

Tackling plastic contamination

Dr David Tompkins, Head of Knowledge Exchange and Innovation at Aqua Enviro, explores the particular problem of plastic contamination in composts and digestates, and how it might be addressed.

Plastic contamination and plastic limits are a core topic for the current compost and digestate Quality Protocol (QP) reviews. Feedstock contamination levels are required to decline to ‘as low as reasonably practicable’ (ALARP) by the end of 2025 and the QP reviews are focusing on limits in the end products – and how these might be changed.

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Since the limits are set in PAS100 and PAS110 rather than the QPs, an overhaul of the standards will be an inevitable consequence of the QP reviews. That is unless the industry lobbies Defra and the EA to port the end of waste process into new GB fertiliser regulations which are currently under development. In either case, limits on plastics will come under close scrutiny.

Although current limits are broadly in line with those applied in other countries, worst-case situations still allow the equivalent of thousands of fragmented plastic carrier bags to be spread on each treated hectare of land. This situation was deemed unacceptable by key Scottish farm assurance bodies nearly a decade ago, and much more stringent limits for plastics were phased in there. Should the rest of the UK now follow suit?

Background

Plastic contamination in composts and digestates is a systemic problem caused by a combination of inadequate processing and multiple upstream failures in governance – from the moment wastes arise to when they are collected and accepted for processing. Various prior attempts have been made to address these failures, the most recent being set out in the series of actions that form WRAP’s 2021 Organics Sector Roadmap. This includes changes to environmental permits.

Perhaps in response to the lack of initiative shown in other parts of the supply chain, the EA showed its hand by consulting on and then amending

Standard Rules permits in 2021. These now include – for the first time – feedstock contamination limits. In all cases, the presence of non-compostable contaminants must be at levels which are ‘as low as reasonably practicable’ (ALARP) by the end of 2025, with limits in the meantime of either one per cent or five per cent depending on the specific permit. This approach is unusual, but not unique – Californian regulations say that source-segregated biowastes can’t be sent to licensed composting facilities if they contain more than one per cent contamination.

These changes are expected to be rolled out to bespoke permits and, in the meantime, the spotlight has shifted to end-product quality. The EA has previously stated that it considers the limits for plastics in BSI PAS 100:2018 and BSI PAS 110:2014 to be too high, and there have been suggestions of alignment with the approach taken in Scotland. The Scottish limits were first introduced in 2014 for use by members of the Quality Meat Scotland Cattle and Sheep scheme, restricting plastic in compost to 50 per cent of PAS100 limits, and in digestate to eight per cent of PAS110 limits. The same restrictions were subsequently adopted by Scottish Quality Crops, at which point the Scottish Environment Protection Agency (SEPA) took the view that regulatory quality controls needed to fall into

line with those adopted by the market. These were phased in between 2017 and 2019. Feedback suggests that the Scottish limits for digestate are readily achievable (for liquid fractions) with appropriate depackaging and screening, whilst for compost, the limits are more challenging to reach.

Outside Scotland, the PAS limits have remained in force, under worst-case scenarios allowing the equivalent of up to 2,500 carrier bags to be spread per hectare each year. Alignment with the Scottish limits would represent significant progress, but how do they compare with standards used elsewhere – and are any of them based on actual evidence of harm?

PAS limits in context

In its 2021 report for the Irish Environment Protection Agency, Percy Foster and Munoo Prasad collated and discussed limits for ‘impurities’ adopted by various countries, to inform its recommendations for compost and digestate quality in Ireland. It settled on 0.25 per cent for plastics in both materials – on a dry weight basis – which aligns with future limits set out in the EU Fertilising Products Regulation (EU FPR). The PAS limits use different units (air dry for compost and fresh weight for digestate), meaning that they have to be converted to allow comparison with those in force

Figure 1: Limits for plastics in compost and digestate from various geographies (% on a dry weight basis, unless otherwise stated). Note that the UK limits have been converted from air dry (for compost) and fresh weight (for digestate) to dry weight to facilitate comparison

	Compost	Digestate	Particle size cut-off
PAS limits	0.14%	0.44%	>2mm
Scotland	0.07%	0.04%	>2mm
Australia	0.05% (film plastics)	-	-
Austria	0.2%	-	>2mm
California	0.1% (film plastics)		>4mm
EU FPR	0.3% (0.25% from 16 July 2026)		>2mm
Finland	0.5%		>2mm
Germany	15cm ² film plastic where total impurities >0.1%		>1mm
Netherlands	<0.05% (Class A)	-	>2mm
Switzerland	0.1%		>2mm



elsewhere. Various assumptions have to be made to do this, around the typical dry solids content in both materials, and nitrogen content in digestates, but once converted it is apparent that the PAS limits for compost and digestate are broadly in line with international norms. The Scottish limits are more precautionary, but by no means uniquely low (Figure 1).

Other points to note from this comparison are that most countries apply a 2mm particle size cut-off and that all outside the UK apply limits on a dry weight basis. In some cases limits vary by 'class' of material, depending on the intended end use (e.g. growing medium vs soil improver), but for field-scale use such single limits don't account for possible variations in application rate, meaning that more plastics may be applied to some soils than others. Since they can have the most visual impact on compost and digestate quality, some assurance schemes apply limits specifically to film plastics. The low density of these materials creates analytical challenges, addressed in Germany by the use of area-based limits. This can help avoid situations where surface contamination of low-density films might otherwise skew weight-based results.

