Creating markets for recycled resources

Comparison of compost standards within the EU, North America and Australasia

Main Report

June 2002

Written by:

Dominic Hogg, Josef Barth, Enzo Favoino, Massimo Centemero, Valentina Caimi, Florian Amlinger, Ward Devliegher, Will Brinton and Susan Antler.

Published by:

The Waste and Resources Action Programme

The Old Academy, 21 Horsefair, Banbury, Oxon OX16 0AH
Tel: 01295 819900 Fax: 01295 819911 www.wrap.org.uk

ISBN 1-84405-004-1

Authors

Dominic Hogg[1] Josef Barth[2], Enzo Favoino[3], Massimo Centemero[3], Valentina Caimi[3], Florian Amlinger[4], Ward Devliegher[5], Will Brinton[6] and Susan Antler[7].

[1] Eunomia Research & Consulting, 120 Cotham Brow, Bristol, BS6 6AR, UK

[2] INFORMA – Consultation Office for Information and Marketing in Waste Management, Germany, Am Landhagen 64a, D-59302 Oelde, Germany

[3] Scuola Agraria del Parco di Monza, Viale Cavriga 3, I-20052 Monza, Italy

[4] Kompost – Entwicklung & Beratung, Technisches Büro für Landwirtschaft. Hochbergstr. 3, A-2380 Perchtoldsdorf, Austria

[5] VLACO – Vlaamse Compostorganisatie VZW, VLACO, Kan de Deckerstraat 37, 2800 Mechelen, Belgium

[6] Woods End Research Laboratory, Inc., P.O. Box 297, Mt Vernon, Maine 04352, USA

[7] Composting Council of Canada, 16 Northumberland St., Toronto, ON M6H 1P7, Canada

This document forms the main body of the report. There are also a set of 19 supplements, and the ISBN number for the full set is: 1-84405-006-8.

Foreword

We would like to thank our Project Manager, Anne Riding of WRAP, for her guidance and forbearance as this Project has evolved. We would also like to thank the other Members of the Review Group for this project for their time and for their critical comments. They are Nina Sweet (Environment Agency, substituted by her colleague Jonathan Lees during maternity leave), Louise Mitchell (Department for Environment, Food and Rural Affairs, DEFRA) and Jim Frederickson (Open University). Thanks are also due to Lori Johnston (Open University) for her editing of this Report and the associated Nation Specific Supplements.

Eunomia Research & Consulting would also like to thank the members of the project team for their co-operation and lively participation in what were very illuminating discussions in the context of this work.

Glossary of terms and abbreviations

Biowaste: mixture of kitchen and garden waste – there are a number of more-or-less equivalent terms used in Europe – VFG compost refers to waste from vegetables, fruit and gardens. GFT compost has a similar meaning. 'GFT' has special significance in Flanders where those municipalities designated as GFT regions are obliged to separately collect 'GFT' waste.

Garden waste: biodegradable waste from gardens, such as grass cuttings, leaves, branches etc.

Green waste: waste from gardens and municipal parks.

Mixed waste compost: unless otherwise specified, this refers to compost derived from refuse, or from a biodegradable fraction which is separated from the refuse following its collection within the residual waste stream.

Mechanical biological treatment (MBT): the treatment of residual municipal waste through a combination of mechanical separation and biological treatment of the mass of waste. The process may have multiple objectives, but a key one is the stabilization of the biodegradable fraction through biological treatment.

MSW: municipal solid waste.

Organic contaminants: will be used throughout this report to refer to chemicals such as dioxins, polychlorinated biphenols (PCBs), absorbable organic halogens (AOX) and other organic chemical contaminants such as phthalates. The term 'potentially toxic elements' (PTEs) will be used throughout this report to denote both heavy metals and organic contaminants.

PTEs (Potentially Toxic Elements): used to denote heavy metals as well as organic contaminants.

QAS (Quality Assurance System): used in this report to cover a range of activities, usually non-statutory in nature, designed to ensure that producers maintain process management and product quality in biological treatment processes.

Residual waste: this is the waste which is collected from households, commerce and industry which has not been separated at source. It is sometimes referred to as 'restwaste'.

Stability/maturity: there is no accepted definition but this refers to measures of the completeness of the composting process (to what extent has the material been completely stabilised by the process?).

Executive summary

A review of standards for composting across Europe, North America and Australasia reveals that 'systems' designed to promote composting in a manner which respects requirements to protect human, animal and soil health tend to have the following elements in place:

1 Standards designed to regulate potentially harmful aspects of compost production and use. These are frequently of a statutory nature;

2 Complementary standards governing, e.g., environmental/health aspects of application to land (usually of a statutory nature); and

3 Standards (quality assurance systems) established to give confidence to consumers through quality assurance, as well as clear specifications for specific market outlets (almost always voluntary in nature).

Range of compost standardisation – from output material to marketed product

These different standards have the potential to come into conflict. Carefully designed, however, they can be mutually supportive in developing markets for compost products based on both the protection of human and animal health and the environment, and fitness for purpose of the end products.

As a result of different political and industrial developments across the world, compost quality assessment has evolved differently from place to place. However, there are a number areas of seemingly close agreement across national boundaries. In addition, most countries, in the context of the development of systems for composting, have in place quality assurance systems which either stand freely, or are supportive of, the existing statutory standards. These systems have a variety of objectives, but they aim to ensure production of quality products to specific standards, and to facilitate marketing through use of quality symbols, and through ensuring that products are tailored to specific end-uses.

It is difficult to comment on the 'success' of compost standards, as they tend to function in the context of wider systems. However, for a 'successful system' it should be possible to answer 'yes' to the following three questions:

1 Does the system help to sell as much compost as is produced and needed?

2 Are the users of the product pleased with it (will they use it repeatedly, and promote its use to others)?

3 In the use of compost, is the environment well protected?

If the answer to these three questions is yes, the system can be said to function well, irrespective of its design.

The first question raises all sorts of questions about the relative costs of waste treatments, and the legislative/ regulatory framework for waste management. Those countries which have encouraged composting most strongly are Austria, Flanders, Germany and the Netherlands. It is worth noting that in these countries compost products are used for a variety of applications in large volumes. As such, they are currently successful. This has not always been the case. In the Netherlands, for example, there have been periods where it has been difficult to develop markets as rapidly as material was produced. The lesson (well-learned in neighbouring Flanders) is that markets must be developed in parallel with the development of production. Each of these countries has in place a statutory standard supported by systems for quality assurance.

Key Conclusions

The following are some of the key conclusions based upon the comparative analysis undertaken. It should be stressed that whilst these constitute our own recommendations, there is no one way to approach the issue. Having said that, the possibility of a new EU Directive covering these issues certainly suggests the wisdom of some 'approximation' to what might emerge from that Directive rather than establishing a UK system which represents a radical departure from existing draft texts.

1 Statutory or non-statutory? The UK is in a declining minority in the EU in its lack of statutory standards for compost. The situation regarding the regulation of biowaste treatment and the use of compost in the UK would benefit from some form of statutory reference point, at least with respect to 'precautionary' issues (see point 5). This will improve the prospects for production of quality composts, and forms the basis for marketing quality products which are not wastes.

2 Input materials. With regard to input materials, the most common approach appears to be one of listing those materials which may be included, as well as those which may be used in mixing (though dilution should be treated separately to production, with reference to the specific classes of materials in any standard). Care has to be taken in drawing up lists of materials for inclusion/exclusion for statutory approval. Since formal legislation is necessary to enforce such restrictions, if mistakes are made in drafting legislation, these can be difficult and time-consuming to rectify in retrospect because of the need to revise legislation. Certain end-users have specific requirements (e.g. organic farmers, who have concerns regarding the presence of genetically modified materials) which effectively exclude certain materials from us by them.

3 Number of compost classes. The question as to whether to include more than one standard has to be considered in the context of:

(a) The scope of the standards (which materials); and

(b) The approach to regulation of mixed municipal wastes and materials with higher levels of contamination.

On the former issue, there are a variety of approaches across countries. However, it seems that subject to the list of materials to be included (and potentially, related regulations concerning application rates), the number should be kept small so as to avoid confusion. Typically, a very high standard is set for products suitable for use in organic agriculture.

On the latter issues, the approach favoured by countries where composting is in an advanced state of development is a clear distinction between product and waste which places materials derived from mixed municipal waste and those with higher levels of contamination, outside the definition of 'compost' as a product. This could be achieved either through: i) establishing statutory standards for compost, or ii) through amending the exemptions under the Waste Management Licensing Regulations, or iii) (for Local Authorities in England) through enshrining the definition of composting under Best Value as composting based upon source-separated materials, or iv) (as happens in Ireland) through the 'interim' measure of specifying standards in licenses for compost plants. Experience in, for example, Germany suggests that it is difficult, in the longer term, to positively market anything which is a waste (see Appendix 2).

4 **Standards for processes.** Standards for processes are rather difficult to establish. The parameter for which a statutory requirement is most often imposed is the 'temperature-time' regime, which is used to assure hygienisation. Interestingly, only Austria sees this as unnecessary (based on extensive experience), preferring instead to test end-products for the presence of pathogens (though also requiring the upkeep of a process diary including a temperature record). Being in a much earlier phase, we would recommend a statutory standard process for hygienisation of products in the UK. This should be set with care, acknowledging that hygienisation occurs both through elevated temperature and through the antagonistic breakdown of material in the composting process.

5 **Product standards.** At a fundamental level, the line which should be drawn between the statutory and 'voluntary' aspects of standards needs to consider the basic fact that any statutory instrument is difficult to change once it is on the statute book. As such, the statutory standard should be limited as far as possible to those elements which seek to ensure protection of the environment and health (of humans and livestock).

With regard to PTEs, aspects of product standards are increasingly set on the basis of a desire to protect soil quality, and this should be a major focus of the precautionary standards. Levels should be set with tolerances in place (i.e. acceptable 'bands' of variation around the guide value), the tolerance band being determined by the strictness of the standard (the percentage tolerance should be greater the tighter is the standard, given the inability of producers to exercise complete control over feedstocks). As far as possible, standards should also be set against a standardised level of organic matter (so that concentrations which are measured are comparable).

Other elements of a statutory standard which should be considered concern the presence of pathogens (which is done in almost all countries examined and provides some 'back-up' to the 'temperature-time' process standards), physical impurities (the details of the approaches taken vary across countries) the presence of weeds (though likely to be far more important in some applications than in others) and stability and the related parameter of phytotoxicity

Lastly, statutory standards could consider establishing minimum levels for organic matter content. Dilution with soil may lead to 'blends' being offered as composts. For this reason, a statutory minimum organic matter level may be useful. Equally, a restriction on adding excavated soil could be considered.

6 **Mechanical biological treatment.** The rationale for establishing a standard for MBT has to be considered in the context of wider waste management policy objectives (and interpretations). In the UK, the interpretation of the Landfill Directive requirement for 'pre-treatment' is relatively weak (i.e. most processes qualify as pre-treatment), so that (subject to the Landfill Directive Article 5 targets), biodegradable waste will continue to be landfilled without any requirement for stabilisation. As such, the rationale for an MBT standard as a 'pre-treatment' requirement appears to be absent. On the other hand, it may make some sense (if it were deemed desirable to specify a 'standard' for lower quality materials) to make this a standard for stabilised biowastes as opposed to a composting standard, since this explicitly draws a distinction between lower quality products with 'waste-like characteristics' and those which are less likely to cause build-up of PTEs in the environment. This is in line with proposals in the Second Draft Working Document on the Biological Treatment of Biowaste.

7 **Quality assurance systems (QASs).** Potential users will be more convinced of the value of compost materials and their consistent quality where quality control systems are in place. Quality control is needed because compost is, after all, made from waste, the handling of which can be problematic. Compost producers need a quality assurance system with continuous internal and external quality control to standardise the production of compost that meets the necessary standards. In this way, compost can be considered and be sold as a useful product, and no longer as a 'waste'.

QASs seem to have played an important role in ensuring positive marketing of quality compost products in many countries. In a context where the absence of statutory legislation gives no reason for producers to engage in voluntary systems, there is less likelihood of them doing so if the quality symbol fails to confer significant value/ marketing advantage to their product.

Two possibilities arise:

(a) Require, or encourage (through exempting producers in specific recognised QASs from some of the statutory testing requirements) producers to be members of QASs; or

(b) Make the declaration of a specific list of variables a statutory requirement (but do not enforce statutory limits).

A suitable list of parameters required under (b), and required for any QAS to be recognised under (a) might include (in addition to those discussed under point 5 above): content of nitrogen (N), phosphorous (P), and Potassium (K), Carbon: nitrogen (C/N) ratio, electrical conductivity, maximum particle size/screening, dry matter content, bulk density, pH, and quality class if there is more than one (at the very least, an indication is needed as to whether the compost is applicable in organic farming/landscaping). In addition, it is worth considering statutory minimum requirements for labelling of the input materials which have been used (biowaste, green waste, sewage sludge or any other industrial sludge; other industrial waste). This is important given the existence of private contracts with food processors/retailers and increasingly, for organic farming and other environmental programmes in agriculture.

In order to be fully subscribed, QASs should ideally be linked closely to some statutory reference point (see point 1 above). This provides a mechanism for promoting participation in the scheme in addition to the marketing advantage for producers, which in isolation may not be sufficiently great for them to consider the additional costs of joining.

8 **Development of end-user specifications.** Generally, it is most important that quality requirements such as organic matter, stability, nutrients, conductivity, readily available moisture content, porosity and its speciation, etc. (which might be collectively worded as 'agronomic' features) take into account specific needs, the views of purchasers, local cropping techniques, and the evolution thereof. This means that standards on such parameters should be made flexible and mostly left up to sector-specific, voluntary agreements.

9 **Compost markets.** Regarding markets for compost, the nature of these is likely to lend itself to classical market development strategies, i.e.:

- ensure bulk markets are functioning well so that demand runs ahead of supply; and
- seek to establish niche markets alongside these with the emphasis on establishing higher value-added markets.

However, the application of compost has to respect environmental parameters. For this reason, as well as ensuring product specifications for specific end-uses (see the next section), the ability of the receiving medium to absorb compost applications must be carefully considered. Loading limits are the direct counterpart of the precautionary product standards for compost, and these have to take into account not just heavy metals, but nutrient content (in field applications, not least since such issues are covered by legal commitments in European countries).

10 **Compost marketing.** Marketing is required. One aspect that is highly important is product recognition. As there are a lot of different kinds of fertilisers, soil conditioning products and growing media, potential consumers often do not know what kind of product is to be used for what kind of application. Information on compost quality and composition data, nutrient availability and recommendations for use is invaluable to the user. The overall marketing activities should be supported not only by the government, but also by the municipalities, compost producers and all others involved in the market.

These are general lessons based on the experience of other countries. There is no unique system, and indeed, in the UK, a comprehensive system will have to fit within and around existing legislation. Already, the basis of what might be a relatively comprehensive quality assurance system has been developed by the Composting Association in its voluntary standard. There are also standards for inputs used under organic farming systems which cover compost, and these are effectively governed by the UK Register of Organic Food Standards (UKROFS). HDRA, in putting in place a certification scheme for organic landscaping and amenity horticulture, is establishing a similar standard for organic products for use in these areas. However, there is no statutory or even quasi-statutory reference point for these standards other than the EU Regulations on organic farming, and hence, outside the organic sector, voluntary standards currently operate in a context in which a) there is potential for producers to produce and market low quality products with negative effects on both the environment, and on public perception of compost, and b) some producers of quality composts who have already established markets perceive that little will be gained from entering standards where costs are incurred in doing so. The organic standards have greater force from the perspective of end-users by virtue of being supported by organic certification bodies.

WRAP has already started a process by which a Publicly Available Specification for compost is being developed, this being a staging post on the way to the development of a BSI standard for compost. This is a positive step in the current circumstances.

One can also point to other peculiarities of the UK composting system. This includes the relative significance of community composting (and there are few parallels to this in Europe). Standards should take into account the activities of this aspect of compost production which may have an important role to play in the sustainable management of waste materials within communities, especially within more remote areas, and also in awareness raising. It may be that some lessons can be learned from the experience of Austria with quality assurance schemes for on-farm composting. On-farm composting is another area of production which (given the potential for income diversification in agriculture through such production) should be closely examined in the context of considering the development of a system of standards (and regulation of biowaste treatment more generally).

Lastly, we have stressed the need to consider flexibility as far as possible in any system of standards which moves towards a statutory footing. Whilst this characteristic is desirable, it would be foolish to ignore developments at the European level, in particular, the Second Draft Working Document on the Biological Treatment of Biowaste. It would seem sensible to ensure that whichever system is considered, it does not fall completely out of line with the proposals therein. To do so risks establishing a system today which has to be overhauled as soon as it has been established. From a purely pragmatic standpoint, this would not be especially wise.

Contents

This main report has 19 'Nation Specific Supplements' which are referenced throughout the document. All of the supplements can be accessed via the WRAP website at www.wrap.org.uk.

1 Introduction

Eunomia Research & Consulting is pleased to present the Final Report to WRAP (the Waste and Resources Action Programme), concerning an independent comparison of compost standards within the EU, North America and Australasia. This is an important project, not only for WRAP, but also for the waste strategies being developed in England and the devolved administrations, as well as UK agriculture and the environment more generally.

Without a suitable system of standards in place, it is questionable whether the market for composts can be developed in such a way as to ensure that waste strategy targets are met in a sensible manner, and that sustainable waste management techniques can be applied to a number of (not only municipal, but also sludges, and organic industrial and commercial) waste streams. This is not solely a question of a need to develop the market for compost in a 'positive' way, but a question of ensuring that the system of standards effectively generates confidence in the products of composting processes. A key issue here is to effectively eliminate from specific markets those materials which are unfit for their stated purpose.

The issue is given further significance by the possible emergence of a European Directive on the Biological Treatment of Biowaste. The Second Draft Working Document on the Biological Treatment of Biowaste lays down standards for two classes of compost, both towards the high quality end, which would be considered as products under European Single Market legislation. This 'product' characteristic (allowing the material to be freely marketed) would distinguish composts from a third class of material, stabilised biowastes, which would still be considered as 'waste' (and subject to Member State legislation on wastes). All biologically treated material falling outside these classes would also be waste.

Eunomia is pleased to have been able to draw on the enormous experience of a team comprising:

- Josef Barth of INFORMA (Consultation Office for Information and Marketing in Waste Management);
- Enzo Favoino, Massimo Centemero and Valentina Caimi of the Scuola Agraria del Parco di Monza;
- Florian Amlinger of Kompost-Entwicklung & Beratung, Technisches Büro für Landwirtschaft (Compost – Consulting and Development – Technical Office for Agriculture);
- Ward Devliegher from VLACO (Vlaamse Compostorganisatie VZW);
- Will Brinton of Woods End Research Laboratory; and
- Susan Antler of the Composting Council of Canada.

In addition, Dr Jane Gilbert and Emily Watson of the Composting Association, responsible for developing a voluntary standard for the industry in the UK, have given us a great deal of help in this project.

The result of the collaboration is a unique reference document in which the supporting Nation Specific Supplements pull together, for the first time it is thought, a detailed account of systems of compost standards in development across three continents. This report aims at a comparative analysis of systems with a view to informing debate here in the UK.

1.1 Aims and objectives

The aim of the project is to provide guidance to WRAP in focusing its efforts and resources in the development of a set of robust and commercially beneficial compost standards in the UK. The key objectives can be summarised as a review of existing standards and an overview, using comparisons across the different standards, of the pros and cons of different approaches to the development of standards. The analysis is intended to inform the process of developing appropriate sets of standards in the UK. The scope of the research is to cover various classes of organic-waste based products with the intention of gaining an understanding of the commercial and regulatory drivers and the degree of success with which they operate.

