and
- cost to the AD operator of transporting and landspreading digestate.

### 5.2 Offering material direct to customers at the site of production – customer collects material

**Advantage**
- no transport and spreading cost associated with product delivery.

**Disadvantages**
- the approach is most applicable to solid products, which for separated fibre would only represent 10% of the whole digestate volume; and
- marketing costs to promote the product to users and overall market place uncertainty.

## 5.3 Offer a complete service – use specialist contractors to deliver and spread the product

**Advantages**

- allows the company to concentrate on its core business and use 'experts' to market, transport and spread the product;
- provides assurance that the material will be removed from the site for recycling; and
- divests risk, it is the contractors responsibility to find suitable land, ensure regulatory compliance etc.

**Disadvantages**

- loss of control on how the material is recycled;
- cost of contractor services; and
- where customers are prepared to pay for the product there will be a loss of direct revenue to the AD plant.

## 5.4 Spread the product on AD operators own (nearby) land

**Advantages**

- control on how the material is recycled;
- transport costs are minimised, especially if an umbilical system is used; and
- saving on manufactured fertiliser costs.

**Disadvantages**

- may distract the company from its core business; and
- need for a large landbank.

## 5.5 Supply digestate as a solid material

**Advantages**

- the product can be delivered to the farmer well in advance of the spreading operation and stored in temporary field heaps;
- delivery can be spread throughout the year (as the product can be stacked and stored in temporary field heaps) and does not have to be concentrated into the period prior to spreading to land; and
- the product is already on-site making for a more efficient spreading operation.

**Disadvantages**

- it can be expensive (and energy intensive) to de-water liquid products (i.e. whole digestate); and
- the resultant separated liquor still needs to be managed, which for present day separation technologies typically represents 90% of the whole digestate volume.

## 6.0 Recommendations

Digestate distribution and marketing should be researched and planned at the project feasibility and planning stage. Viable outlets for the digestate should be assessed and matched to the type of product that will be produced.

### 6.1 Step by Step Guide to developing a market for digestate

There are a number of steps that AD operators should take to develop a robust digestate distribution strategy. The scenario below focuses on digestate distribution to agricultural land, which is currently the most common destination. However, the principles can be used in marketing the product to new or emerging markets.

#### *6.1.1 Step one: Identify the likely market opportunity*

Decide whether to keep the digestate whole or separate into liquid and fibre fractions:

- Whole digestate can be applied via tanker or umbilical systems to agricultural land.

**Separation**

- The fibre can be stored in temporary field heaps ahead of land spreading, resulting in a flexible window of application.
- The liquor (90% of whole digestate volume) can be applied via tanker or umbilical systems to agricultural land; or if permitted discharge to sewer.

#### *6.1.2 Step two: Assess the local market*

- Assess the characteristics of the local farming industry. The ALOWANCE (WRAP, 2013) and ALOWANCE-Scotland (ZWS, 2013) mapping tools can be used to identify potentially available agricultural land within an identified radius of the AD plant.
- Identify suitable arable crops and grassland.
- Identify land recycling restrictions such as:
    - Nitrate Vulnerable Zones (and associated N loading rate/closed spreading periods);
    - Sites of Special Scientific Interest (SSSIs), Nature Reserves, land in Countryside Stewardship, Higher Level Stewardship agreements etc; and
    - physical restrictions (e.g. steep slopes, proximity to watercourses, water protection zones).
- Identify market competition from other organic materials (e.g. livestock manures, compost, biosolids):
    - will farmers be receptive to taking digestate when compared to alternatives?;
    - assess if farmers are likely to pay for the digestate – has it a value to them?; and
    - advise farmers that as for most organic material applications, they should consult the purchaser of their crop regarding any restrictions on the use of digestate.
- Determine the preferred logistics model, for instance:
    - a package for all digestate transport and spreading to land by either a contractor or the digestate producer (storage at AD plant);
    - a package where the farmer stores digestate on the farm followed by land spreading either via a contractor or themselves.
- Security of outlets. Develop long-term agreements with farmers/spreading contractors/haulage contractors to facilitate investment in infrastructure and machinery.
- Assess storage capacity based on:
    - production volumes;
    - landbank type (crop type) and availability;
    - contingency for lengthier storage (if required); and

- secure structures.