Challenges with sampling and testing

Data is only meaningful if samples are representative of the original material. Achieving this depends on having robust sampling procedures that are implemented by appropriately trained

staff. Sampling approaches for compost are set out in a British Standards European Norm (BS EN) standard (12579:2013), but sampling of digestates is captured only in industry guidance. The sampling port for digestate may be smaller than the final off-take port and act as a filter that keeps larger plastic fragments in the digester, unquantified. This needs attention, as does the lack of independent sampling currently allowed by the UK compost and digestate certification schemes. Sampling by trained, independent third parties is common in other certification schemes and although their use would incur additional cost, it could also improve confidence in material quality and overall scheme robustness.

Regulators want to see PAS limits reduced, but where should those limits be set?

Once back at the lab, materials are tested with simple dry and/or wet screening methods, followed by visual identification and manual extraction of physical contaminants that are >2mm. These methods have developed over time, based on operational experiences – but their reliability and accuracy are largely unknown, with neither ring testing nor other conformity assessments routinely implemented. Potential weaknesses in the test methods include the propensity for film plastics to fold and pass through the 2mm screen, the reliance on visual identification of different

types of physical contaminant and the potential for poorly cleaned plastic fragments to skew sample weights. These weaknesses need to be explored experimentally – and addressed. Experiments could also explore the potential benefits of adopting an area-based approach for film plastics, as suggested in work for SEPA completed five years ago.

Research would also be necessary to determine whether the lower particle size limit should change. There are limited data for non-UK composts which show that the <1mm fraction can contain an equivalent proportion (by weight) of plastics to the >1mm fraction, but in the absence of evidence it's not possible to state that the same would be true of UK materials or the +/- 2mm fractions. Nonetheless, it is impossible to deny the ever-increasing research and public interest in microplastics (>5mm), and mounting evidence of harm to soil organisms from microplastics under experimental conditions.

There are currently no limits in place anywhere for microplastics of <1mm – in composts, digestates or any other biofertiliser or soil improver. Testing for microplastics in these matrices is challenging, requiring separate extraction and identification / quantification steps. Techniques such as FTIR (Fourier-Transform Infrared) and Raman spectroscopy allow different polymer types to be distinguished, and when coupled with suitable scanning software, can allow particles to be counted and categorised by surface area. This can



allow micro and nano-plastic particle numbers to be determined, but doesn't generate a weight-based metric. Mass can be determined through the use of destructive techniques such as Pyrolysis-Gas Chromatography-Mass Spectroscopy (Pyro-GC/MS), but this has its own limitations. In all cases, these methods can be expected to be more expensive than the current PAS-specified methods.

Evidence of harm

The impacts of plastics on soils, soil organisms and crops are various. Soil physical properties such as bulk density, aggregate stability and water retention capacities can be adversely affected, while a growing body of research reports ecotoxicological impacts under experimental conditions. These include: abnormal gene expression in earthworms; changes to microbial communities and biomass; delayed or reduced seed germination rates; reductions in shoot, root and/or overall plant biomass. Very small plastic particles can also be absorbed and transported into the edible portion of crops.

Although alarming, extreme caution should be taken when attempting to translate any of these experimental impacts into field situations. Experiments tend to be short-term and use acute doses of microplastic to elicit an effect. There is also significant inconsistency within published papers, with reported impacts being difficult to reproduce. Soil concentrations of 10% or more by weight of microplastics can be used in experimental systems,

and quick calculations suggest that it would take decades of application of PAS-compliant composts and digestates contaminated at the highest permissible level to achieve even the lowest soil concentrations used to produce experimental effects. Moving to the Scottish limits would extend this theoretical threshold out to a century or more of 'worst case' applications – but this would be a highly precautionary response. There is simply insufficient data to recommend evidence-based limits for plastics in soils (and hence, composts or digestates). The same is also true for marine and freshwater environments, where there is already a much larger evidence base.

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It must also be highlighted that compost and digestate represent just two of the potential sources of plastics in soils. Others include: sewage sludges, runoff from roads, aerial deposition, littering, and plastic film mulches. There is currently no source-apportionment data for plastics of any kind in UK soils, making it impossible to determine whether any one source should be prioritised for action over any other.

What needs to happen next?

The compost and AD sectors find themselves in an interesting position. The regulators want to see PAS limits reduced, but the available evidence doesn't (yet?) tell us where those

limits should be set. It's undeniable that plastic contamination has a huge visual impact and is innately undesirable – but in the absence of scientific evidence any new limits need to be dictated by compost and digestate users – whether in the growing media, field horticulture, landscaping or agricultural sectors. Alignment with the Scottish limits is one logical solution, and a process of knowledge exchange would be extremely helpful – allowing the industry to collectively develop and apply best practices to meet these limits, which could be phased in between now and 2025. Understanding whether those limits are tight enough will require stakeholder engagement.

Aside from the limits themselves, a number of other aspects should be considered in the QP or PAS reviews:

- 1 Sampling methods – particularly for liquid digestates – to understand whether samples are representative
- 2 Independent sampling – to improve confidence in the assurance schemes
- 3 Lab methods – particularly for liquid digestates – should be reviewed to see how reliable they are. The benefits of including an area-based limit for film plastics should be incorporated into this review
- 4 Proficiency testing – should be introduced for plastics (and other analytical parameters)
- 5 Research – to understand the sources, impacts and implications for micro and nano-plastics in soils, to identify priority areas and develop an action plan. Research should be funded by central government

Serious consideration should also be given to moving the end of waste requirements for compost and digestate into the new UK / GB fertiliser regulations. It's clear that the status quo on plastic contamination in these materials is no longer acceptable, and that limits will have to come down – whatever the regulatory framework under which this happens.

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