1.2 This report

This report follows the following structure:

Section 2:	Examination of Standards, in which the framework for analysis is set out.
Section 3:	Overview of Precautionary Standards, looking at those precautionary standards aiming to protect health and the environment, and complementary standards typically falling under statutory regimes.
Section 4:	Voluntary Standards, typically Quality Assurance Systems (QASs), looking at the QASs which are a key element for maintenance of product quality and the marketing of compost.

Section 5:	Mechanical Biological Treatment, in which developments concerning the regulation of MBT are assessed.
Section 6:	Key Messages, in which some concluding comments are made of relevance to the UK situation.

The report is supplemented by an extensive review of compost standards in 19 different countries:

1 Austria
2 Belgium
3 Denmark
4 Finland
5 France
6 Germany
7 Greece
8 Ireland
9 Italy
10 Luxembourg
11 Netherlands
12 Portugal
13 Spain
14 Sweden
15 United Kingdom
16 Australia
17 New Zealand
18 Canada
19 United States.

These are presented as a collection of Nation Specific Supplements to this main report. It is impossible to do complete justice to the material in the Supplements in this report, and the interested reader is referred to that material for further information concerning both standards, quality assurance systems, and the situation regarding composting in the countries concerned.

2 Examination of standards

2.1 Introduction

No market is ‘free’ in the sense often implied by liberal commentators. All markets are structured by norms and rules of both formal and informal types. A free market would be an anarchic one, and indeed, the transactions between parties who do not know each other, which occur routinely in our increasingly globalised economy would simply not occur in the absence of rules and norms, most of which are developed with the backing of some form of sanction (to eliminate bad practice in transactions). Hence, in modern markets, norms and rules are often established through state intervention, backed by sanctions for those who seek to step outside the ‘rules’ that are established. These rules have the power to exclude certain products and actions whilst including others. Alongside these ‘statutory’, or more formal regulations, a range of other rules and norms exist which add structure to markets.

Recent years have seen an increase in the importance of organic waste management in most European countries. The practice of source-separation of municipal biowaste for composting is now well established in Austria, Germany, Netherlands, Luxembourg, Belgium (most notably, Flanders) and Denmark (though the Danish situation is focused predominantly on the capture of garden wastes). The practice is also diffusing swiftly in Italy, prompted by the so-called Ronchi Decree, requiring all provinces to achieve 35% recycling/composting by March 2003. The Italian experience is spreading in parts of other Southern Member States (such as France, and Spain, through ongoing developments in the Catalonia region).

There is growing appreciation of the role of kitchen waste collection in cost-optimised systems of waste collection and treatment, alongside an increasing awareness of the fact that low levels of soil organic carbon are becoming a limiting factor for crop production in Southern European agriculture. Other countries, notably Sweden and Finland, are also considering major increases in source-separation. Finland has established a target of a 75% capture-rate of biowastes by 2005. Sweden has instigated a variety of measures to promote composting as a means of meeting requirements for landfill diversion under the EU Landfill Directive.

The collected and treated amounts of organic material differ across EU countries. Regarding municipal waste, around 35% or 17 million tonnes (see Table 1) of the estimated total recoverable potential of the 49 million tons bio- and green waste is presently separately collected. This results in a compost production of around 9 million tonnes in Europe.

Outside the EU, from New Zealand to North America, source-separation programmes are being developed. Both within and outside the EU, it is increasingly well-recognised that the effectiveness of, and the rationale for these activities in diverting materials away from landfill, depends upon the establishment of reliable end-use markets for the material. This in turn requires that the composts themselves are such that end users can be satisfied that they meet their requirements. This is where standards have a key role to play.

Table 1: Amount of separately collected and composted bio- and green waste from municipal waste in the EU

Country	Total MSW	Organic MSW		Separately collected	Separately collected as% total	Separately collected and home composted as% total (inc home comp)
		excl home composting	incl home composting[1]	TOTAL		
Austria	2,800,000	800,000	1,570,000	600,000	75.00%	87.26%
Flanders	3,126,044	1,158,795	1,264,795	723,795	62.46%	65.61%
Denmark	2,780,000	973,000		652,000	67.01%	
Finland	2,510,000	1,004,000		93,000	9.26%	
France	28,000,000	9,800,000		1,600,000	16.33%	
Germany	49,100,000	9,000,000		7,000,000	77.78%	
Greece	3,900,000	1,833,000			0.00%	
Ireland	2,060,000	556,200		6000	1.08%	
Italy	28,400,000	9,542,400		1,500,000	15.72%	
Luxembourg	250,000	109,500		34,000	31.05%	
Netherlands	8,220,000	3,452,400		1,700,000	50.00%	
Portugal	3,800,000	1,406,000		14,000	1.00%	
Spain	17,200,000	7,585,200		50,000	0.66%	
Sweden	3,810,000	1,500,000		400,000	26.67%	
UK	34,000,000	10,880,000		618,517	5.68%	

Sources: Amlinger, F. (2000) 'Composting in Europe: where do we go?' Paper for the International Forum on Recycling, Madrid, 14 November 2000; Barth, J. (2000) 'Composting, quality assurance and compost utilisation – sustainable solutions in the European countries', unpublished mimeograph; Hogg, D. et al. (2002, forthcoming) Economic Analysis of Options for Dealing Biodegradable Municipal Waste, Final Report to the European Commission.

[1] In most of the European countries no statistical data about home-composting is available, so an estimation about full extent of the potential of organic waste is very difficult.

The initiative of Flanders in establishing the compost promotion organisation, VLACO, reflected a view that (based on experience in the Netherlands) there is little point in encouraging source-separation of materials for composting in the absence of end-use markets for those products. The establishment of markets for compost must be undertaken in parallel with the development of source-separation initiatives. This means not only 'ruling in' different products deemed fit for specific purposes but also 'ruling out' those which would be likely to jeopardise the use of compost in specific applications.

This is the most obvious way to explain the demise of mixed waste 'composting' in most of Europe. By mixed waste composting, one understands a process in which unseparated refuse from households is collected and, with varying degrees of separation of different materials, used as the feedstock for a composting process. The problems with such composts have been increasingly well recognised since the beginning of the 1980s. Not only do they contain higher percentages of physical impurities such as plastic, glass and other materials which could not be separated from the mixed waste stream, but evidence shows that the materials are also much more contaminated with heavy metals (HMs) and organic contaminants.[1] [2]

Such practices have considerable potential to undermine the development of markets for quality composts which offer potentially significant benefits to horticulture, agriculture, landscaping and home gardening. Markets for bioremediation are potentially significant (though relatively small at present), whilst lower-grade products may be used in restricted applications depending upon the objectives of policy-makers, and the linkages to other policies in place.

It is quite clear that the UK, and especially those English and Welsh authorities with recycling and composting targets in excess of 25-30%, will not meet such targets in the absence of a proper marketing framework for composts. This framework has to ensure protection of human health and the environment whilst ensuring fitness for purpose of different compost products used in different applications.

Thus, 'mixed waste composting' is re-emerging in a different guise and in the context of a different strategy for waste treatment. This process is now used predominantly after source-separation as a means to treat the residual waste in a rational manner. The heat from composting processes can be used to dry and stabilise material before manufacture of refuse-derived fuels, or alternatively, the residual fraction can be separated into biodegradable materials and other residual wastes offering the possibility for thermal valorisation. The biodegradable materials can be stabilised (either with or without a prior digestion process) through biological treatment. This material, which is inferior in many respects to that derived from source-separated materials, is typically landfilled or used in restricted applications.

Against this backdrop, it seems desirable to understand what regulations and standards governing which stages of the process leading to the production of composts and/or stabilised biowastes, are in existence elsewhere. Furthermore, there is a need to understand the rationale for their existence. It is equally important to understand, especially in European countries with considerable experience of using compost in agriculture, whether certain standards have deliberately not been set because risks associated with the use of compost are deemed to be minimal.

It should be added that in few other EU countries is the term 'compost' as ambiguous as it is in the UK. Much of what is termed 'compost' in the UK is not compost at all (hence, the term 'peat-free compost', which ought to be an oxymoron). There may be merit in examining the use of the term 'compost' more widely such that, for example, peat-based soil improvers cannot call themselves composts. This reflects a need to distinguish composts from other recycled wastes and common fertilisers. Without such distinguishing features, compost sales may lag.

2.2 Fundamentals of compost standards

As mentioned above, it is increasingly necessary to support global and 'transactions between remote parties' by systems of standards. The compost world is no different. There is a need, on the one hand, for regulators to exercise their duty and show caution through applying standards to protect human health and the environment when it comes to the treatment and application of organic waste. On the other hand, transactions in the compost market require standardised products to reduce transaction costs and improve consumer confidence. Furthermore, it is crucial that the emphasis on protection of human health and the environment does not divert attention from the utility of the material being produced. The regulatory aspect has to take place alongside initiatives to establish product specifications which meet the demands of the different end users of compost materials.

The problem is that these two aspects of the standards issue can, if not co-ordinated, lead to conflicting, or perverse, results. What one might call 'the waste approach' focuses on the harmful aspects of compost including, typically:

- standards containing limit values for heavy metals, contaminants, bacteria, etc.; and

- additional laws and regulations aimed at implementing the precautionary principle (e.g. those relating to water and soil protection, fertiliser laws and plant construction laws/licensing regulations) which limit the impact of heavy metals and nutrients (e.g. phosphorous, nitrogen) in soil, or the impact of compost plant emissions.

In contrast, what one might term 'the market approach' focuses mainly on product qualities and the product properties from which users derive benefits, as well as information related to successful application possibilities. Producers seek to emphasise these points, whilst consumers, although clearly interested in these aspects, also have an interest in the precautionary standards applied. Therefore, a successful scheme for the production and use of compost both protects human health and the environment, and facilitates the development of outlets for the materials through developing product specifications, ideally in close conjunction with the end users in the different sectors (agriculture, horticulture, viniculture, landscaping etc.).

Voluntary quality assurance systems for compost – as are found in countries where quality composting is far more advanced than in the UK, such as Austria, Germany, Belgium and the Netherlands – can help to bridge the gap that might otherwise exist between the two sometimes competing approaches of 'waste' and 'market'. Voluntary systems set standards which go beyond the precautionary requirements of regulators, so that as well as achieving the standards required by legislators in respect of health and environmental protection, the quality achieved conforms to that demanded by the market when it comes to a product ready for sale.

Given these considerations, although this project is oriented towards a comparison of 'standards', the systems which are in place in many countries are such that 'standards' are actually only part of the whole framework for the production and marketing of quality composts. Quality assurance schemes also play an important role in the overall framework. 'Standards', understood in the limited sense of statutory limit values for heavy metals, usually cover only the precautionary elements of the overall system. The more market-oriented aspects (of interest to WRAP) tend to be found in the quality assurance systems and other voluntary initiatives.

From this perspective, the UK Composting Association 'standard' is unusual since, in the absence of statutory measures which establish the precautionary basis from which to launch a successful marketing campaign, it seeks to establish its own limit values, whilst also requiring plant operators to assure the quality of their product. However, it does not go as far as more advanced QASs which effectively establish, in a more or less comprehensive manner, the market-oriented specifications for different end-use markets for compost. This is an important step which ought to be considered as a priority in developing markets for compost in the UK.

Other standards which exist in the UK are those of the Soil Association (and other organic sector bodies – limit values are effectively set for all certification bodies through UKROFS, the UK Register of Organic Food Standards) which reflect EU legislation concerning organic farming (note that the HDRA standard is not bound by these since the EU regulations apply to agriculture, not horticulture and landscaping). In this standard, although the limit values applied to the material are tighter than those applied under the Composting Association standard, the supporting quality assurance mechanisms are much less onerous for producers. Indeed, whilst limit values for PTEs are tight, the requirements for sampling and for quality control are less comprehensive. This might be due to the fact that well-managed green waste compost sites are assumed to produce material which meets the requirements of the standard. Whilst, therefore, the Soil Association standard has some 'statutory footing' (through UKROFS, which reflects EU regulations governing organic farming), it does not have the same level of quality assurance applied as the Composting Association's voluntary standard. Similar comments may be applied to the standards within the HDRA organic certification system for landscaping and amenity horticulture.

In most of what follows, we concentrate (in the UK situation) on the Composting Association's voluntary standard since this implicitly covers (or seeks to cover) a wider range of input materials, it is aimed at a wider range of end-users, and it seeks to support the limit values specified in the standard with a comprehensive quality assurance scheme. A producer who meets the Soil Association and HDRA standards and is also compliant with the Composting Association quality assurance systems will comply with the Composting Association standard. However, at present, it is not possible to say that a producer who has Soil Association accreditation would be producing compost in a manner acceptable under the Composting Association standard (because of the relative absence of quality control in the former). To ensure that all standards achieve a minimum level of production quality control, there would be some merit in using the Composting Association standard as a pre-requisite of the HDRA and Soil Association standards.

2.3 Comparing systems of 'standards'

It is immensely difficult to conduct a meaningful comparison of compost 'standards' across the countries under examination. Each situation has its own specific characteristics, and each system functions within a background 'policy framework' which implies that the approach undertaken in one country is not necessarily suitable for adoption in another. Furthermore, there are some differences in approach which exist, due, for example, to differences in scientific opinion regarding how (and therefore at what levels) limit values for potentially toxic elements (PTEs) should be established, and the approaches to testing composts for various characteristics.

However, it seems fair to state that over time the trend has been a clear one towards development of composts which are 'cleaner' from the environmental perspective. On this matter, the US is frequently regarded as an exception owing to the much higher (i.e. more easily achieved) limit values set for certain heavy metals, although this is more a comment upon the approach to setting these limit values than a consequence of some supposed lack of environmental concern.

Those countries which already have high rates of capture for source-separated biowaste, are also those which implemented compost standards at a relatively early stage. Indeed, the focus on compost with better environmental characteristics; the development of standards to support this; the emergence of legislation to support the source-separation of biowastes; and the development of organisations to support compost marketing and use; can be seen as the four-track response to unsuccessful attempts to develop large markets for compost derived from unseparated municipal wastes.

In Europe, more recently, the Landfill Directive has begun to have an effect. Regarding biowastes, this effectively occurs through two avenues. On the one hand, it has strengthened the focus on source-separation of biowastes for composting/digestion as a means to meet Landfill Directive targets for municipal waste. On the other hand, the requirements to pre-treat waste prior to landfilling have been implemented in different ways in different member states. Whilst some Member States of the European Union have implemented, or intend to implement, bans on landfilling (either of all municipal waste, or of fractions thereof, including biowaste fractions), others have specified pre-treatment requirements which require a form of stabilisation of the biowaste fraction of waste to be landfilled.

It should be mentioned, therefore, that the UK is in a situation where:

- Previous experience with compost from unseparated wastes has been somewhat similar to that from elsewhere (it is difficult to market this product). Furthermore, compost from unseparated wastes is more contaminated with heavy metals, organic contaminants and inert materials

- Although in England targets for recycling and composting exist, there is still some confusion as to what 'composting' actually is. Hence, although the local authorities with higher level targets in place will be required to 'compost' municipal waste (they will probably not meet targets through recycling dry recyclables alone), what this will imply (source-separation or not) is not clear. No statutory reference point exists to define 'compost' either in terms of its environmental characteristics (i.e. PTEs and physical contaminants), its sanitisation (i.e. has the material been through a process which ensures the product meets basic hygiene requirements?) or any other qualities.

- The implications of the wording of the current legislation, though it does not define 'compost', is that 'compost' is a waste (since its use is, under certain conditions, exempt from waste management licensing – if it were not a waste, it would not be necessary to include it within the scope of exemptions from licensing). The conditions under which materials can (or, perhaps more importantly, cannot) be applied to land without licensing are not at all well-defined.

This suggests the absence of those elements of policy which might help to support a system of compost standards, whether voluntary or statutory. This is not to say that introducing source-separation of municipal waste, or indeed, a voluntary system of standards, is unlikely to be effective in the UK at present. It does suggest, however, that the effects of targets for 'composting' are unlikely to be as profound as in circumstances where the broader policy framework implicitly demands the treatment of source-separated materials. Furthermore, the level of engagement of producers in a voluntary system of standards is likely to be limited as long as the broader policy framework leads to the system being perceived (mostly) as an additional financial burden.

Notwithstanding the differences in approaches mentioned, we have sought to set the discussion of standards within a 'stylised' scheme (there is no such thing as a 'typical' scheme when one looks across all countries). This is outlined in Figure 1. This forms the basic framework upon which our comparison is based. It is also, incidentally, suggestive of the elements which might constitute a well-functioning scheme.

2.3.1 Relevance of precautionary/statutory standards

The key reason for making standards statutory is related to the fact that compost is often derived from waste materials (though not always; for example manure may not be classified as 'waste', as in the UK). In this context the Austrian Waste Management Act requires that: 'hazardous, negative or other effects that impair the general well-being of man, animals, vegetation, their basis of existence and their natural environment, shall be kept as low as possible.'

Statutory standards therefore mainly comprise precautionary requirements (e.g. related to hygiene, harmful substances, and impurities) and should cover all monitoring aspects related to the waste property of compost.

It is important to recognise that because of the (typically) legal status of these definitions, these requirements cannot be changed easily in short time periods. For example, the absence of 'biodegradable plastics' as suitable raw material for composting in the German Biowaste Ordinance is intensely problematic. Re-opening the Ordinance is not something which many are keen to do, as it took a great deal of time to negotiate, and re-opening it would inevitably create opportunities for all sorts of new changes to be considered and debated (with all that this implies for parliamentary time etc.).

Figure 1: Range of compost standardisation – from output material to marketed product

These standards can either establish a basic platform (in which case, they merely lay down basic requirements, e.g. a list of heavy metal limits as in the Netherlands or in Belgium/Flanders), or they can be an extensive framework where source-separation, collection, treatment, analysing, monitoring and application requirements are laid down so that the statutory standard covers the whole biological waste management cycle, as is the case in Germany and Austria (excluding marketing in Germany). In Austria, detailed labelling requirements for the marketing of compost are also included. These countries have the benefit of more than 10 years experience in composting and 10 years operation of voluntary quality assurance systems, so they are able to bring to bear the experiences gained in a special Biowaste Ordinance. Besides this, both Germany and Austria are quite famous for their extensive use of standards.

For countries only now introducing source-separation and composting, it would be wise to follow the platform strategy, with a minimum range of precautionary requirements when it comes to the extent of legal regulations for biological waste treatment. After a certain period of development and experience with the system, a more practical approach which more accurately corresponds to the country-specific conditions can be developed (and implemented through statutory regulations if so desired). This enables a degree of flexibility to be retained in the system as it develops (the more that is not binding by law, the better from the point of view of flexible development). Evidently, the degree to which this approach is feasible also depends upon the degree to which regulators and policy-makers are willing, or able, to retain such flexibility.

If the statutory standard is limited to basic precautionary requirements, it ought to be accompanied by a flexible instrument such as voluntary quality assurance systems. If the statutory standard refers to the voluntary standard, the latter becomes 'quasi' statutory. This was the approach which was adopted for several years in, for example, Germany, where in the approval guidelines of composting plants, it was stated that 'Quality monitoring has to be executed according to BGK standard or similar'. Because of the lack of any 'similar' standard, the BGK (i.e. the German quality assurance scheme) standard acquired a de facto statutory status.