### *6.1.3 Step 3: Preparing for management of the distribution process*

- Determine whether the digestate will be marketed as a product (i.e. you will operate under the Quality Protocol and the digestate will be certified as produced to BSI PAS110) or whether the digestate will be used as a waste:
  - BSI PAS110 gives extra reassurance of product quality to the customer; and
  - recycling to land as a waste must be undertaken in compliance with Standard Rule Permits for Mobile Plants SR2010 No.4 or SR2010 No.5 (SI, 2010).
- Identify service expectations – what will farmers require from the service.
- Identify who manages the digestate and in turn the market:
  - the AD operator;
  - an appointed contractor; or
  - the farmer/landowner.
- Determine contractual agreements:
  - decide if and how to appoint a contractor;
  - identify responsibilities of digestate supplier and receiving farmer; and
  - agree model for payment.

### *6.1.4 Step 4: Marketing*

- Quantify the typical nutrient content of the digestate:
  - value (financial and nutrient) in terms of N, P, K and S;
  - added value – organic matter; and
  - identify digestate benefits for end-user i.e. savings on manufactured fertiliser and spreading costs/time.
- Decide on a marketing approach; including for example:
  - a leaflet explaining the benefits of using digestate, with clear product information.
  - promotional case-studies;
  - visual aids, web pages; and
  - providing support from a FACTS (Fertiliser Advisers Certification and Training Scheme) qualified professional.
- Assess potential 'resistance' to digestate use and identify competition from other organic materials.
- Promotion; including for example:
  - Hold 'breakfast' type meetings for 6 to 10 farmers and invite a technical speaker to discuss the benefits of using digestate; and
  - Arrange visits to AD plant.
- Quality assurance and record keeping to provide traceability:
  - provide soil analysis data for nutrient planning;
  - field risk assessment for spreading; to minimise diffuse pollution risks and odour nuisance; and
  - provide a single point of contact for the distribution operation.
- Ensure environmental compliance with, for example:
  - animal-by product regulations (SI, 2011; SRNI, 2011; SSI, 2011; WSI, 2011);
  - Nitrate Vulnerable Zone regulations (SI, 2008; SRNI, 2010; SSI, 2008; WSI, 2008);
  - Codes of Agricultural Practice (DARD, 2008; Defra, 2009; Scottish Executive, 2005a; WAG, 2011);
  - cross compliance rules (DARD, 2013; RPA, 2013; Scottish Executive, 2005b; Welsh Assembly Government, 2009).

## 7.0 Conclusions

The UK market for digestate is immature and as a consequence current distribution strategies are less developed than for other organic material recycling sectors (e.g. biosolids and paper crumble supply). With the advent of larger scale AD plants, the industry is having to address the issue of finding market outlets for large volumes of (liquid) digestate. Similar issues have been previously addressed by the compost, water and paper industries.

### 7.1 Lessons from other organic material sectors

The experience gained by established organic material recycling sectors, such as the composting and water industries, should be valuable to AD operators, particularly in understanding how they have addressed the needs of the market. However, there are differences between the materials, notably whole digestate is a much 'wetter' (*c.*4% dry matter-dm) material than compost (*c.*60% dm) or biosolids (25-95% dm for solid materials), and as a result the costs of storage and land recycling are higher than for solid-based products. Drawing on experience from other sectors the following lessons can be learnt:

- The storage, transport and spreading costs associated with the recycling of whole digestate (or separated liquid) are usually greater than the fertiliser value of the product. Choices about how digestate is distributed can be critical to the viability of an AD project.
- Distribution as a solid material allows greater market reach through reduced transportation costs. Digestate enhancement systems, such as separation, dewatering or thickening, may be used to separate the whole digestate prior to transportation into a fibre and liquor portion. Also, a stackable product can also be stored in temporary field heaps, rather than requiring investment in secure liquid storage facilities. However, typically 90% of the whole digestate volume will still remain as digestate liquor that requires management (e.g. via land recycling or if permitted direct disposal to sewer).
- The land recycling of digestate is constrained by crop growing seasons, Nitrate Vulnerable Zone regulations (and Codes of Good Agricultural Practice) in relation to field application rates and closed spreading periods, and the availability of agricultural land within economic transport distances. The provision of adequate and secure storage is *essential* to enable year round production to be matched to land access and availability.
- Access to an available local landbank, using umbilical (i.e. no tanker) spreading equipment, will increase spreading opportunities as a result of the lower ground pressure (weight) of the application system and will reduce transportation costs.
- Charging the customer (farmer) for digestate supply, reflecting its value as a source of crop available N (plus phosphate, potash and sulphur) will help to off-set producer costs (i.e. for storage, transport and land application). However, this approach is very much dependent on the farmer being willing to take the digestate; competitive product pricing (relative to manufactured fertiliser use) will be required to obtain and retain a sustainable landbank. Many water companies initially supply biosolids free of charge, until the value of the product has been recognised by farmers so it is likely that some digestate producers will initially have to take this route to market. Importantly, a fertiliser marketing approach to digestate supply and use (not disposal) should be supported by professionally qualified (i.e. FACTS) advice.
- Accreditation to BSI PAS110 will increase customer confidence in digestate as a product and help to increase market access.