This discussion raises questions concerning what the basic minimum requirements might be for statutory standards. Probably (and this has already been confirmed to a certain extent by the experiences of other countries), these should establish limit values on hazardous substances (to be set by the authorities tasked with health and environmental issues, in most cases, the Environment Ministries, possibly in agreement with the Ministries of Health). The minimum criteria should probably include heavy metals, organic pollutants (as deemed necessary), and pathogens. Possibly, this could be supplemented by a measure to assess when material has been sufficiently stabilised through a composting process (e.g. a stability test, ammonia concentration or similar). Basic minimum requirements should also stipulate the stage in the composting process when a representative compost sample should be taken (e.g. when the producer deems the compost ready for distribution and use), how to obtain a representative sample, how frequently samples should be taken, the EU-harmonised methods of testing that any laboratory analysing a compost should follow, and a requirement that the laboratory is independent from any compost producing business or organisation.

These limit values should, in any case, clearly define when a 'compost' can be considered as a product, and can therefore be marketed and used with no 'waste-related' restrictions and no need for licensing. The implication of this distinction is that, of course, if outputs from a plant fail to meet the specified limit values, the output should still be considered as a waste, deemed suitable for applications only under restrictions, permitting procedures, and so forth.

For the sake of clarity and to promote a clear understanding on the part of purchasers, as well as public opinion as to reliable products, it seems sensible to make classification as simple as possible, with a small number of classes for composts considered as a product, and one class for stabilised material to be considered as a waste (the Draft EU Directive lists two classes for the product, partly in an attempt to draw together the differentiated situations in various EU countries). Such an approach would then leave quality requirements such as stability, nutrients, conductivity, readily available moisture content, porosity and its speciation, etc. up to specific agreements or QASs or regional labels (of which there are several in Italy, for example). The role of the government is then to ensure that minimum statutory standards are set such that producers are not compromising the need to maintain sustainability of cropping on farmlands in the long run (which depends on the prevention of excessive loading with heavy metals and organic pollutants) nor endangering human/ animal health. Equally, areas of restoration can sometimes be used for purposes such as grazing in the longer-term (e.g. at landfill sites), so issues of accumulation may still be relevant in lower grade applications.

Note that certain end-users such as organic farmers have quite specific requirements for compost standards. It is important to acknowledge their needs, and the links to requirements for certification. This has led, in the EU, to several countries establishing a 'very high quality' class of compost which is acceptable to organic farmers. The limit values established under these standards has led to some discussion as to whether they are not set at such high levels that they become increasingly meaningless since producers cannot comply with them.

2.3.2 Complementary statutory standards

Statutory compost-specific standards do not stand alone. Further legal regulations influence organic waste management indirectly and amount to the creation of a complementary statutory standard. The relevant statutory legal instruments typically include:

1 Waste laws. These may establish requirements regarding source separation and separate collection. Good examples are the biowaste ordinances in Germany and Austria. In the Netherlands, the VNG (the Netherlands Association of Municipalities) has an agreement with the AOO (the Waste Management Council of the Netherlands) that source-separation will be implemented in all municipalities (though in practice, this does not actually occur) In Flanders municipalities are divided into two categories according to whether or not their region has a compost plant suitable for treating kitchen waste (those with such plants are FT regions, those without are arden-waste regions). This is the basis for determining requirements for the frequency of separate collection and the materials to be targeted.

2 Plant design and licensing regulations. These regulate siting, emissions, plant management and occupational health issues. It is our impression that most countries appear to deal with odour and nuisance issues (such as they are likely to arise) through the planning and licensing regimes rather than through standards per se. This ensures siting of facilities in suitable locations.

3 Fertiliser, soil protection and water laws. These regulate application restrictions/maximum dose rates, and licensing of composts. Good examples here are the mechanisms used by European Member States to implement the Nitrate Directive, as well as legislation (in all countries) limiting the loading of heavy metals per unit area of land (in, for example, agriculture). Where source-separation occurs, it transpires that the relatively low level of concentration of heavy metals obtained implies that nitrate, not heavy metals, is often the limiting variable in compost applications.[3]

It is very important that these laws are co-ordinated with the compost-specific regulations. This is the case in Germany where the Biowaste Ordinance regulates the waste part of biowaste recovery and the Fertiliser Ordinance regulates the nutrient and application part (see Supplement 6, Section 2). Similarly, the legislative framework in Flanders (Supplement 2, Section 2) and that which is emerging in Italy shows similar coherence (see Supplement 9, Section 2). A negative example occurred in Austria, where before the enforcement of the new Compost Ordinance, biowaste compost could not be marketed as a fertiliser or soil amendment (i.e. a product) under the regime of the fertiliser law from 1994. Nonetheless the use of biowaste compost in agriculture was still possible as long as it did not conflict with provincial soil protection laws or the Water Act (recent changes in the legislation are documented in Supplement 1, Section 2).

2.3.3 Voluntary quality assurance systems – the connecting link

Voluntary standards should take as their foundation the precautionary criteria of the (usually) statutory standards and define the product and sales aspects. They should effectively broaden the range of statutory criteria and requirements to the extent that consumers are/will be satisfied. An important characteristic of voluntary standards is that they are much more flexible than statutory standards, this being a positive precondition for acceptance by the market in periods where new products (e.g. compost) are introduced into the market, or where a market is being established.

The European quality assurance systems have, as their main elements:

1 **Quality assurance as an instrument of product standardisation:** Quality assured composts are accepted as 'products' only if product standards coincide with the ideas of the relevant parties, these being, fundamentally, the end users for the specific products being considered for specific end uses.

- **Quality assurance** is a good basis for sales consulting, for public relations work, and for fostering a positive image.

- The **quality symbol** makes possible the establishment of a branded 'quality-tested compost' and a positive image for compost.

- **Regular analyses** during compost production act to guarantee a quality-controlled product. Recording process variables, e.g. temperature, moisture, aeration and homogenisation activities can help to ensure quality. For example, if there is an intermittent problem with the hygiene quality of the compost, recording details of activities such as irrigation of batches with leachate and the stage in the process when this happened can help to identify the cause of a problem;

- **Standardised analyses** carried out in accordance with specified methods enable an objective assessment of the compost quality.
- The **results of compost analysis** form a basis for the product declaration and the application recommendations.
- A continuous tracking of batches enables **traceability** of products back to input supply, ensuring that checks on inputs become possible in instances of sub-standard products reaching the market (which are rare because of the quality control).

The net result is a compost product of continuously high and defined quality which is therefore marketable and saleable on a large scale.

2 **Quality assurance as an instrument of product specification:** When the quality is stipulated and designed for a product with a specific application, both precautionary and beneficial aspects must be considered. Special emphasis has to be directed towards the adjustment of product-related requirements in close collaboration with the associations and organisations concerned with end-use. Neither quality assurance nor the statutory standards provide direct influence on the domain of compost application. Recommendations for application have to be established in co-operation with acknowledged experts in the various areas of application who ideally define a product specification as basis for product application from their particular (expert) point of view. Specific applications may require that additional, internal standards are met (e.g. compost mixtures for roof greening mixtures, for tobacco or asparagus). Considerable attention is often given to landscaping and gardening since both are areas where there is likely to be both high demand for quality compost and humus products, and considerable marketing potential.

With the combination of statutory standards and voluntary quality assurance systems both the precautionary and beneficial aspects of compost application can be maintained. This type of market-oriented compost product qualification promotes the development and growth of outlets for the material. This is critical in developing the treatment of biodegradable waste through composting and digestion.

It is important to recognise, as mentioned earlier, that the end-product specifications should not be tightly bound-up in statutory regulations, especially in cases where compost markets are in the early stage of development. The market must be driven by the demands of end users, not the will of regulators. Only Austria, with considerable experience with compost production and use (and therefore, many years of learning what is appropriate in different end-uses), makes end-use specifications part of the statutory framework (see Supplement 1, Sections 3.4–3.5).

2.3.4 Quasi-statutory voluntary standards

No successful voluntary standard is truly voluntary in the course of time. Market forces and the way in which standards function are likely, where the standards result in a successful product, to lead to quasi-statutory status. Participation in quality assurance schemes is, for all countries, a voluntary act. However, once the quality standard is in force, the market begins to demand these qualities and composting plants are likely to react as a result. This is beginning to happen in the UK, where composting contracts issued by some local authorities require the contractor's facility and compost to become certified as compliant with the Composting Association standards. Some contracts are also being specified with the standards laid down in the second draft of the Biowaste Directive in mind. This could be viewed more as a supply effect than a demand effect, although local authorities are themselves significant decision-makers in the context of procurement within the public sector.

Compost markets tend to be segmented, with different products used in different applications. Unsurprisingly, in all countries, the very best qualities are asked for first. In markets with a surplus, this is especially true. Therefore composts without quality assurance or a certificate are likely to be marketed, with the passing of time, only in more local markets around the composting plant (where the plant manager him/herself underpins the quality and gives confidence to customers) or in restoration projects.

Voluntary standards have to be accepted by all the relevant parties otherwise they can not fulfil their purpose. This is most likely to be the case when the voluntary standard is connected to well-known and official standardisation organisations (for example, ÖNORMs of the Austrian Standardisation Institute; KIWA certification institute in the Netherlands; RAL, the German Institute for Quality Assurance and Certification (also for Luxembourg); SCC, the Standards Council of Canada) or to an official quality management procedure (quality management according to ISO 9000 in Sweden and in France) or to Eco-Labels (e.g. the VLACO label in Flanders). Trials in Sweden and France failed to find a standardisation organisation in the country which fitted the needs of a voluntary quality assurance system, and for this reason they chose a more complicated route to create a new institution in the framework of ISO 9000.

The situation can be still more complicated since 'voluntary' quality assurance systems can, as in Flanders, be more closely linked with statutory systems of standards, with a degree of interdependence between the two. This official and quasi-statutory status becomes very significant when legal disputes occur. Such disputes are not uncommon in cases where the quality assurance organisation withdraws a quality label or certificate because of quality problems in composting plants.

In the UK, the Soil Association standard is linked to the Eco-label of the association itself. However, as yet, there is no broader connection to standards institutes (such as BSI, the British Standards Institute) for the Composting Association standard. As such, this standard lacks the official/quasi-official status of standards in the countries mentioned above. WRAP is in the process of developing a Publicly Available Specification for compost based upon the Composting Association standard. This is a key step on the path towards the development of a BSI standard.

2.4 Perceptions of composting producers

As well as a potential tension between the precautionary approaches of regulators, and the desire to market a composted product, there also exist potential tensions between the interests of individual compost producers and the desirability of developing a coherent system for production and sale of quality compost.

There is a tendency to view some of the more developed European systems as unnecessarily bureaucratic, and indeed, the relevant ordinances in Austria and Germany are substantial pieces of legislation in their own right[4]. Equally though, these systems are well-developed and are based upon many years of experience. They are also successful in ensuring high standards of production and the sale of significant quantities of compost (making use of a considerable proportion of the available compostable materials in the municipal waste stream), even in the context of crowded markets for soil improvers. However, the tendency may be for individual producers, especially those with well-established markets, to take the view that such standards are unnecessarily cumbersome measures which simply impose additional costs. They are especially likely to take this view where they are established producers, have established relationships with end-users and have reliable market outlets.

It seems reasonable to make a number of observations of a general nature at this point:

1 Firstly, and as already mentioned, it would be a mistake for a country in the early stages of development of such processes to enshrine too many aspects of the system in law. It is especially important to allow the more market-oriented agronomic features to be established in a flexible, non-statutory context, with reference to specific end-use characteristics as long as (a) this does not lead to unfair competition between producers in the marketplace, and (b) health and environment are not compromised by allowing such flexibility.

2 Secondly, those producers who claim that they do not need statutory standards should presumably (as long as the standards are not set with an unnecessarily heavy hand) be able to demonstrate compliance with those standards to the extent that these are deemed to be necessary for the protection of health and the environment. To the extent that this might be a minimum requirement for protection of health and the environment from the standpoint of society, the standard is simply formalising the requirement for producers to do what they should be doing anyway (in which case, the argument in respect of 'additional costs' is bogus).

3 Thirdly, even if it were the case that individual producers were simply seeing an additional cost imposed upon them, taking a look at the broader context suggests that for the development of a mature compost market, such actions are likely to be if not necessary, then desirable. This is to acknowledge the more strategic significance of the measures being considered here, another aspect of which is to offer producers some protection where issues of liability surface.

Currently, with a voluntary standard in place in the UK, there is no requirement for compost producers to assure the quality of their production processes, nor indeed the characteristics of the product, other than to the extent that end-users require these things, and/or other regulations (which are not compost-specific or apply to the application of compost only) imply such requirements (e.g. organic certification schemes). Up to a point, therefore, it can be said that it is difficult to know what is being spread and for what purpose when people speak of 'compost applications' in the UK. In such an environment, it is perhaps unsurprising that those with responsibility for the health of UK agriculture have taken an extreme precautionary position in respect of the application of 'compost' to land.

It goes without saying that such a situation is not helpful to producers of compost, not to mention the development of sustainable management of wastes in the UK. Statutory standards can help here, both by acting to prevent the marketplace being compromised by the prevalence of poor practices and low quality material, and by setting in law elements designed to ensure protection of health and the environment.

3 Overview of precautionary standards

3.1 Level of development of standards

Different countries have developed their precautionary standards for compost products to different levels. The standards vary also in that in most, though not all, countries, they have statutory force. As mentioned above, quality assurance systems may exist which will typically be voluntary in nature. Table 2 shows the level of development, as well as those standards which are statutory and those which are voluntary in nature. Table 3 identifies the existing statutory regulations. Only a few countries (the UK, Portugal, Sweden and Australia) have no obvious statutory regulation, although those in existence in France (currently), Greece, the United States and New Zealand could not be said to be especially stringent (though equally, state level initiatives in the United States can go beyond what is specified at the federal level). In both Ireland and Luxembourg, licensing procedures play an important role.

It is notable that:

1 **Those countries where separate collection is furthest advanced, and where compost production (as a percentage of total potential) is highest, have statutory standards in place.** However, it is worth pointing out, at the same time, that these countries – Austria, Flanders, Denmark, Germany, Luxembourg and the Netherlands – also have in place requirements for separate collection (including provision of service from municipality and/or participation of householders) of either kitchen waste, or garden waste, or both in their territory. Hence, it could be argued that these systems co-evolved, usually in the wake of poor experience with low-grade materials from mixed waste composting (see above). In Denmark, the collection of garden waste is far advanced. The 1994–1997 waste strategy established a target that no more than 15% of garden waste should be incinerated. The Danish Environmental Protection Agency reported that this figure was 2% in 1999 (with an estimated 1% landfilled). However, food waste collection is poorly developed in Denmark and only bulky waste (of MSW) is able to be legally landfilled in Denmark. Hence, the situation in these two component waste streams is quite different (garden waste and household waste are different categories in Denmark, and standards for compost from the two types of waste have developed in different ways);

2 **Those countries with standards which are 'high but voluntary' include the UK and Sweden.** The market in these countries requires rules and regulations for compost and digestion residuals. Rather than waiting until statutory standards define processes, qualities and monitoring systems, in these countries, producers have implemented their own standards in an attempt to develop a more sustainable solution to the issue of biowaste processing.

Table 2: Degree of development, nature (statutory or voluntary) and rationale for standards development

	Level and type of standards	Statutory	Voluntary	Driven by/ influenced by EU directives	Intended to support waste policies	Intended to help develop markets	Intended to protect human health
Austria	Statutory: High Voluntary: High	Yes three classes Compost Ordinance	KGVÖ Regulations and Ö-Norms (partly withdrawn by Compost Ordinance)	Partly	yes	yes	yes
Belgium Flanders	Voluntary: High Statutory: High	Yes only one class, Ministry of Agriculture	Two classes according to the VLACO Quality Assurance System	no	yes	yes	to some degree
Walloonia	Statutory: High	Yes only one class, Ministry of Agriculture	None	no	no	no	to some degree
Brussels	Statutory: High	Yes only one class, Ministry of Agriculture	None	no	no	no	to some degree
Denmark	Statutory: Medium Voluntary: High	Yes only for sewage sludge and composted household organics (one class)	Yes DAKOFA Compost Product Sheet	no	no	yes	yes
Finland	Statutory: Low	Yes one class, Ministry of Agriculture	None	no	yes	no	yes
France	Statutory: Low Voluntary: Medium/low	(Marketing has to take place in line with statutory legislation NF U 44-051 which also contains minimum standards for some agronomic features)	NF Compost Urban Standard	no	no	no	partly (soil improvement)
Germany	Statutory: High Voluntary: High	Yes two quality types Biowaste ordinance	RAL Quality Assurance four compost types plus two digestion residual types	no	yes	yes	yes
Greece	Statutory: Low	Yes only for MSW and sludge compost	None	yes	yes	no	yes
Ireland	None other than those in EPA Licensing	Occurs on case-by-case basis through licensing (so has statutory force)		yes	partly	no	yes
Italy	Statutory: Medium	Yes two categories of soil improvers, one set of limit values, law no.748/ 84	None	yes	yes	yes	no

Luxembourg	Statutory: Very High (It is part of the licensing/ approval procedure for plants)	Yes two compost types according to the German RAL quality assurance	None	yes	yes	yes	in future according to Germany
Netherlands	Statutory: High Voluntary: High	Yes two classes by law (heavy metal content) only for biowaste	Yes KIWA Standard for biowaste and BFOR for green waste compost	no	yes	yes	in future probably according to Germany
Portugal	None	None	None referring to sewage sludge	no	no	no	no
Spain **Current**	Statutory: Low	Yes one class, Ministry of Agriculture	Yes	no	no	no	no
Draft	Statutory: Medium	Yes one class, Ministry of Agriculture	no	yes	yes	yes	yes
Catalunya **Draft**	Statutory: Medium	Yes two classes, Junta de Residuos	no	yes	yes	yes	yes
Sweden	Voluntary: High	No	Yes RVF Standard for compost and digestion residuals	partly	yes	yes	yes
UK **Composting Association**	Voluntary: High	No	Yes one class	partly	yes	yes	yes
Soil Association	Voluntary: Medium	No	Yes – one class	yes	no	no	yes
Sludge (UA) Regs	Statutory: High	No	Yes – one class	yes	partly	partly	yes
UKROFS	Statutory, if 'organic'	Yes – one class	No	yes	no	no	yes
Australia	Voluntary: Medium	No (though state and federal guidelines cover some limit values)	Yes products classified as soil conditioners and fine mulch by Standards Australia	n/a	no	partly	yes
New Zealand	Voluntary: Low	No (though DoH biosolids regulations cover some limit values)	Yes one class defined by industry	n/a	no	yes	yes
US (sludge) [1]	Statutory: Medium	Biosolids (sludge)	Yes	n/a	yes	yes	yes
Canada	Statutory: High Voluntary: High	Canadian Council of Ministers of the Environment: two classes (A; B) Canadian Food Inspection Agency: One class	Bureau de normalisation du Quebec: 3 classes (AA; A; B)	n/a	yes	yes	yes

Notes: Level of standards means the level of the quality requirements, not the extent of the standard. E.g. the statutory standard in the Netherlands mainly cover the heavy metal limits, which are so strict that no plant can manage the highest quality class. So the standard is high, the extent of the regulations is small.
[1] States in the US may apply their own rules. By law, these must be at least as stringent as federal laws.

Table 3: Statutory regulations concerning compost quality (current and proposed)

	Legal regulations for compost quality
Austria	Compost Ordinance (FLG II Nr. 292/2001)
Belgium	Royal Decree (Arrete Royal) with additions from March 1990
Denmark	Statutory Order No.49 of 'Application of Waste Products for Agricultural Purposes' (Ministry of Environment and Energy, January 2000) Statutory Order Regarding Fertilisers and Soil Improvers No. 612 (Ministry of Agriculture and Fisheries, 1993)
Finland	Decisions of the Ministry of Agriculture and Forestry (46/94)
France	French regulation NF U 44 051 on Soil Improvers
Germany	Biowaste Ordinance
Greece	Common Ministerial Decision KYA 114218/97 (ϕ 1016B/17-11-1997)
Ireland	(Licensing according to waste management act)
Italy	Law on Fertilisers (L 748/84) as modified by Decree 27 March 1998
Luxembourg	Integrated into licensing
The Netherlands	BOOM-decree ('Decree of other organic fertilisers')
Portugal	None
Spain	Ordinance, 28 May 1998, on Fertilising and Related Products
Sweden	None
UK	None
Australia	None
New Zealand	DoH Limits on PTE concentrations in dry biosolids
US	US EPA Sludge Rule
Canada	Canadian Food Inspection Agency (CFIA): Fertilisers Act and Regulations Canadian Council of Ministers of the Environment (CCME): Guidelines for Compost Quality

Note: These laws tend to provide only a basic framework with a list of, for example, potentially toxic elements (PTEs), and a statement concerning e.g., the need to protect the environment. Only in Germany and in Austria are there detailed legal regulations concerning biowaste treatment.

3. The reasons for introducing standards do not vary greatly across countries. Reflecting 'point 1' above, the countries with statutory standards in place use these to support waste policies, e.g. the German Closed Loop Waste Management Law requires implementation in the form of ordinances such as the Biowaste Ordinance or the Packaging Ordinance. Note that EU Directives are not so influential, though the second draft of the EU Biowaste Directive is having an influence in those countries without standards in place. For example, in Ireland, standards established in licences for compost facilities tend to be based upon the limit values in the Second Draft of the Directive. The market development rationale, on the other hand, is also strong. Similarly, protection of human health features strongly in most countries' rationale. As we shall see, this manifests itself in different ways in different countries. In Australia and New Zealand, labelling requirements are relatively 'alarmist'.

Conclusion: The UK is in a declining minority in its lack of statutory standards for compost. Those nations currently without compost specific standards are increasingly looking to implement such standards (and some, such as Ireland, are making the transition through the licensing process) Biowaste treatment in the UK would benefit from being placed on a statutory footing, at least with respect to precautionary aspects. The exact shape of this arguably depends upon what the scope of any given legislation is intended to be and the degree to which other aspects of the biowaste collection and treatment regime are altered.

3.2 Standards on input use

Table 4 shows that only some countries specify in the scope of their standards that certain materials should be excluded for use in producing compost. This can cause difficulties in that certain countries exclude some materials from the scope of the standard (e.g. Australia), whereas others make more explicit and detailed comments concerning what is ruled out, or ruled in, in terms of materials used in compost production. As the table below shows, it is more usual to 'rule materials in' than to 'rule materials out', for reasons which (upon closer examination) are quite understandable.

If the aim is to define standards for higher quality materials (and this is the usual approach), it makes more sense to rule on what should be used than to risk creating loopholes through trying to define what cannot be used. In addition, and as mentioned above, implementing such demands on a statutory basis is best done in the light of some experience with composts (for fear of setting these restrictions incorrectly in relatively inflexible statutes).

It should be noted that even where there are no specific standards set for the inclusion or exclusion of specific materials, this is often implicit in the way in which production standards are set. So, for example, in Australia, it is expected that materials that may otherwise be contaminated are source-separated. The Composting Association standard in the UK more or less explicitly states that it is felt unlikely that the standard will be met by materials which have not been separated at source (and allows for additional tests to be required as part of certification where feedstocks are suspected of contamination).

In Germany the municipalities regulate in their waste statutes what should be collected in the biobins and what should not. Some municipalities exclude meat residues in order to obtain biowaste with a lower salt content, which can therefore be used in potting soil mixtures. In Austria meat residues are allowed only where regional provisions for the separate collection schemes for biowaste include meat in the recommendations for separate collection in the household. In Austria there is a long-standing tradition of on-site agricultural (i.e. on-farm) composting, and plant residues from agriculture and manure which are reused on agricultural land are not classified as waste, and therefore are not considered in mass-related provisions within the compost ordinance.

Positive lists in statutory regulations are very inflexible, as the German Biowaste Ordinance shows. During the preparation of this ordinance, biodegradable plastics were overlooked. All efforts failed to alter this after the enforcement, because to open the ordinance for this special case means to open it for all other objections too, which could result in months or years of additional negotiations for a new version. An alternative, more flexible approach which would prevent such problems might be to lay down a statutory list of suitable waste groups (e.g. as in Austria, the Netherlands, Sweden) and to establish an institution (e.g. the voluntary quality assurance organisation) which checks raw materials for their suitability for the production of high quality composts. The German Compost Quality Assurance Organisation BGK and the Dutch Association of Waste Processors VVAV are seeking to establish such an organisation at the moment.

Table 4 Input materials ruled in or out in compost standards

	Are any input materials specifically excluded?	Are any input materials specifically included?
Austria	No	Bio- and green waste, sewage sludge, municipal solid waste (after removal of harmful waste materials), additives/conditioners. Note that non-hazardous household waste and similar commercial waste may only be composted along with sewage sludge (there is a ban on dilution with source-separated biowastes). A list of additives/conditioners also exists (see Supplement 1, Table 1.4).
Belgium Flanders	No	Source-separated biowaste and green waste. Some additional types of organic waste according to case-by-case licensing. No generally applicable written standards as to the latter.
Walloonia	No	Source-separated biowaste and green waste.
Brussels	No	Source-separated biowaste and green waste.
Denmark	No	Waste separated at source, including composted waste, from private households, institutions and private enterprises together with sludge and sewage. Garden waste can be treated and used without any restrictions.
Finland	No	Organic garden and household waste, mixing with animal manure and sewage sludge is allowed.
France	No	In future only green waste and source-separated household waste because of the subsidy strategy of the EPA (ADEME).
Germany	No	Organic residues from households, gardens and parks together industrial organic residues a positive list exists (see Supplement 6, Section 3.3).
Greece	No	Only mixed waste composting.
Ireland	No	No.
Italy	Algae and sea plants	A positive list is given; this basically includes source-separated food waste, garden waste from private and public gardens, slurries and manure from husbandry, sewage sludge, agroindustrial by-products, wood and textile (untreated) industry residues.
Luxembourg	Animal carcasses, slaughterhouse wastes, sewage sludge, waste from animal breeding e.g. animal manure	Organic residues from households, gardens and parks together with industrial organic residues.
Netherlands	Potatoes	Vegetable, fruit and garden waste from households together with industrial organic residues a short positive list exists.
Portugal	No	Mixed waste only.
Spain	No	Only source-separated material in Catalunya.
Sweden	Sludge	Purely source-separated material from gardens, households, restaurants, food processing, agriculture and forestry.
UK Composting Association	No	No, though it is clear from the standards that composting of un-separated materials is likely to result in failure to meet the standard.
Soil Association	Sewage sludge, peat as a soil conditioner, materials contaminated with genetically modified organisms	Manure, slurry, animal bedding, plant wastes, food processing industry by-products, wastes from untreated timber, microbial and plant extracts, seaweed, mushroom composts, worm composts 'from Non-organic animal manures', processed animal products from slaughterhouses and fish industries, 'composts from organic household refuse'.

Australia	No, though the standard does not apply to home composted materials for own-use, organic fertilisers such as blood and bone, liquid organic wastes, liquid seaweed products; and 'compost starters' and 'activators'.	Organic products and mixtures of organic products that are to be used to amend the physical and chemical properties of natural or artificial soils and growing media.
New Zealand	No	No
Canada	No	No
USA	No	No

It is important to note that the scope of standards (in terms of what is or is not included) also influences the way in which standards are set (see next section). Strictly speaking, the standards may be non-comparable for this reason alone. For example, in different countries, sludge may be treated within the compost standards (e.g. Austria, the UK, Italy) or it may be treated under separate legislation (e.g. Flanders, Sweden, Luxembourg). In some countries, such as the US and Australia, sludge legislation influences that regarding compost due to the absence of federal legislation specifically relating to compost. In New Zealand, the Department of Health limit values for compost appear to have been influenced by the EU Sludge Directive.

Conclusion: The most common approach appears to be one of listing materials to be included in compost, as well as those which may be used in mixing (though dilution should be treated separately, with reference to the specific classes of materials in any standard). Care has to be taken in drawing up lists of materials for inclusion/exclusion for statutory approval. Mistakes or oversights in legislation can be difficult and time-consuming to rectify.

3.3 Number of classes at precautionary level

It is interesting to note that different countries have established different numbers of classes of composts (see Table 5). Whilst Austria recognises three classes, other countries have two and many only have one. The second draft of the EU Biowaste Directive included two classes of compost, with a third standard for stabilised biowaste.

At the precautionary level, the countries which have more than one standard are: Austria, Germany, Luxembourg, the Netherlands and Canada (as well as Catalunya in Spain).

In the Netherlands, only one production plant currently reaches the limit values for 'very good' compost (because of the tight limits on zinc content in the Netherlands), so in practice, there is really only one standard.

Austria has three classes:

Class A+: top quality; limit values taken from Council Regulation (EEC) No.2092/91 on Organic Farming (see below).

Class A: high quality; suitable for use in agriculture.

Class B: minimum quality; suitable for non-agricultural use.

Due to the extremely low permitted values for individual parameters (e.g. nickel), it is very difficult to achieve Class A+ standards. However, this is the class which must be achieved by farmers running organic farms in keeping with Council Regulation (EEC) No.2092/91 'on organic production of agricultural products and indications referring thereto on agricultural products and foodstuffs'.

Compost produced from separately collected biowaste generally achieves Class A quality. Class B quality can be achieved by the use of suitable sewage sludge. Limit values for each are shown in the table below.

Table 5: Number of classes in compost standards and rationale for differentiation

	Number of Classes	Description of Classes
Austria	Three	Class A+ (top quality; limit values taken from Council Regulation (EEC) No.2092/91 on organic farming) Class A (high quality; suitable for use in agriculture) Class B (minimum quality; suitable for non-agricultural use).
Belgium Flanders	One (Ministry of Agriculture) Three (VLACO, voluntary)	Biocompost (compost from source-separated biowaste) Humotex (compost from aerobically composted digestion residuals) Green waste (compost from source-separated garden waste).
Brussels	One	Source-separated biowaste and green waste.
Denmark	One	Product standard.
Finland	One	Product standard.
France	One (N FU 44 051) Two (Compost Urbain)	Two (Compost Urbain – standards with same limit values for heavy metals and different standards for physical contaminants Class A and B) voluntary marketing standards.
Germany	Two	Two classes defined with respect to heavy metals.
Greece	One	Only mixed waste composting.
Ireland	No	No.
Italy	One set of limit values Two categories of soil improver	composted green soil improver (ammendante compostato verde ; compost only from vegetable waste); and composted mixed soil improver (mmendante compostato misto compost from vegetable waste, plus sewage sludge and/or food leftovers, etc.) (differentiated by organic carbon content, C/N ration and humic /fulvic acid content).
Luxembourg	Two	As German RAL standard also differentiation between fresh and mature compost.
Netherlands	Two	Limit values distinguish between very good compost and good compost (through heavy metals).
Portugal	One standard 'assumed' (no law)	Through heavy metals.
Spain	One in Spain Two in Catalunya	Catalunya classes defined through reference to heavy metals.
Sweden	One	Product standard.
UK Composting Association	One	Product standard.
Australia	One class of PTE limits Four classes	Four different products defined through the various limit values in the standard. These four products are divided into the two classes, 'composted product' and 'pasteurised product', each of which contains two sub-classes, 'soil conditioners and fine mulch', and 'mulch'. Ongoing consultations on revising the standard may lead to a standard for vermicompost.
New Zealand	One	Product standard.

Canada	Canadian Food Inspection Agency (AAFC): 1 class Canadian Council of Ministers of the Environment: 2 classes (A; B) Bureau de normalisation du Quebec: 3 classes (AA; A; B)	The AAFC recognises only one class of compost, reflective of product safety criteria. It is based on the limits of CCME's Category B and BNQ's Type B compost for trace elements. It reflects the requirements for product maturity, absence of pathogen content and the limits on the presence of sharp objects as part of the foreign matter criteria. Within the CCME Guideline, two compost categories have been established (Category A; and Category B). The difference between the two categories reflects limits set for trace element concentrations. Category A compost may be used for all types of applications: on agricultural lands, in residential gardens, in horticultural operations, in nurseries or other enterprises. Category A criteria for trace elements are achievable using source-separated municipal solid waste feedstock. Category B compost has restricted use. The controls established for its use are determined by each province or territory individually. Under the BNQ Standard, compost may be classified in three ways (Type AA; Type A; and Type B). The requirements for Type B compost are considered to be the minimum necessary to obtain a good compost. Compost classified as Types AA and A is of higher quality. Total organic matter content and foreign matter content are the distinguishing factors between the three types. Trace element content is the classification feature that differentiates Type AA and Type A compost from that of Type B compost.
USA	One	Product standard (biosolids).

Note that additional limit values are set for compost from mixed MSW in respect of organic pollutants (see Table 16). Furthermore, compost derived from (un-separated) non-hazardous household waste and similar commercial waste must be labelled as Municipal Solid Waste Compost. The areas in which municipal solid waste compost may be used are restricted (i.e. landfill surface cover or biofilter media). It is important to note that this type of municipal solid waste compost cannot be marketed freely but must be transferred from the producer directly to the user.

All other material is classified as waste and remains waste whatever is done with it (and it is subject to the landfill levy etc.).

One argument against the Austrian approach is that experience in some countries appears to suggest that where more than one standard exists, there is a tendency to seek out the higher quality product (irrespective of application). Furthermore, where the highest quality standards are set very high, the highest class may be all but meaningless since it may be the case that very few producers are able to achieve this (as is the case in the Netherlands). Indeed, at the high quality end of the scale, there may little to be gained from differentiation. Probably the major issue at the highest quality end is the suitability of composts for organic farming, where not only heavy metal limits, but also, the question of possible contamination with genetically modified organisms becomes important.

The counter-argument to the 'one standard' approach might be that where the highest quality is rarely achieved (either because of the input materials or the way the standard is set), a compost which falls short of high quality requirements in certain environmental characteristics can still have a potential use at least in some less sensitive application areas. Also, if, for example, it is intended that the scope of the standard is to include sludge and other wastes which are likely to contain higher concentrations of heavy metals and organic contaminants, then if the intention is to 'allow' these materials into a system of standards, setting only one standard may imply setting it so low as to make the standard 'too coarse' in its ability to distinguish between quality classes. Hence, setting another standard below the highest quality level might effectively provide appropriate opportunities for sludge based composts for example. Irrespective of the final decision, the aim should be to seek limits and application rates that lead to a low accumulation rate for PTEs, thus maintaining agricultural soil in a productive and fertile condition in the long run. Hence, it may be necessary to ensure a proper matching of application rates to classes of compost where more than one standard is set to ensure that soil is protected.

Actual quality achievement for biowaste, green waste and sludge compost against the three Austrian classes is shown in Table 6. For Austria only 30% of biowaste composts would fulfil the requirements for the use in organic farming under the provisions of the Compost Ordinance. Table 6 also shows that it will be barely possible to generate sludge compost as a marketable product for use in agriculture (Classes A+ and A).

Table 6: Distribution of Austrian compost types within the quality class system of the draft Austrian Compost Ordinance (biowaste, green waste, sewage sludge compost)

Compost type	Quality class compost ordinance	% of samples
Biowaste (BWC) n = 224	Class A+	30%
	Class A	57%
	Class B	11%
Yard Waste (YWC) n = 34	Class A+	56%
	Class A	41%
	Class B	3%
Sewage Sludge (SSC) n = 22	Class A+	0%
	Class A	1%
	Class B	82%

It is also important to consider the inter-relationship between requirements in respect of source-separation, the classes of compost described in the standards, and the end-uses to which materials in those classes are put. The approach taken in the Austrian system allows for regulation of materials which are not separated at source. In Austria, it has been estimated that 87% of all municipal biowastes are separately collected or home composted (see Supplement 1, Section 1.1). This means that a relatively small fraction of biowastes are entering the residual waste stream (some of which is incinerated, and some of which is treated through mechanical-biological treatment).

The situation is very different in the UK (it is almost the complete opposite). It would seem most beneficial (from the point of view of developing markets for quality products) to develop a system of quality compost based on separate collection rather than seeking to develop outlets for large quantities of material which pose greater risk to the environment and health. The latter should be subject to greater control through regulation.

3.3.1 The issue of mixed waste composting

Figure 2 shows a comparison of PTE concentrations from compost made from different feedstocks. This shows not only that sludge compost is more contaminated than source-separated biowaste and green waste composts, but that composts from mixed municipal waste are more contaminated than sludge composts. Hence, it is frequently the case, as in Italy (the situation depicted in the Figure), that countries develop standards which are such that sludge compost meets the limit values set, but composts derived from mixed municipal waste do not.

A similar situation can be observed in the Second Draft of the Biowaste Directive, where limit values were established with the intention of protecting soil against the build up of PTEs.

Few sludges would meet the criteria laid down by some nations for high quality compost (regarding, for example, the limit values for zinc and cadmium). But such composts may still have considerable value, if not in crop cultivation. Implementing only one standard is likely to result in a situation where one implicitly categorises all such materials as waste. Creating a second class of products in terms of consumers and soil/environmental protection enables these products to find useful application.

Figure 2 and Table 7 both show the differences in heavy metal concentrations of materials derived from source-separated materials, and those derived from mixed municipal waste. The mixed waste compost fails to meet standards in the Italian Fertiliser Law on virtually every heavy metal limit applied.

The Second Draft of the Biowaste Directive sets limit values for two classes of compost, and one for 'stabilised biowaste'. The latter can only be used

> 'as a component in artificial soils or in those land applications that are not destined to food and fodder crop production [such as final landfill cover with a view to restoring the landscape, landscape restoration in old and disused quarries and mines, anti-noise barriers, road construction, golf courses, ski slopes, football pitches and the likes].
>
> For spreading on land or in areas likely to be in direct contact with the general public, stabilised biowaste shall also fulfil the sanitation requirements laid down in Annex II.
>
> The use of stabilised biowaste shall be allowed on condition of not being repeated on the same areas for at least 10 years and for a total quantity not exceeding 200 tonnes of dry matter per hectare.'

These limit values are shown in Table 8, with the Class II compost standard being similar to that in the Italian Law on Fertiliser. In other words, under the Biowaste Directive, material from the biological treatment of mixed waste is unlikely to be classified as compost, but would still be regarded as a waste. Composts, on the other hand, would have the status of 'product', and as such, could be freely marketed.