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# Appendix I – Study of AD Operators Marketing Practices

Sixty seven AD operators were identified and approached for a telephone interview; a summary of their responses is provided below:

- 24 said yes to an in-depth telephone 'chat';
- 14 did not respond or reply to messages left or follow-up emails (3 attempts were made);
- 6 operators had an 'educational' remit so had potential to showcase market development;
- 9 could not talk about their activities on the basis of commercial sensitivity; and
- 14 operators ran small plants and only spread digestate onto their own land.

A telephone guidance sheet was used to ensure consistency in the questions asked and to act as an *aide memoire*. The following information was collated:

- The name of the company contact and their role within the organisation. [It was important to establish we were speaking to the right person. Several of the companies have a 'no comment' approach to enquiries].
- General information on the AD plant, its operation and output:
    - quantities processed (feedstocks/outputs);
    - is the digestate treated – mechanically, chemically or other?;
    - do they have BSI PAS110 certification or are they thinking of securing BSI PAS110 certification?;
    - do they produce a product (brand)?;
    - do they spread to their own land or supply other land users?;
    - do they haul and spread themselves, or do they employ a partner or contractor?;
    - do they receive a payment for the digestate supplied?;
    - have they a particular market? Agriculture, horticulture, amenity, forestry etc.?;
    - do they undertake any form of marketing or sales for their digestate?;
    - do they encounter any constraints/barriers?;
    - do they have contingency plans in place to address constraints/barriers?;
    - what issues do they feel are a barrier to further development of the digestate market?; and
    - would they be interested in participating in a more detailed interview with a possible face-to-face meeting to discuss a business case study?

As a result of 'resistance' to answering some questions (usually due to commercial sensitivities) the approach was changed to an informal discussion, rather than a structured 'interview process'.

The following key comments and issues on digestate distribution were raised during the telephone discussions:

- the 'high' cost of digestate transport from the AD plant to agricultural land for spreading (or storage); this was mainly related to distance, but travel time was also influenced by the type of road;
- some digestate producers had concerns that farmers' would not pay for digestate, meaning that they might have to 'subsidise' farmers to take it;
- the cost of digestate disposal (to sewer);
- the need for contingency plans, including the provision of sufficient storage and what to do with digestate that failed to meet BSI PAS110 standards. Obtaining BSI PAS110 was

considered a lot of work for some small businesses which put pressure on senior staff; and
- odour problems and logistical management issues.

Digestate producers were asked if they undertook any marketing:
- 3 said yes;
- 7 not applicable; and
- the remainder gave no response.

Digestate producers were asked if they employed or partnered with a contractor for spreading digestate:
- 11 said yes;
- 8 said no; and
- the remainder gave no response.

Digestate producers were asked if they spread digestate on their own land:
- 11 said yes;
- 9 said no; and
- the remainder gave no response.

Digestate producers were asked if they spread digestate on land other than their own land:
- 10 said yes;
- 10 said no; and
- the remainder gave no response.

From the telephone survey it was clear that to secure a sustainable agricultural landbank for digestate recycling involves investment in adequate (secure) storage and precision application equipment to apply digestate evenly and at target application rates that is backed up by professionally qualified (e.g. FACTS) qualified advice i.e. a fertiliser marketing approach needs to be taken. It was apparent that AD operators were (not surprisingly) very dependent on local markets – each AD plant operated in its own 'bubble' and that the markets for digestate varied from site to site, driven by local circumstances.

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