Figure 2: Heavy metals levels of soil improvers (compost and manure) from different sources compared to limit values in Italian Law on Fertiliser

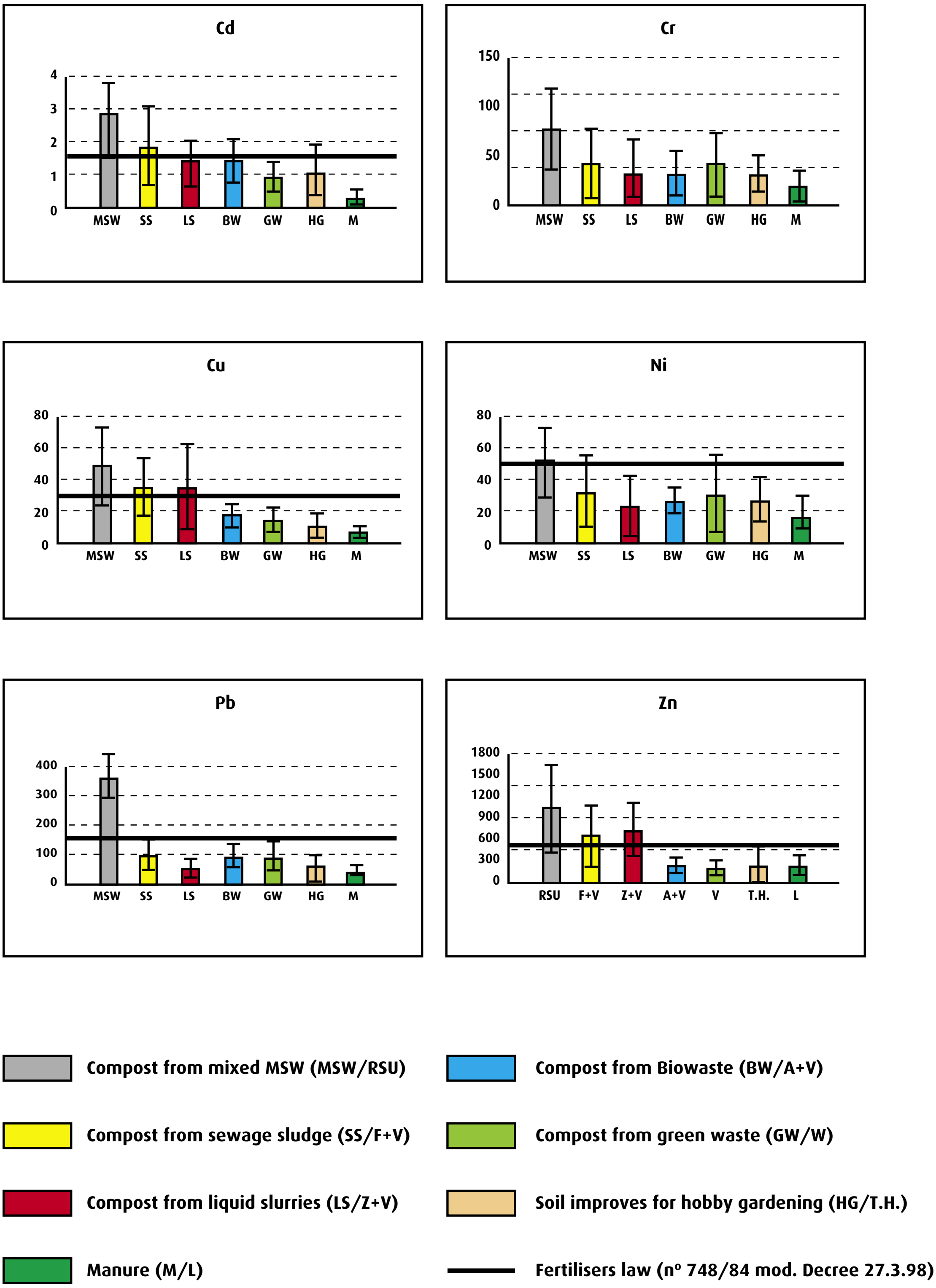


Table 7: Features of composted products from different feedstocks (Source: ADEME)

Parameters	UM	Compost from MSW (n = 100)	Compost from biowaste (n = 20-28)	Compost from green waste (n = 336)
VS	% dm	42.5	37.6	46.9
C/N		18.0	14.9	18.0
PH		7.8	8.3	8
N total	g/kg dm	12.7	16.8	15.5
NH4	g/kg dm	1.2	0.4	0.9
Pb	ppm dm	318.1	85.5	87.3
Cd	ppm dm	4.5	0.9	1.4
Cr	ppm dm	122.0	28.5	45.6
Cu	ppm dm	161.8	95.9	50.8
Ni	ppm dm	59.8	23.8	22.4
Hg	ppm dm	1.6	0.6	0.5
Zn	ppm dm	541.5	288.5	186.4

Table 8: Limit values set out in 2nd Draft Working Document on the Biological Treatment of Biowaste (12 February 2001)

Parameter	Compost/digestate a		Stabilised biowaste a
	Class 1	Class 2	
Cd (mg/kg dm)	0.7	1.5	5
Cr (mg/kg dm)	100	150	600
Cu (mg/kg dm)	100	150	600
Hg (mg/kg dm)	0.5	1	5
Ni (mg/kg dm)	50	75	150
Pb (mg/kg dm)	100	150	500
Zn (mg/kg dm)	200	400	1 500
PCBs (mg/kg dm) b	-	-	0.4
PAHs (mg/kg dm) b	-	-	3
Impurities >2 mm	<0.5%	<0.5%	<3%
Gravel and stones > 5 mm	<5%	<5%	-

[a] Normalised to an organic matter content of 30%.

[b] Threshold values for these organic pollutants to be set in consistence with the Sewage Sludge Directive.

The question of how to regulate and set standards for composts derived from mixed municipal wastes is one which continues to attract a great deal of attention in the UK. It cannot be denied that the shift since the 1980s (especially in Europe) has been increasingly away from composts from mixed municipal wastes, partly owing to a growing appreciation of the lower PTE concentrations achievable if MSW is not used.[6] The UK itself has some less-than-positive experience with composts derived from mixed waste.

One view is that just one standard for quality compost should be set in order to distinguish the boundary between 'products' and 'waste'. This appears to be the approach which is being taken in Germany and Italy, where the concept of 'mixed municipal waste composting' is increasingly relevant only in the context of legislation concerning pre-treatment (through stabilisation) of material to be landfilled.

In Austria, there is no question of low quality composts being used in the absence of restrictions. Though not classified as 'wastes', composts from mixed municipal waste are not classified (as the higher classes are) as products either. The Austrian approach (including mixed MSW within the system of standards) relates partly to the issue of dilution. It is felt that only addressing high quality compost in statutory regulations reduces the possibility to monitor dilution. It forces regulators to state what is accepted regarding mixing and what not. The Austrian approach clearly states that where mixed MSW is used for producing compost: (1) it must not be mixed with anything 'clean', including soil; (2) it is restricted to Quality Class B; (3) use of the material is restricted to landfill sites at limited rates [200 t dm/ha]; and (4) a stringent control contract which controls the input materials and the process independently is required. The aim is to have an effective legal tool to restrict MSW compost from unwanted misuse and to promote high quality compost.

Hence, while the approach is different, the objectives – of pushing compost production towards the quality end, and ensuring that compost from mixed MSW does not compromise the development of markets for higher quality products – are essentially the same in the Austrian system as they are in the Italian and German systems (and others which do not set standards for low quality materials).

Countries in which mixed MSW compost effectively falls within the existing standard tend to be those with no compost-specific standard in place. They are also not countries with well-developed compost production.

France has probably been the country with the greatest quantity of mixed waste composting in place (see Supplement 5, Section 1). The situation is changing. The Circulaire on the Management of Organic Waste, 28 June 2001 defines conditions to implement a strategy for the development of composting, stressing in particular the need for the following:

1 quality and confidence on the part of purchasers;

2 the need to define and run a quality label.

The second of these constitutes the background for the revision of those statutory standards currently in place, which have been shown to suffer from some shortcomings. Hence, the following issues are now being considered in a revision of statutory standards:

- agronomic requirements, with particular reference to stability of organic matter (various working groups are focusing on suitable test methods for respirometry, biological assays and the like); and

- health and safety issues (e.g. microbiological features, heavy metal maximum allowable concentrations (MACs) in the compost and in the soil, maximum loads).

The updating of the standard is due to be issued by 2002. Strategic planning at ADEME and the Ministry of the Environment is currently providing for the construction of many new facilities devoted to source-separated waste. As for facilities processing mixed MSW, the following moves are being considered:

- no more permits for new facilities;

- upgrading of old facilities to improve their performances when processing mixed MSW; and

- conversion into quality composting for source-separated materials.

Most recently, mechanical-biological treatment of mixed waste or rest waste is being considered as a suitable strategy for pre-treatment before landfilling.

Conclusion: The question as to whether to include more than one standard has to be considered in the context of:

1 the scope of the standards; and

2 the approach to regulation of mixed municipal wastes and materials with higher levels of contamination.

Regarding the former (point 1 above), to the extent that one includes sludge and / or other (than municipal) wastes in the scope of the standard, this should be dealt with either through (a) one quality standard set such that (clean) composts from other feedstocks fall under the scope of the legislation; or (b) defining more than one standard, probably such that these implicitly relate to the different feedstocks covered by the standard. The potential advantage of the second of these is that application restrictions could be set on the basis of the different classifications, whilst the first has the merit of simplicity.

Regarding the latter issue, (point 2 above) one could either (i) draw a sharp distinction between waste and product, with all materials not achieving the (lowest) statutory standard being considered as waste; or (ii) set standards which effectively regulate the processes and fate of the materials much more rigorously than for source-separated materials. As with higher quality materials, these standards would have to incorporate measures to ensure sanitisation and hygiene of the material. In our view, in the absence of specific legislation supporting source-separation, the risk of adopting approach (ii) is that the emphasis in the UK fails to shift towards quality composts, with the result that low-cost compliance with the Landfill Directive may be pursued through the creation of large quantities of low-grade material. Furthermore, this route offers little incentive for more sustainable resource management if by ‘composting’, one means ‘treating mixed waste’ without seriously attempting to encourage source-separation.

To the extent that low quality materials claim to be ‘composts’ (in the absence of any legal definition which might prevent such a label being applied), the likely outcome is that the poor perception of ‘waste-derived’ composted materials, which has been based upon previous decades’ experiences with mixed waste composting, will remain.

3.4 Standards on process control

The degree to which the standards for process control which are in place are monitored varies. Furthermore, it is important to understand in this context the role of QASs as opposed to standards in process control. This raises, in turn, a number of issues concerning the nature of tests, their frequency of use, and the procedures for dealing with non-compliance in this regard. These are dealt with separately later in this report.

Statutory process control in most countries is limited to hygiene and sanitisation aspects for compost and also for digestion residuals in Germany and Sweden. The treatment process must lead to a product which is hygienically irreproachable, in which bacteria (e.g. Salmonella) are absent, and weeds and germinable plant parts are minimised. The process control in this respect is achieved by recording of temperature in the hot phase of the composting process, as shown in Table 9 overleaf.

Odour and emissions management are usually dealt with as part of the permitting procedure for plants because these requirements have to be fulfilled by means of plant design and construction. It is not unusual, therefore, to see that such aspects are regulated at a local level (as in Canada and the USA for example). As a range of composting systems are often available, and these can be very different from each other, it is difficult to stipulate process parameters that guarantee stabilisation without stifling market diversity and future innovation. Hence, stability/maturity tests tend to be carried out on the product rather than in the process.

Process control in biological waste treatment plants (i.e. composting and digestion plants treating organic wastes) is likely to be expanded in the future. These tendencies are already emerging in the voluntary Quality Assurance Systems. France and Sweden are about to establish a system similar to the Quality Management System ISO 9000, which is a system based on process management. Best practice in operation, and traceability of the raw material from the point of collection or acceptance, through the treatment process until the end product, are the main elements of these systems. The extensive KIWA regulations in the Netherlands concerning the internal process control IKB (see Supplement 11, Section 3.2), and the extended diary of Austrian plants (with many parameters to be recorded daily) constitute process controls. To avoid expensive certification according to ISO 9000 – which has disadvantages when it comes to the common end product certification for compost – the German Compost Quality Assurance Organisation BGK requires 'best practise plant operation' from members which, includes extensive process control (see Supplement 6, Sections 4-7).

3.4.1 Hygienisation (sanitisation)

It can be seen that most of the schemes in place require, either through statutory standards or through voluntary schemes, the mass of compost to be raised to a minimum temperature for a minimum period of time. Where the compost is in open-air windrows, this will be a longer period of time, and these temperature regimes are also frequently linked to requirements for turning (this should be viewed as being necessary rather than as an additional requirement).

Two things are important to understand when considering regimes which tend to focus on pasteurisation, but which use this as a proxy to achieve hygienisation:

- First of all, the achievement of higher temperatures may slow down the composting process. As such, process controls of this nature may not lead to optimum rates of compost production.

- Secondly, and most importantly, it should be recognised that the 'temperature–time' regimes are not the only factor determining the level of 'pathogen kill' in the composting process. The composting process entails considerable changes in the biochemistry of the composted biomass. Antagonistic breakdown of the mesophilic microbial biomass in the maturation phase plays – under balanced aerobic humid conditions – a significant role in the elimination of pathogens. It is extremely difficult for certain microorganisms to survive once the organic matter has been transformed into humified biomass.

Table 9: Presence of standards applied to control composting processes

	Temp/time	Odours	Emissions to air	Other?	Stability (process duration)
Austria	Documentation only	Case-by-case, within the licensing procedure	No	No	No
Belgium Fl	Yes	General and case-by-case; no specific standards	No		No
Belgium Wall	Yes	No	No	No	No
Belgium Brus	Yes	No	No	No	No
Denmark	Yes	No	No	No	Yes 3 months for controlled deactivation
Finland	No	No	No	No	No
France	Yes	No	No	No	No (discussion about respirometric test)
Germany	Yes	No	No	No	Yes
Greece	No	No	Yes	No	No
Ireland	No	No	No	No	In licensing of plant
Italy	Yes	No (though some local regulations e.g. at regional level do give a set of provisions)	No (see left)	No (see left for waste water management)	No; a minimum retention time of 90 days only in the case of simplified permitting procedures ('communication')
Luxembourg	Yes	No	No	No	Yes
Netherlands	Yes	No	No	Plant owner has to describe and show how the chosen process leads to a good quality and guarantees sanitation. This is controlled	Yes
Portugal	No	No	No	No	No
Spain					Not today, but in Draft for Spain and Catalunya
Sweden	Yes	No	No	No	No
UK (Composting Association)	Yes	No	No	Moisture	Yes
Canada	Yes	Yes (provincial level)	Yes (provincial level)	No	Yes (BNQ and CCME)
USA	Yes (Sludge Rule)	Yes (state level)	Yes (state level)	No	Some
Australia	Yes (references to Good Practice Guide)	No (though referred to in Best Practice Guide)	No	No	No, but suggestion to report on self-heating test
New Zealand	Yes	No	No	No	No

Three test methods are common for composting plants:

1 The hygienic effectiveness of the individual composting procedure is determined by a process test with defined samples of micro-organisms introduced to a batch at the start and their survival evaluated upon completion of the process (e.g. in Germany, Luxembourg).

2 Indirect test criteria on hygiene effectiveness can be used for a plant in practical operation through monitoring and recording the temperature of each composting mass daily. Standards are typically set in the form of a minimum temperature requirement for a minimum period of time (e.g. >55°C for more than 2 weeks in windrows, >65°C for more than three days for in-vessel plants).

3 Saleable compost products are tested for organisms that cause plant diseases and for plant seeds.

In most of the countries surveyed a combination of a specified temperature–time regime and end product tests (typically using Salmonella spp and Escherichia coli) is used to guarantee sanitisation. There is no clear agreement on the regime, though a degree of convergence exists (see Table 10).

Table 10: Process requirements (temperature/time) for sanitisation

	Minimum temperature °C	Days
Austria		
Belgium	60	4
Denmark	55	14
France	60	4
Germany Biowaste Ordinance for Compost	55	14
	60 (in-vessel)	7
	65 (not in-vessel)	7
Germany Biowaste Ordinance for Digestion	55	1 (dwell. time 20 days)
	or 70	1 hour
	as pre- or post-treatment	
Italy	55	3
The Netherlands	55	4
Sweden	55–70, depending on compost/digestion plant and risk potential of material	
UK Composting Association	55	3 if outdoor static aerated pile or in-vessel
		15 if outdoor turned windrows (mixed 5 times in this period)
UK Soil Association	60 (to be 'aimed for', but not required)	There is a time period for composting, but not related to the temperature attained
Canada (CCME)	55	3 in-vessel
		15 for windrow
		3 for aerated static pile
USA	55	5 – in vessel
		15- windrow
Australia	55	3 requirement for three turns of windrow with internal temp reaching 55 for 3 days before each turn
New Zealand	55	3

There is a tendency to treat in-vessel facilities differently on the basis that the temperature of the whole mass is likely to be higher, other things being equal, owing to the containment of the material. There appears to be considerable agreement that temperatures higher than 55 °C and below 65 °C have the desired effect, although the duration for which this temperature must be achieved varies between different countries. It is worth reflecting on the position which was reached in the context of the second draft of the Biowaste Directive. An extract from this is given in Box 1. The temperature regime given here is similar, but the duration for which the temperature needs to be reached is at the higher end of what exists in national standards.

Austria is exceptional in that no minimum temperature is specified. However, temperature recordings are required each day during the thermophilic phase. The reason for not requiring any such minimum temperature is interesting: 10 years of experience and research on Salmonellae and Enterobacteriaceae (E. coli and other colony forming units) in Austria have given no evidence of any compost-derived disease problem in practice.

Box 1: Extract from Working Document: Biological Treatment of Biowaste, 2nd Draft

2.2 Composting

The composting process shall be carried out in such a way that a thermophilic temperature range, a high level of biological activity under favourable conditions with regard to humidity and nutrients as well as an optimum structure and optimum air conduction are guaranteed over a period of several weeks.

In the course of the composting process the entire quantity of the biowaste shall be mixed and exposed to an appropriate temperature as in the following table:

	Temperature	Treatment time	Turnings
Windrow composting	≥55 °C	2 weeks	5
Windrow composting	≥65 °C	1 week	2
In-vessel composting	≥60 °C	1 week	N/A

2.3 Anaerobic digestion

The anaerobic digestion process shall be carried out in such a way that a minimum temperature of 55 °C is maintained over a period of 24 hours without interruption and that the hydraulic dwell time in the reactor is at least 20 days.

In case of lower operating temperature or shorter period of exposure:

- the biowaste shall be pre-treated at 70 °C for 1 hour, or
- the digestate shall be post-treated at 70 °C for 1 hour, or
- the digestate shall be composted.

Mechanical/biological treatment

Sanitation to be obtained as in Section 2.2 in case of aerobic treatment or Section 2.3 in case of anaerobic treatment.

3.4.2 Odours

Few of the countries apply specific standards for odour control. Olfactometry tests do exist to measure odours, but most countries probably recognise that this is better dealt with on a case-by-case basis pending knowledge of the location. Some further information is offered in Appendix 1.

3.4.3 Moisture

Persistent, extremely low moisture in a composting mass can significantly reduce biological activity and decrease the likelihood that thorough sanitisation is achieved, and that pathogen re-growth will not occur at a later maturation or storage stage. Such scenarios are rare but nonetheless possible. Daily recording of moisture levels does not make sense for plant operation and is not technically feasible. Only the moisture content of the end product is relevant in the context of bagging and selling. Hence, moisture measurement during compost production tends not to be a topic for statutory standards but for end product declaration and definition.

Conclusion: Standards for processes are rather difficult to establish. The most frequently used standard is the 'temperature–time' regime, used to assure hygienisation. Interestingly, Austria sees this as unnecessary (based on extensive experience), preferring instead to test end-products for the presence of pathogens. It remains the case that there are relatively few process parameters which can be 'measured' to ensure end-product quality. As such, the control of processes seems more likely to occur through ensuring processes are carefully managed. Given that the key aim is to produce quality products, however, the emphasis for testing purposes is likely to be the product. Clearly, processes can be adjusted to make the production of quality products more likely, and it is these that seem likely to become the focus for quality control in the process phase. It is not clear that this can easily be stipulated in statutory legislation given the range of processes now available. One possibility may be to require 'process diaries' to be maintained (as in Austria) in which water regimes are monitored, and practices for screening, turning, aeration, addition of materials etc. are recommended in order to ensure end-product quality. However, such aspects are frequently dealt with through QASs rather than statutory standards or regulations.

3.5 Standards for end product quality

3.5.1 Procedures for standard setting

Countries which start to establish organic waste recycling with a view to producing high quality compost usually concentrate, in the first phase, on separate collection and composting processes. Legal regulations are usually set up for harmful elements in the compost, limit values for heavy metals being the most obvious example. Here the limit values are often deduced from the range for sewage sludge because of a lack of standards established specifically for compost (this appears to be the case in Australia, New Zealand, the United States, and France)[7]. In other countries, there has been an attempt to develop a precautionary standard specific to compost, based upon a desire to prevent the build up of PTEs in soil. This is linked to ideas of soil multifunctionality, in which the intention is to ensure that all possible functions or uses of a soil are preserved[8].

The US has been an exception in this regard. Since the late 1980s, it has adopted a risk-based approach to setting limit values for PTEs (through the US EPA's proposed rule Standards for Disposal of Sewage Sludge)[9]. In this rule the concept of exposure path-ways and risk analysis to determine concentration limits for contaminants was developed. The effect was that it relaxed allowable metal loading limits over prior standards, and is presently the most lenient published standard in the world. Some individual limit values are higher by a factor of 100 or more than those set in European countries.

Many of the assumptions underlying the approach used in the US have been reviewed and criticised over time, including (in the context of the choice of critical pathways), amongst others, assumptions concerning the rate of uptake by crops and the choice of organisms in the specific pathway (because, for example, soil micro-organisms are believed to be more sensitive to some heavy metals than other organisms, such as earthworms) [10]. Brinton's assessment is perhaps worthy of note:

'Background levels that exist in soils took a back seat to issues of whether raising the levels substantially posed a significant risk. The imperfect nature of the science of risk-analysis has always been recognised. However, the current extrapolation of the [US EPA] 503 approach outside the sludge realm to composts in general, and now fertilisers and soil, is illogical and possibly harmful. This is readily illustrated with heavy use of composts such as in potting mix formula where metals achieve toxicity to plants at levels well under the EPA allowed limits. There is a tremendous body of scientific data regarding heavy metal content of soils and organic wastes, and Europeans have made extensive use of the data in designing standards that they believe are 'real-world' and manageable. The major difference is that European compost standards are not focused through a 'sludge lens' as is the case in America. This may have marketing implications that are not easy to quantify. Unfortunately when American spokespersons advocate that they have the more scientific approach, risk analysis becomes elevated beyond what it is known to be useful for. In the future, composters must consider how to apply quality assurance procedures tied to more practical scientific goals.'[11]

Increasingly, certainly in Europe (as indicated in the above quote), the argument moves in favour of soil protection as being the relevant metric for the stipulation of limit values (i.e., a prevention of the build up of heavy metal concentrations in soil). This is clear from the second draft of the EU Biowaste Directive, in which limits on concentrations of heavy metals, as well as application rates, were specified. This does not mean that risk analysis is without support as an approach to setting standards for compost. Some scientists believe the state of knowledge is such that a risk-based approach can be used to regulate compost applications. The question then arises as to what is to be gained from not pursuing the 'European-style' precautionary approach? If this is a question that has a straightforward answer, one might be able to determine the relative merits of the two approaches. More likely, such a straightforward answer is not so easy to come by, and some may see this as part justification for the precautionary approach.

The level of limit should be related to products which can be produced from the materials derived from large-scale source-separation projects and to quality levels which can realistically be achieved in continuous, regular production in composting plants. Pilot-scale projects are not suitable for the definition of standards. Examples from the Netherlands and Denmark show standards which are not well designed and can therefore hardly be fulfilled in practice.

Since the Danish EPA was unable to give any guarantees for a compost fund, which was demanded by farmers to protect them from any negative consequences arising from the use of compost, in 1997 it specified, together with the Ministry of Environment, very sharp limit values for heavy metals and organic toxic contaminants. More rigorous limits still were set in 2000. The EPA is proceeding from the assumption that a high quality compost would be more readily accepted in agriculture. Analyses of compost made from household and garden waste showed that most composts would not comply simultaneously with the maximum allowed values for cadmium (0.4 mg/kg dm, as compared with 39mg/kg dm under the risk-based USEPA Sludge Rule) and for DEHP (Di(2-ethylhexyl) phthalates) (50 mg/kg dm) applicable from the year 2000 (see Table 11).

Table 11: Cadmium and organic pollutants (DEHP) in compost containing different fractions of organic household waste in Denmark

% of household waste in relation to garden waste in raw material	Number of plants	Cadmium in compost (mg/kg dm) (Limit value = 0.4)	DEHP in compost (mg/kg dm) (Limit value = 50)
85-100	2	0.27	60
70 80	2	0.40	31
40 60	2	0.50	4.8
10 30	2	0.40	0.55
0	2	0.47	0.55

3.5.2 Comparison of standards

The quality criteria upon which compost standards are based varies across the countries both in the range of criteria, the requirements, and the limit values (Table 12). The issue of the number of classes related to heavy metal limit values has been discussed in Section 3.3. It is clear that there are conflicting views. On the one hand, some perceive that it has been more or less well-established that when diversified compost standards based on heavy metal contents are available, only the 'best' compost will be asked for. From this perspective, where more than one standard exists, large quantities of good quality compost which is sufficient for various uses might fail to find an end-use.

Table 12: Classification of compost and digestion residuals quality in Europe

Country	Types and quality classes
Austria	Statutory: Quality Class A+ (for organic farming), Class A (for food and fodder areas) and Class B (for non-food areas), based on different raw materials and heavy metal contents.
Belgium/Fl	Quasi Statutory: Yard waste compost and vegetable, fruit and garden VFG compost and humotex.
Denmark	Organic household waste compost with no classification up to now. No quality criteria for green/yard waste compost necessary.
Germany	Statutory: Biowaste Ordinance Type I and II with different heavy metal contents. Voluntary RAL Standard.: Fresh and matured compost, mulch and substrate compost, liquid and solid digestion residuals.
Italy	Statutory: One level. Voluntary: Composted amendments form source-separation (two types depending on the raw material) and compost from mixed MSW.
Luxembourg	Statutory: Fresh and matured compost.
Netherlands	Statutory: Compost and very good compost.
Sweden	Voluntary: Compost and digestion residuals.
Spain	Source-separation or not.
UK	Voluntary: The Composting Association Standard defined by heavy metal content (and impurities and pathogens).
Canada	Voluntary: AAFC – one class based on heavy metal content. Voluntary: CCME – two classes based on heavy metal content. Voluntary: BNQ – three classes – heavy metals differentiate between top two and third; organic matter and foreign matter levels distinguish top two.
USA	Statutory: one class based on heavy metal content.
Australia	Voluntary: level of pasteurisation and particle size/stability.
New Zealand	Voluntary: range of parameters, not heavy metals.

From this perspective, quality classes based on the raw material or the ranges of application (rather than PTE content) are more likely to be useful in meeting the requirements of the compost market, given the protection offered by the PTE-related standard.

The counter-argument relates to the potential for ensuring clear rulings on dilution, and transparent regulation of low quality materials.

Note that digestion residuals are being included in quality assurance systems for the first time in Germany and Sweden.

Voluntary and statutory compost standards are classified according to heavy metal contents in Austria, Germany, Luxembourg, Netherlands, Spain, Sweden, the Netherlands, UK, Canada and the US. The type of raw material is decisive in Austria, Belgium, Denmark, Germany, Italy, Spain and Sweden. The degree of maturity defines classes in Australia, Germany, Luxembourg and Spain (and to some degree in Canada). Compost types based on application are established in Austria and Germany. In New Zealand, there is no obvious basis for making a distinction across classes.

3.5.3 Comparison of heavy metal content

Usually, maximum allowable concentrations for a common range of heavy metals in composted materials are used to compare the quality standards in different countries. This kind of comparison is not sufficient. The range of limit values set (common or exceptional qualities) and the allowed excess (cut-off limits, or tolerances around target limits) have to be taken into consideration too for a meaningful comparison to be made. On the basis of this consideration the heavy metal limits in the five countries with the strictest compost quality levels do not differ so much from each other.

Two different philosophies are the basis of the fixing of the limits for heavy metals:

1 Fixing a very low, and strict level for the heavy metals, yet allowing a considerable variation (e.g. Austria, Denmark, the Netherlands); and

2 Establishing a moderate limit level for heavy metals and relatively small allowed deviations (Germany).

Hence, although the Dutch level is the lowest (see Table 13), for the most critical heavy metal element, zinc, the limit value effectively becomes 286 mg/kg dm, which is a strict, though achievable level. Equally, Italian standards may not be so tight in absolute terms, but there is an absence of any 'tolerance' band.

It is recommended that quality criteria and limits are set which are guide values[12]. Since composting plants have only little influence on the quality of the raw material a level of tolerance regarding exceedences should be allowed (e.g. Germany allows a tolerance of 25% and the Netherlands a deviation factor of 1.43 for single heavy metals in a single analysis). Particularly when limit levels are very tight, plants generally produce compost very close to these limits. When the composting process is finished it can be ascertained for the first time by the plant whether the compost produced fulfils the quality requirements or not. An allowed variation gives the plants a level of security (and stability) in their compost production. In the UK, the standards set by the Composting Association incorporate tolerances within a weighted scoring system.

Thus, compost samples which occasionally exceed one or more upper limits, or which more frequently exceed one limit but only by an insignificant amount, will not necessarily lead to the award of compliance being withheld.

It also has been taken into consideration that all the limit values have to be analysed by laboratories, and that it has to be established that the requirements of the criteria laid down can be fulfilled in the daily practice of a composting plant. In doing this, there ought to be a sensible ratio between efforts and costs for the control and the analysis. This is not the case in every country. Particularly where standards and QASs are voluntary, the costs are likely to be one factor limiting participation in the scheme (see Section 4.4).

Another important fact influencing the stringency of the limit values has to be the quality of sample taking and analysis. Experienced sample takers, mostly working for laboratories, will perform the sample taking to a higher standard and according to the regulations, especially when it comes to open profiles in the heap and the reduction of larger samples for the final sample. The level of errors in the orderly sample taking and analysis done by experienced personnel during the German inter-laboratory checks on a reference compost sample (the 'ring-test') is around 40%. Hence, if strict limits and standards are to be imposed, these possible sources of failures have to be taken into consideration. One might argue that this has a bearing on testing frequencies.

Table 13: Heavy metal limits and allowed deviations (mg/kg dm) of common compost qualities in countries with strict quality levels

Country	Chrome	Nickel	Copper	Zinc	Cadmium	Mercury	Lead
Austria				(+30%)[1]			
Class A	70	60	150	500	1	0.7	120
+ 50%	105	90	225	650	1.5	1.05	180
Belgium							
Agriculture Ministry	70	20	90	300	1.5	1	120
Denmark							
Statutory Order	100	30	1000	4000	0.4	0.8	120
+ 50%	150	45	1500	6000	0.6	1.2	180
Germany + Lux.							
RAL and Biowaste Ordinance II	100	50	100	400	1.5	1	150
+ 25%	125	75	125	500	1.875	1.25	187
Netherlands							
Compost	50	20	60	200	1	0.3	100
x 1.43	72	29	80	286	1.4	0.4	143

[1] The 30% for Zn and 50% tolerance for the other PTEs are tolerances which only apply for controlled analyses by the responsible authority on the market or at the composting plant. This tolerance is not intended to be applicable for any batch investigated on behalf of the producer.

Comparing heavy metal limits (see Table 14), the Dutch quality level is noticeable, because it clearly sets an especially high quality standard, not in keeping with standards in the rest of Europe. Comparisons of the Dutch and the German quality level during the next inter-laboratory test of approved laboratories in 2002 may highlight the situation in respect of the relative values actually achieved in respect of heavy metals.

Table 14: Heavy metal limits for European compost standards (mg/kg dm except where stated)

Country	Regulation	Cd	Crtot	CrVI	Cu	Hg	Ni	Pb	Zn	As
Austria	Compost Ordinance: Quality Class A+ (organic farming)	0.7	70	–	70	0.4	25	45	200	–
	Compost Ordinance: Quality Class A (agric.; hobby gardening)	1	70	–	150	0.7	60	120	500	–
	Compost Ordinance: Quality Class B (landscaping; reclaim.) limit value	3	250	–	500	3	100	200	1800	–
	Compost Ordinance: Quality Class B (landscaping; reclaim.) guide value (if exceeded to be marked within labelling)	–	–	–	400	–	–	–	1200	–
Belgium	Ministry of Agriculture	1.5	70	–	90	1	20	120	300	–
Denmark	Compost after 01 06 2000	0.4	–	–	1000	0.8	30	120/60 for priv. gardens	4000	25
Finland	Fertilised growing media	3	–	–	600	2	100	150	1500	50
France	NF Compost Urbain	3				8	200	800		
Germany	Quality assurance RAL GZ – compost/digestion	1.5	100	–	100	1	50	150	400	–
Germany	Bio waste ordinance (I)°	1	70	–	70	0.7	35	100	300	–
	Bio waste ordinance (II)°	1.5	100	–	100	1	50	150	400	–
Greece	Specifications framework and general programmes for solid waste management	10	510	10	500	5	200	500	2000	15
Ireland	Limits in recent licences	1.5	100	–	100	1	50	150	350	15
Italy	Limit values for solid organic fraction	10	500	10	600	10	200	500	2500	10
	Green (ACV) and MIXED[13] (ACM) Composted Amendment	1.5	–	0.5	150	1.5	50	140	500	
Luxembourg	Licensing for plants	1.5	100	–	100	1	50	150	400	–
Netherlands	Compost	1	50	–	60	0.3	20	100	200	15
	Compost (very clean)	0.7	50	–	25	0.2	10	65	75	5
Portugal	Decree on sludge (limit values utilised also for MSW)	20	1000		1000	16	300	750	2500	–
Spain	Decr.1310/1990 pH>7 (sewage sludge in agriculture)	40	1500	–	1750	25	400	1200	4000	–
	Decr.1310/1990 pH<7 (sewage sludge in agriculture)	20	1000	–	1000	16	300	750	2500	–
	Order 28/V/1998 on fertiliser B.O.E.n'm.131.2 June 1998	10	400	–	450	7	120	300	1100	–
Spanish draft on composting	Class AA	2	250	–	300	2	100	150	400	–
	Class A (Stabilised Biowaste)	5	400	–	450	5	120	300	1100	–
Catalunya draft on composting	Class A	2	100	0	100	1	60	150	400	–
	Class B (Stabilised Biowaste)	3	250	0	500	3	100	300	1000	–

Sweden	Guideline values of QAS	1	100	–	100	1	50	100	300	
UK	UKROFS 'Composted household waste'	0.7	70	0	70	0.4	25	45	200	–
	Composting Association Quality Label	1.5	100	–	200	1	50	150	400	–
Canada	BNQ Types AA and A, CCME Category A	3	210	–	100	0.8	62	150	500	13
	BNQ Type B, CCME Category B and AAFC	20	1060 [a]		757 [a]	5	180	500	1850	75
USA	EPA CFR40/503 Sludge Rule	39	no ceiling	–	1500	17	420	300	2800	41
	NY State DEC* Class I	10	100	–	1000	10	200	250	2500	–
	WA State Dept of Ecology, Grade A	10	600	–	750	8	210	150	1400	20
	WA State Dept of Ecology, Grade AA	39	1200	–	1500	17	420	300	2800	20
	Texas TNRCC Grade 1 Compost	16	180	–	1020	11	160	300	2190	10
	Texas TNRCC Grade 2 Compost	39	1200	–	1500	17	420	300	2800	41
	Rodale Organic Seal of Compost Quality	4	100	–	300	0.5	50	150	400	10
Australia	ARMCANZ limits for biosolids	3	400		200	1	60	200	250	20
New Zealand	DoH Values (1992)	15	1000	–	1000	10	200	600	2000	–
EC	Draft W.D. Biological Treatment of Biowaste (class 1)	0.7	100		100	0.5	50	100	200	
	Draft W.D. Biological Treatment of Biowaste (class 2)	1.5	150		150	1	75	150	400	
EC/'eco-label'	2001/688/ EC	1	100		100	1	50	100	300	10
EC/'eco-agric'	2092/91 EC- 1488/98 EC	0.7	70	0	70	0.4	25	45	200	

[a] Set in BNQ standard only

The Austrian and UKROFS (for organic farming) standards, together with the German Biowaste Ordinance Compost Type 1 form a second group with strict limit values. For the UK and Austrian examples, the influence of Annex II/A of EC regulation 2092/91/EEC on organic farming is clear. This contains a positive list of admissible fertilisers and soil improvers. Included are – amongst others – pure plant and vegetable materials (plant compost, park and garden waste compost) and – with amendment from 29 July 1997 (EC regulation 1488/97/EEC) – composted household waste, with a transition period until March 2002.

The latter amendment is linked to limit values for heavy metals and the requirement that the raw material must be gained from a closed and controlled collection and processing system. The need of farms for the compost has to be recognised by the inspection body. Heavy metal limits are distinctly beneath the values of the Eco-label as shown in Table 15. These limit values do not apply for green compost from garden and park waste.

Table 15: Maximum concentration of heavy metals for composted household waste from separate collection of Annex II A 2092/91 EEC (mg/kg dm)

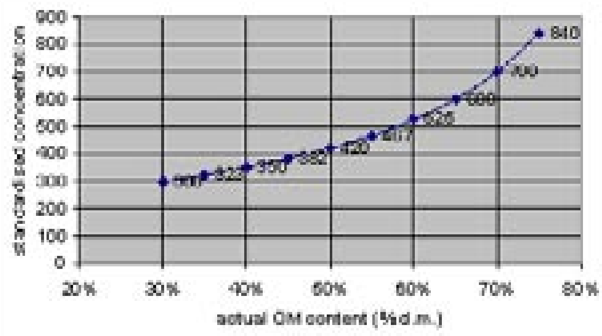
Cd	Crtot	CrVI	Cu	Hg	Ni	Pb	Zn
0.7	70	0	70	0.4	25	45	200

Below this, a group of countries (Austria Class A, Belgium, Germany Biowaste II, Ireland, Luxembourg, Sweden and the UK) form a second group with similar quality levels (marked with italic typeface in Table 14 to show the countries with similar standards to the UK Composting Association). The exceptional Danish standard for cadmium and its background is mentioned above.

It sometimes happens that tests on compost where you would anticipate a higher level of heavy metals appear to show a relatively low concentration following measurement. This can often be traced to situations where such materials have not undergone proper maturation, and therefore the 'concentration' of heavy metals which occurs in parallel with process-related materials loss has not taken place. As organic matter is mineralised over time, but heavy metals may accumulate in soils, in order that the influence of maturation on the concentration of heavy metals is properly assessed, many regulatory schemes (as for instance in the German Biowaste Ordinance) provide for the assessment of heavy metals to be standardised at a specific level of Organic Matter (30% in Germany) whereas 'fresh' materials often show 60 to 70% organic matter. Standardising the heavy metal concentrations to a specific level of organic matter enables materials to be compared on a level playing field.

The effect of this is shown in Figure 3. This shows the effects of standardisation in this way on composts of different organic matter content whose concentration of Zinc is measured to be 300ppm in all the samples shown. It shows that a compost which shows concentrations of 300ppm at 70% organic matter would actually be equivalent (in its zinc concentration) to a compost with a concentration of 700ppm zinc if the organic matter content had been reduced to 30%. Clearly, without such standardisation of measurements, bogus claims for the low-level concentration of heavy metals in compost can be made simply by reporting measurements on immature products.

Figure 3: Effect of standardisation to 30% organic matter on reported zinc concentrations



3.5.4 Comparison of standards for organic contaminants

Some countries have established limit values for organic pollutants (see Table 16). In Germany and the Netherlands no limit values for organic compounds are provided because of the low level that has been detected in composts derived from the source-separated materials. The Federal German Council, however, asked the German Federal Government to investigate the need for limit values for harmful organic compounds before 31 December 2002. Analyses of the pesticide content in bio- and green waste in Germany and Luxembourg have shown a very low level too.

It should also be noted that in Australian state guidelines for biosolids, limit values apear for PCBs and for a number of pesticide (usually herbicide) products. Typically, these limits cover lindane, heptachlor, DDT and derivatives, and the drins (aldrin, dieldrin, etc.). Indeed, a number of local regulations exist concerning the use of pesticides in gardens, partly related to concerns for the fate of these once composted. It is notable also that Denmark, with its high rate of composting of garden waste, has tight legislation concerning pesticides and recently implemented a ban on the use of garden pesticides.

Brinton, citing a Swedish report[14], notes that pesticides of concern which have been frequently detected in composts include: carbaryl, atrazine, chlordane, 2.4-D, dieldrin, chlorpyrifos, diazinon, malathion, and others. Degradation-resistant herbicides have been identified as a source of plant phytotoxicity of composts, even at very low levels. Woods End Laboratory has developed plant bio-assays which reveal damage to seedlings at levels down to 3-parts-per-billion. This raises the possibility that in the near future all composts must pass a plant bio-assay to assure absence of potential to harm plants.

Table 16: Limit values for organic contaminants in compost

	Austria Mixed MSW compost only	Denmark Biowaste compost 1 analysis per year)	Luxembourg Guide values for fresh and matured compost
PCB [1]	1 mg/kg dm		0.1 mg/kg dm (4 analysis per year)
PCCD/F [2]			20 ng/kg dm (4 analysis per year)
Dioxins	50 ng ITEQ/kg dm		
PAH [3]	6 mg/kg dm	3 mg/kg dm	10 mg/kg dm (2 analysis per year)
AOX [4]	500 mg/kg dm		
Hydrocarbons	3000 mg/kg dm		
LAS [5]		1300 mg/kg dm	
NPE [6]		30 mg/kg dm	
DEHP [7]		50 mg/kg dm	

[1] PCB: Polychlorinated biphenyls; [2] PCCD/F: Polychlorinated dibenzofuran; [3] PAH: polycyclic aromatic hydrocarbons; [4] AOX: Absorbable organic halogens; [5] LAS: linear alkylbenzene sulphonates; [6] NPE: nonylphenol; [7] DEHP: Di (2-ethylhexyl) phthalate.

In the US, the issue of banning chemicals that enter compost focuses on certain herbicides that are very persistent to degradation (e.g., chlorpyralid and picloram), and the issue is being debated within a small group, especially in Washington State and New York. Research into the fate of these chemicals in compost suggests they may decompose slower in compost than in natural soils[15]. A perceived problem is that the chemicals being discussed are the same that are used elsewhere in farming systems. The question as to how these can be banned in one use and not in another similar use is one which has affected the debate around pesticides policy in Denmark and is now being asked in the United States.

3.5.5 Comparison of standards for content of pathogens, impurities and weeds

All countries with statutory standards in place, with the exception of the Netherlands, where only a limited version exists, have testing criteria in place for the content of pathogens (see Table 17). Pathogen testing usually involves testing for the presence of specific micro-organisms, such as Salmonella and fecal coliform. Voluntary systems also often have such tests in place (Sweden, Netherlands, United Kingdom, Canada, Australia and, indirectly, New Zealand). These tests support the process-oriented 'temperature–time' regimes in seeking to ensure a hygienic product.

Testing for the presence of impurities is also necessary. All countries with standards have such a standard in place, with the exception of the US EPA standard (presumably since this is a standard for sludge). The standards allow for greater content of impurities in the form of stones than for plastic and glass.

In respect of the presence of weeds, there is not such a uniform picture. Those countries with the most developed systems – Austria and Germany – have such a standard on a statutory basis, as does Flanders and other regions of Belgium. Sweden, the Netherlands, Denmark and the UK each have voluntary standards in place.

Table 17: Requirements concerning pathogens, impurities and weeds

	Presence of pathogens	Presence of impurities	Presence of weeds
Austria	Statutory, dependent on area of application	Statutory, impurities >2mm, agric.: max. 0.5%; non food: max. 1.0%	Statutory, horticulture/ hobby gardening/sacked compost: max. 3 plants/litre (germination test)
Belgium Flanders	Statutory, indirect process control	Statutory, stones >5 mm, max. 2%, impurities >2mm, max. 0.5%	Statutory, no weed seeds allowed (germination test)
Belgium Waloonia	Statutory, indirect process control	Statutory, stones >5 mm, max. 2%, impurities >2mm, max. 0.5%	Statutory, no weed seeds allowed (germination test)
Belgium Brussels	Statutory, indirect process control	Statutory, stones >5 mm, max. 2%, impurities >2mm, max. 0.5%	Statutory, no weed seeds allowed (germination test)
Denmark	Statutory	Statutory plastic, metal, glass portion >2 mm may not exceed 0.5% weight in dm	Voluntary 3 content levels: Very low (<0.5 seeds and plant parts/l), noticeable content (0.5 2/l), large content (>2/l)
Finland	Only remark ay not contain to a harmful extent	Statutory max 0.5% fm	No
France	Statutory no harmful micro-organisms which may endanger man, animals or the environment	Yes	No
Germany	Statutory process and product tests	Statutory, 0.5% weight/dm plastic, glass, metal; stones >5mm <5% weight statutory	Statutory, germinating seeds and sprouting plant parts must be more or less absent (<0.5 plants/l compost for potting compost)
Greece	Statutory no Enterobacteria should be detectable	Plastic <0.3%dw; glass <0.5%dw	No
Ireland (licensing)	(under licensing regime) for human and plant pathogens	<1.5% of >25 mm in dry matter	No
Italy	Statutory	Statutory, plastics (mesh size <10 mm): <0.5% weight/dm; Inert materials (mesh size <10 mm): <1% weight/dm Inert materials (mesh size >10 mm): absent	Statutory, Fertiliser Law requires weed seeds to be absent Old Decree weed seeds absent in 50g
Luxembourg (licensing)	Statutory process test and product test	Statutory, plastic, glass, metal (>2mm) <0.5% weight/dm; stones (>5mm) <5% weight dm	Statutory, maximum 2 seeds/ litre
Netherlands	Voluntary product tests	Voluntary glass (>2mm) <0.2% dm, stones (>5mm) <2% dm, glass (>16m) absent	Voluntary, max 2 germinating seeds and sprouting plant parts per litre
Portugal	No	No	No
Spain	Statutory product test	Statutory, plastic particles and other inerts must not be over 10 mm	Statutory, Yes
Sweden	Voluntary – product test	Voluntary, plastics, glass and metals (>2mm) <0,5% dm	Voluntary, ≤2 per litre

UK (Composting Association)	Product test – for 2 human pathogen indicator species	Voluntary, of total air-dried sample: ≤1% m/m glass, metal and plastic, of which plastic 0.5% m/m; and stones ≤5% m/m. (Impurity if >2 mm)	Voluntary, ≤5 viable propagules per litre
Canada	CCME (Statutory) and BNQ (Voluntary) set limits for faecal coliforms and absence of Salmonellae	CCME (Statutory) and BNQ (Voluntary) foreign matter defined as any matter over a 2 mm dimension that results from human intervention and having organic or inorganic constituents such as metal, glass and synthetic polymers (e.g. plastic and rubber) that may be present in the compost but excluding mineral soils, woody material and rocks.). Three classes specified in terms of % oven-dried mass	No
USA	Statutory – product test	No	No
Australia	Through state or federal guidelines on biosolids	Voluntary – Glass, metal and rigid plastics >2 mm ≤0.5%dm; Plastics — light, flexible or film >5 mm, ≤0.05% dm; Stones and lumps of clay ≤5% dm Suppliers and their customers are advised to agree upon an acceptable maximum level of visual contamination by light weight plastic	No
New Zealand	Voluntary – not explicitly set only through cross-reference to DoH regulations	100% passes through 15mm x 15mm orifice	No

3.6 Other product characteristics

3.6.1 Stability/maturity

Compost stability is increasingly recognised as an important characteristic. In specific situations, immature, poorly stabilised composts may be problematic. Continued active decomposition when these composts are added to soil or growth media may have negative impacts on plant growth due to reduced oxygen in the soil-root zone, reduced available nitrogen, or the presence of phytotoxic compounds[16]. Consequently, tests have been developed to evaluate the maturity of compost materials. It should be mentioned, however, that no clear agreement on the best approach exists.[17]

Many countries have in place some form of measurement for stability within the domain of statutory or voluntary standards. These are shown in Table 18.

Table 18: Product stability tests in place

	Stability test
Austria	As the only maturation parameter the cress test requires a minimum performance of Lepidiu sativum grown over a period of about 9 days. Parameters measured are biomass, germination rate and delay of germination.
Belgium Flanders	Statutory – nitrate-ammonium ratio >1 for biowaste compost – this is expected to be changed to a stability degree of 'Rottegrad IV'[1].
Denmark	Voluntary – the degree of stability (on product sheet) is designated as either not-ready, fresh, stable or very-stable, and shall as a minimum be calculated on the basis of the analytical methods 'total oxygen demand in 96 hours' and the 'Solvita' compost test.
Germany	Voluntary, Rottegrad (degree of decomposition) [1].
Luxembourg	Statutory, Rottegrad (degree of decomposition) [1].
Netherlands	Voluntary, Rottegrad (max. temp. recording) [1].
Sweden	Voluntary self-heating or Solvita test.
UK	Voluntary, none, though declaration of C/N ratio required.
Canada	CCME and BNQ, compost is deemed mature if two of the following requirements are met: (1) C/N ratio <25; (2) oxygen uptake rate <150 mg O2/kg volatile solids per hour; and (3) germination of cress (Lepidium sativum) seeds and of radish (Raphanus sativus) seeds in compost must be greater than 90% of the germination rate of the control sample, and the growth rate of plants grown in a mixture of compost and soil must not differ more than 50% in comparison with the control sample. OR Compost must be cured for at least 21 days; and reduction of organic matter must be >60% by weight. OR If no other determination of maturity is made, the compost must be cured for a six-month period. The state of the curing pile must be conducive to aerobic biological activity. The curing stage begins when the pathogenic reduction process is complete and the compost no longer reheats to thermophillic temperatures. The CCME guideline also identifies the following criteria that may be used instead of the above to confirm compost maturity: Compost must be cured for at least 21 days; and compost will not reheat upon standing to greater than 20 °C above ambient temperature.
USA	Statutory in some states see Supplement 19, Section 4, for Massachussets Rule, and also main text.
Australia	Voluntary, none, but self-heating recommended.
New Zealand	Voluntary, testing of the following: pH, conductivity, nitrate, ammonium, maximum particle size[2].

[1] The Rottegrad test can be regarded as a particular form of self-heating test.
[2] Note several of the other standards include measurements such as these in addition to the tests for stability listed in this table – in most countries, we have concentrated on direct stability tests.

In the United States, there is no one standard approach to assessing stability. In recent work by the California Compost Quality Council (CCQC) in conjunction with the California Integrated Waste management Board (CIWMB), Woods End Laboratory and other peer-reviewers, maturity has been defined as the degree of completeness of composting. This is in contrast to earlier definitions used in America, and indicates that maturity is no longer viewed as a single property that can be tested for separately. Maturity must be assessed by measuring two or more parameters of compost, after the C:N ratio has been measured. The system proposed in California is as in Table 19.

Table 19: CCQC proposed compost parameter tier system to determine maturity index

STEP 1: Measure Carbon Nitrogen Ratio (C:N)	
STEP 2: If C:N <25, proceed to one each of (A) and (B)	
Group A parameters (select one)	**Group B (select one)**
Respiration:	1 Ammonium: Nitrate Ratio
1 CO_2-evolution (includes lab CO_2 or Solvita test)	2 Ammonia concentration (inc. Solvita ammonia)
2 O_2-uptake	3 Volatile Organic Acids
3 Dewar Self Heating Test	4 Plant test

3.6.2 Phytotoxicity

The issue of stability is partly related to that of phytotoxicity. Usually, mature composts are less likely to cause problems for plant growth. Hence, the use of plants to indicate compost maturity is used in some countries (see Austria in Table 18). Other countries also have bio-assay tests to test for phytotoxicity. Others have tests for the presence of plant pathogens. The countries with standards in place are Austria, Germany, Italy, Luxembourg, the Netherlands, UK, Australia (see Box 2) and New Zealand.

All of the standards on phytotoxicity, with the exception of that in Italy, rely on some form of plant growth test. This may be a measurement of germination/growth using compost, or measurement of performance relative to a reference potting mix. In Italy and the Netherlands, the compost is assessed for potentially harmful organisms. These are, in the Netherlands, nematodes, Rizomanie virus, and Plasmodiophora brassicae (vol.), and in Italy, nematodes, cestodes and trematodes.

Box 2: New Zealand Seed Germination Test to Determine Phytotoxicity in Compost

The test involves visually scoring the germination and early root growth of radish seeds in the test sample, using a known non-toxic sample (aged bark) as a control.

Aged bark shall be purchased from HortResearch, Ruakura Research Centre, Hamilton.

1. Sample must be moist before testing.
2. Take two petri dishes and write details of sample on lids.
3. Mix equal parts of the sample and pumice (grade 0–3 mm) thoroughly in a container. Shake well for 30 seconds.
4. Lightly press sample into base of dish.
5. With a nail, make 8 ‘holes’ in the sample media.
6. Drop one radish seed (Yates ‘Salad Crunch’) into each hole.
7. Carefully brush back media to cover the seeds and replace lid.
8. A control sample of aged bark is prepared at the same time as per Steps 1 to 7 above.
9. Leave on bench and keep moist and out of direct sunlight and check daily.
10. After 3–4 days record number of seeds germinated and score root growth as follows:

Root length	Score
0	0
1–20% of control	1
21–80%	2
81–100%	3

NGIA STANDARD

The score for root length must be ≥2.

Seed germination must be ≥75% of the control sample.

Conclusion: The PTE aspects of product standards are increasingly set on the basis of a desire to protect soil quality. This should be the main focus of the precautionary standards. These should be set with tolerances in place, the tolerance band being determined by the strictness of the standard. The standards set should be achievable using good practice composting methods, and they should be set in such a way that they can be standardised (e.g. using organic matter content). Attention should be paid to testing regimes, specifically, their cost and the desired frequency of testing (given the potentially high frequency for errors in sample-taking and testing). Clearly, the range of PTEs which one might wish to see tested for should be influenced by the nature of the materials one expects to see being submitted for testing. Even some source-separated materials, however, are likely to be affected by pesticide residues.

As regards impurities, the details of the approach taken vary across countries. It is clear, however, that at least one such standard is desirable here. Furthermore, depending upon the number of classes in the standard, there may be more than one threshold set for physical impurities. Equally, further delineation could be left to the more market-oriented standards with specific end-uses seeking to either make use of, or go beyond, the statutory minimum requirements.

The same could be true of the presence of weeds. This is likely to be far more important in some applications than in others.

It is important to recognise that in some quarters, there are concerns that the 'environmental' characteristics of compost are attracting so much attention that the quality of the product in use is becoming less significant. Both stability and the related parameter of phytotoxicity are important for this reason (they are more closely related to the product's value 'in use'). In some contexts (e.g. for determining stability of mixed waste where biological treatment is used as a pre-treatment to landfill/one-off landscaping), it seems desirable to make stability a statutory requirement for the material treated (because the end-use of the material is likely to be restricted, and therefore, the need to allow for different levels of stability is absent). This process of stabilisation should be linked to sanitisation requirements given the likely heightened significance of pathogen kill in the mixed waste context.

In other cases, it is probably not necessary to make stability part of a statutory requirement. There are two reasons for this:

1 In some agricultural applications, the use of fresh compost may be desirable. Generally, the stability required might be established through discussions with end users (in the context of quality assurance systems); and

2 Since no clearly accepted approach for measuring stability exists, to specify such a test in statutory standards risks ossifying the approach (it becomes awkward to change the standard).

The latter point appears to have particular significance in the UK at present, where a period of experimentation and learning in this regard might be highly desirable (at least for composts derived from specific source-separated materials). On the other hand, there may well be a temptation for producers to generate unstabilised compost. A 'middle way' might be to specify minimum retention times but this has the drawback that certain fresher materials may no longer be available.

The logic for requiring testing for phytotoxicity at the statutory level also deserves consideration in the context of developing standards. Arguably, the logic of requiring this at the statutory level can only be judged in the context of an understanding of the development of the structure of any standard (i.e. the way in which compost classes, if there is more than one, are to be differentiated). For similar reasons as discussed above (in respect of stability), however, it may be desirable to specify tests through quality assurance in the context of specific end-use markets.

3.7 Waste as product

An important aspect of compost standards is the question of when material defined as compost ceases to be considered as a waste (and hence, is no longer subject to licensing or permitting legislation).

In Austria (Supplement 1, Section 3.8), every compost batch produced has to be accompanied by documentation including all essential information to show if the requirements for input material and product quality for the application area concerned are met. A key document is the Compost Declaration. In accordance with the Compost Ordinance, any compost batch with this document loses its former legal status as waste and acquires the status of product.

In France, the key issue is whether or not the product meets the statutory 'NF' standards. These refer to conditions of marketing, and once a material meets such requirements, no further restriction (in waste legislation) is posed on its use and marketing, nor is any permit required for its application. In France, this applies also to compost from mixed MSW.

Italy adopts a different approach. Concerning the use of quality compost (compost from selected materials), Decree 22/97 and the subsequent Decree of 5 February 1998 (regarding simplified procedures for permits for recycling activities), stated that, since composting was a process of recycling and not simply disposal, it had to be regulated in order that compost produced could be used as a product (a fertiliser). The updating of the National Law on Fertilisers (Law 748/84) through Decree 27 March 1998, classifies compost as a soil improver, provided that it is derived from source-separated organic materials (including sludge) and shows particular biological, chemical and physical features, set in the Decree itself (and to be inserted as an update in the former Law on Fertilisers). Hence, the standard effectively makes the distinction between waste and product.

In Germany, the question – 'Is compost a 'product' or still 'waste'? – is answered partly through reference to quality assurance systems. If the compost is subject to voluntary continuous quality assurance through an acknowledged quality assurance organisition, it is likely to be considered a 'product'. In this case it is – e.g. when applied in agriculture – nearly exempted from authority controls and a soil investigation. Further details of the German approach and rationale are given in Appendix 2.

3.8 Standards on end-product use

The regulations and standards for compost use vary considerably across countries. There are countries where compost use is included in a dense net of different regulations (Germany, Austria), and then there are countries where compost can be used without any legal directions (Sweden). These differences are partly a consequence of the history of these countries and partly relate to the stage of development with respect to organic waste treatment of the country concerned .

Significant differences in the marketing situation also exist across the various countries. Generally it can be recognised that in the countries with a large compost production infrastructure like Germany, problems which some had anticipated would arise in seeking to sell compost did not arise and no surplus on the market was found. This is at least partly due to good marketing and public relations, intensive communication with the compost users and the quality assurance of the compost. In other words, coherent approaches to policy, standards, quality assurance and market development have tended to produce positive outcomes.

The following comments seem pertinent in respect of market prospects:

1 Horticulture and landscaping have proved for all countries one of the most receptive markets with good development prospects. In the US, these are the largest markets for compost materials accounting for an estimated 5 million tonnes of material.

2 In two cases the use of compost in forestry is regulated in an extremely restrictive manner. In Germany it is nearly impossible to apply compost in forestry as a 'pro-nature' cultivation is preferred (no nutrients and heavy metals). In Austria the use of biowaste compost (as well as sewage sludge compost) is prohibited by the national Forest Law as it is considered generally as 'waste disposal'.

3 In Germany and in Austria the agricultural unions have a negative view of compost use on agricultural areas. However, farmers can usually be convinced about the advantages of compost use, and indeed, this is a major outlet for compost. Especially contradictory is the situation in Austria where in spite of the opinion of the agricultural union, farmers produce a considerable proportion of total compost at their own plants. In Italy, three regions now actively encourage compost utilisation in agriculture through subsidy payments. The German Farmers' Association welcomed the new German Biowaste Ordinance (BioKompV enforced at 1.10.1998), which contains very strict regulations for those composts without quality assurance. From their point of view, compost can only be utilised on agricultural land for a long period of time if the soil quality is maintained and protected. This once again highlights the significance of the standards/QAS combination in giving confidence to (major) end users.

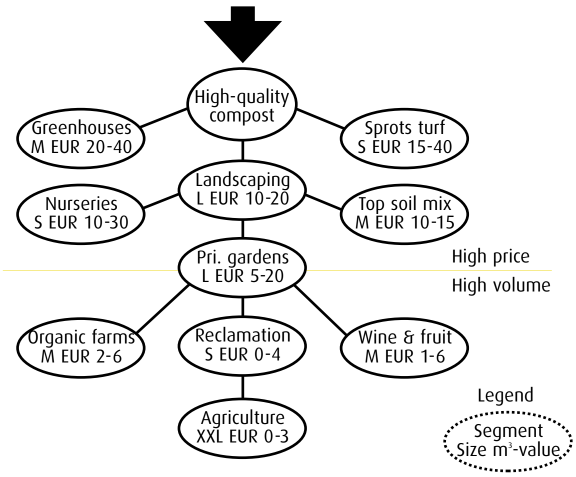
4 Different products tend to vary in importance in their specific market context. Countries such as Denmark and Belgium, with significant livestock sectors, are perhaps less likely candidates for compost use in agriculture. In Canada, changes are taking place in nutrient management which may favour the use of compost.

Where contaminants are concerned it should be noted that compost from source-separated materials performs well in comparisons with other soil improvers and growing media. This is reflected in the figures from an Italian database, which are illustrated in Figure 2 (in Section 3.3.1 above). Note that for manure and other 'un-stabilised' products, were these to be stabilised, the heavy metal concentrations would be higher than represented in that figure.

3.9 Market outlets

Figure 4 gives a European perspective on ranges of value (and market size) for composted materials. It can be seen that there are a variety of uses for compost with different potential market sizes. Table 20 gives further information on market sizes in some key countries.

Figure 4: Compost marketing hierarchy indicating market prices and volumes



Note: The volume is indicated as the relative size (small (S) to extra-extra-large (XXL)) of the market segment. Prices are known ranges for compost products within the market segment (EUR/m³).
Sources: Carlsbæk, M. SOLUM, personal communication, in Amlinger, F. (2000) 'Composting in Europe: where do we go?' Paper for the International Forum on Recycling, Madrid, 14 November 2000.

Table 20: Compost market shares by outlet in UK and key EU countries (%)

	Austria	Flanders	Denmark	France	Germany	Italy	Lux	NL	UK
Total (tonnes)	300,000e	221,000	388,000	725,000	4,000,000	550,000		800,000 [1]	462,768
Landscaping	30	25.7		9		12	20		
Horticulture	10				21				
Agriculture	30	8.6	12		36			70	
Field crops				43		33			
Vegetable crops				5					
Vineyards				9			43		
Market gardening					5				
Nurseries			8		7				
Growing media									9
Home/hobby gardening	20	19.3	43		14	48	18	10	
Soil conditioner									36
Retail				15					
Parks etc.			13		4		8	10	
Mulch									36
Soil mixing companies		15.5							
									2
Other wholesalers		9.9							
Organic fertiliser manufacturers				9					
Soil sanitation		2.2							
Potting soil		10.3							
Export		4.7						10	
Reclamation	5		14	10	10	3			14
Other	5	4.3	24		3	4	11		3

[1] Estimated value.

Note that the classifications as stated in the Nation Specific Supplements have been used (so that the list of market sectors is rather long) so as to preserve the integrity of the market shares quoted.

3.9.1 Utilisation restrictions

Utilisation restrictions exist for different end-use applications. Direct regulations such as dosage restrictions (permitted quantity of compost per ha) are to be distinguished from indirect regulations (qualified fertilising has to be executed in a way that considers the nutrients in soil and in compost, and the up-take by the plant).

The basic restrictions in the EU countries usually concern the permissible quantity of compost (stated in tonnes dry matter) at a maximum heavy metal content which can be spread annually, or over a 2-5 year period. In the time available it has not been possible to identify all the regulations regarding dosage in all countries. The following, however, provides an indication of the nature of the restrictions applied:

- Austria allows 8 tonnes of dry matter (dm) compost (Class A+ and A only) per ha/year (as an average over 5 years) on food production areas. For reclamation or erosion prevention on agricultural land, 160 t/dm/ha are allowed over a period of 20 years. In non-food production areas 40 t/ha and 20 t/ha for Class A and Class B, respectively, in 3 years are applicable in regular fertilisation. For certain landscaping projects and the layers on landfills, 400 t (class A) and 200 t (class B) dm/ha within 10 years can be used (see Supplement 1, Table 1.18).

- Compost application in Belgium is calculated on the basis of an allowed dosage for heavy metals, and the allowed levels of mineral application set out by the Manure Action Programme MAP (see Supplement 2, Table 2.6).

- In Denmark the annual quantity of nitrogen and phosphorous are restricted to 210 kg/ha and 30 kg/ha, respectively. Furthermore there is a load limit on food production areas of 7 t/dm/year (averaged over 10 years) and of 15 t/dm/year for areas which are not used for the production of food.

- In Germany the maximum quantity over three years is 20 tonnes for composts of the heavy metal content category I and 30 t/dm/ha for heavy metal content category II.

- The French regulation NF U 44 051 limits only the quantities of heavy metals permissible for sludge application.

- In its draft decree on biostabilised waste materials, Italy stipulates a usage of 100 t/dm/ha in landscaping projects, with higher dosages of up to 300 t/ha and more possible if these are supported by risk assessments.

- The Netherlands also sets restrictions of phosphorus applications. A phosphate quantity of 85 kg/ha (80 in 2002) on arable land and on grass land is limited for the 'best compost quality' and for green waste compost. The standard quality compost can be applied at a level of 6 t/dm/ha on arable land and 12 t/dm/ha every two years. The quantity for grassland is half this level. Since 2000, a new regulation from the Agricultural Ministry stipulates that the supply of heavy metals through compost should not exceed the level of removal by the plants.

- In Sweden the levels of phosphorous in the soil (5 classes) determine the application of nutrients (22-35 kg/ha total phosphorus and 150 kg/ha nitrogen) from compost. Guide values for heavy metal applications to arable land exist too.

- In the UK no special regulations for compost exist except in the case of composted sewage sludges, where the Sludge (Use in Agriculture) Regulations limit inputs of heavy metals to agricultural soils. The voluntary Code of Good Agricultural Practice for the Protection of Water recommends that a maximum of 250 kg/ha total nitrogen is introduced from manures, including composts. Additionally, it allows for composted organic waste – amongst other materials that contain 'very little plant available nitrogen' – to supply up to 500 kg/ha total nitrogen 'in catchments less sensitive to nitrate leaching'. To encourage adherence to relevant law and good practice, the Composting Association Standards specify that 'application or use of the compost is conducted in accordance with relevant Codes of Practice and statutory regulations'.

- Some US states have compost standards which incorporate an application rate of 100-250 m^3/ha in landscaping of 20–40% in horticulture mixtures (depending on salt, maturity, density and C:N ratio).

- In Australia, there are no specifications for different areas of use. There are specifications for loading rates for products of differing salinities in respect of the product's sensitivity to salinity (see Table 21). Other specifications on loading may be established under federal/state guidelines.

Table 21: Maximum application rate (litre/m2) of product with different salinities for plants of different sensitivities to salinity

Electrical Conductivity range (dS/m)	Sensitive plants	Tolerant plants
0–1	Unlimited	Unlimited
1–2	<15	<60
2–4	<8	<32
4–8	<4	<16
8–12	<2.5	<10
>12	<2	<8

Notes: These rates are for mulches or for incorporation into soil to a depth of 5 cm. When incorporated into soil to a depth of at least 10cm these amounts can be doubled. The rate of application of product has to be stated on the primary package or information sheet.

The above mentioned restrictions mostly focus on continuous application as occurs in agriculture. In most of the non-food applications – e.g. landscaping, one of the main markets – compost is applied once or infrequently. Here larger amounts (e.g. 200 t/dm in 10 years) must be used to achieve the desired application effects. Until now only the Austrian Compost Ordinance considers this aspect.

In general, it can be ascertained that with today's quality composts the factor which limits application rates is not only (or not even) the heavy metal limits, but more likely, the nutrient contents, and especially phosphorus and nitrogen. Note that it is important to understand the differences between compost products and mineral fertilisers in terms of the way in which the applied nitrogen is made available to plants. Although this depends upon a number of factors (climate, rainfall, etc.), it is accepted that nitrogen in compost is less readily available than that from mineral fertilisers. For this reason, in Flanders, for example, discussions have been ongoing concerning revisions of the law which implements the Nitrate Directive to take account of the fact that the nitrogen content of compost is not so available to be leached into groundwater as nitrate in mineral fertilisers.

In addition, a tendency can be detected for compost application to be included in fertiliser management systems. Regarding compost application, Germany refers to the need to follow 'best fertilising expert practise', whilst in the Netherlands, the Mineral Accounting System MINAS (obligatory since 2001 for all farmers with more than 0.5 livestock units) requires farmers to account for the mineral balances when nutrients are applied in any form.

Both should lead to a balanced application between input and output of organic and inorganic fertilisers. Belgium (Flanders), Ireland and New Zealand refer to a similar consideration. The basis of the calculation is the availability of compost nutrients in soil. To date, however, no general formula for the calculation exists.

Conclusion: The nature of compost markets is likely to lend itself to classical market development strategies:

- Ensure bulk markets are functioning well so that demand runs ahead of supply; and
- Seek to establish niche markets alongside these with the emphasis on establishing higher value-added markets.

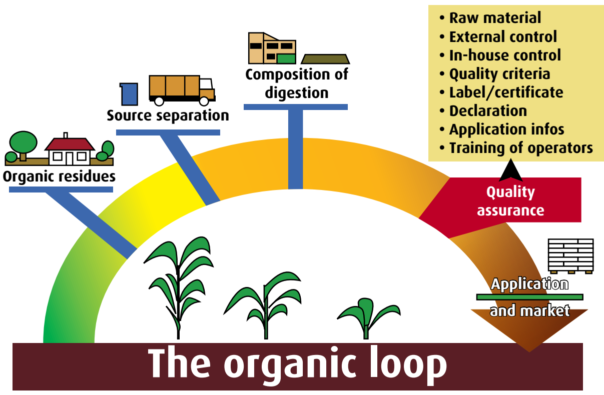
However, the application of compost has to respect environmental parameters. For this reason, as well as ensuring product specifications for specific end uses (see the next section), the ability of the receiving medium to absorb compost applications must be carefully considered. The efforts to generate quality composts with low PTE concentrations are intended to ensure environmental protection. Loading limits are the direct counterpart of the precautionary product standards for compost, but these have to take into account not just heavy metals, but nutrient content (in field applications, not least since such issues are covered by legal commitments in European countries).

Some consideration should be given to the nature of nitrate in compost as opposed to nitrate in synthetic mineral fertilisers and manures. Application rates for good quality compost tend to be limited by implementation of the EU Nitrate Directive. Yet nitrate in compost is less freely available than nitrate in other forms. Hence, consideration should be given to the possibility for establishing different application rates for nitrate which relate to the form in which the nitrate is applied. This is possible within EU legislation where proper justification is given.

4 Voluntary quality assurance systems (QASs)

All investigations indicate that the market for the end product is the most crucial issue. Both producers and users are of the opinion that sustainable recycling of organic wastes demands clear regulations regarding what is suitable to recycle and how it should be managed and controlled. A well-founded quality assurance programme supports sustainable recycling of organic wastes (see Figure 5). Collecting source-separated materials for composting is futile if there is no use to which these valuable materials can be put.

Figure 5: Main elements of the organic loop



Quality assurance links compost production with the markets for compost and their application. It is carried out from the point where statutory standards following the precautionary principle normally stop. In many cases statutory standards ignore markets and compost application to the extent that soil protection is not considered of major importance by end users. Exceptions here are sewage sludges and products used in organic agriculture. For sewage sludges, the regulations concerning applications are frequently prescribed (as, to some extent, in the UK through the Sludge Use in Agriculture Regulations and the Safe Sludge Matrix). For products used in organic agriculture, the product standard in terms of PTE concentrations is closely related to the end-use application. For other products though, QASs close the recycling loop for (usually source-separated) organic residues.

In countries where no, or only very limited statutory standards exist, QASs are important in the recovery of organic waste because they influence all stages of the treatment of organic residues:

Separate collection: Quality assurance can be used to draw conclusions on the quality of collected materials and can be used to suggest measures for improvement (for example, in approaches to source-separation).

Plant engineering: Errors in the plant engineering can be quickly identified via quality controls. Regarding the issue of hygiene, quality assurance also serves to guarantee worker protection.

Compost production: Only regular or continuous process monitoring and recording as well as constant quality and product checks can ensure errors in compost production are avoided.

Marketing: Consumers want a standardised quality compost. Only a quality assurance system guarantees this. A statutory standard is also useful here since it requires testing and evaluation before deciding whether the material is of acceptable quality to release. A QAS improves confidence that the product offered is consistently of the specified quality and conforms to statutory requirements. An associated quality symbol supports all the marketing efforts.

Public relations work: A good image for compost can be built up with assured quality and through a quality symbol for the compost product.

Application: The analytical results form the basis for declaration, and recommendations for use, and consequently for the correct and successful application of compost.

Product range: Only by precisely knowing the properties and their extent of fluctuation can a range of compost products be developed.

Policy/regulation: Through statistical evaluation of the test results the legislators are made familiar with the present standard of compost and the possibilities of the composting plants. This data can be used to inform the development of policies and regulations that are appropriate for the current practical situation.

Certification: A quality assurance system is a pre-condition for certifying the composting plants to, e.g. the EU-Standard ISO 9000.

Besides these points, all marketing analysis over recent years shows that users of compost demand a standardised quality product that is verified by independent organisations. A study in the south of Germany showed that 94% of the commercial users were making this a pre-condition of use. Research carried out by the German Compost Quality Assurance Organisation BGK concerning the expectations of the green sector regarding compost led to the conflicting result that the quality symbol seems to be relatively unimportant (see Table 22).

Table 22: Expectations of the green sector for compost products

Percentage of interviewed persons	Requirement
65%	Compost use should not create health problems
64%	Low content of heavy metals
61%	Analysis by approved labs
56%	No impurities (glass, stones...)
52%	No seeds in the compost
48%	Information about raw material
43%	Good declaration of nutrients
40%	Recommendations how to use
36%	Compost has a quality symbol
35%	Origin of the compost

While other elements have been rated as being of higher priority than a QAS symbol, these elements are in fact part of any typical quality assurance system. By encompassing all such parameters, QASs ought to eliminate the need for more complex and detailed explanations. The result of the study was a new communication strategy in the BGK which clearly pointed out what the quality assurance system contains and what stands behind the symbol.

The introduction of separate collection and composting should preferably go hand-in-hand with the introduction of statutory standards and (much less preferably, or) a voluntary quality assurance system. Countries advanced in their experience of composting have recognised this and have developed systems or are preparing them at present (see Table 23 for details of systems in place). The more advanced QASs tend to be supportive of a statutory standard. An exception is the Swedish system.

Participation in quality assurance is, for all the countries, a voluntary act. However, if the quality standard has established itself (and especially if it is statutory), the market begins to demand these qualities and composting plants come under pressure to furnish proof of quality (this is very much evident in Germany and Flanders). Normally (and this applies to all countries), one finds a surplus of humus products, soil improvers and organic fertilisers, so that only the very best qualities and products are asked for. Therefore composts without quality assurance or a certificate will increasingly find only local markets around the composting plant (where the plant manager him/herself stakes a personal reputation on quality and gives confidence for his customers), or in restoration projects (such as at landfill sites).

The central role of quality assurance can be seen in countries with a developed composting system such as Austria, Germany, the Netherlands, Sweden and Belgium (Flanders). These countries have established an extensive quality management system for composting plants, in which around 500 composting and 20 digestion plants currently take part (see Table 24). These treat around 5.5 million tonnes of organic waste. Several others countries like the UK, Canada, New Zealand, and France are at relatively early stages of the conceptual design in the introduction of a QAS. Furthermore, there are issues (discussed in Section 4.4) as to whether the QAS in certain contexts, where no statutory limit values exist, can really attract producers into the scheme. With this in mind, it should be noted that Table 26 shows that few producers take part in the Canadian scheme. In the UK, a number of compost producers follow ISO 9000 and/or 14001 as a quality management framework and some have good procedures for monitoring and recording compost production and testing of samples. However, not all of these yet feel sufficient pressure from end users to become certified as compliant with the Composting Association Standards.

Table 23: Survey on voluntary compost quality efforts in various countries

Country	Status of quality assurance/certification activities and organisation
Austria	Fully established quality assurance system (in redesign phase because of influences of the new statutory compost ordinance) (Austrian compost quality association KGVÖ together with the Austrian ÖNORM Standardisation Institute) Agricultural Composting Associations (ARGE Kompost; BKAL) have established a quality assurance system in 5 provinces. Establishment of common rules for acknowledgement is in progress. No quality symbol.
Belgium	Fully established quality assurance system in the Flanders region (Flemish compost promotion organisation VLACO).
Denmark	Recently implemented quality assurance system for compost (Criteria, standardised product definition, analysing methods) (DAKOFA – Association of waste processors – compost division).
Finland	No official efforts as yet.
France	Proposal for quality criteria, research program for a quality management system (Research carried out by the French EPA – ADEME).
Germany	Fully establish quality assurance system for compost and anaerobic digestion products (German Compost Quality Assurance Organisation BGK together with RAL German Institute for Certification and Standardisation).
Greece	No efforts until now.
Ireland	A first draft of a proposal for quality assurance is presented (in future probably the Irish Composting Association CRE).
Italy	Proposal of a quality assurance system (Italian Compost Consortium CIC).
Luxembourg	Statutory system similar to German Quality Assurance System exists as part of the licensing procedure for composting plants.
Netherlands	Fully established quality assurance and certification system (Association of waste processors VVAV together with the Dutch certification organisation KIWA).
Portugal	Proposal for quality assurance exists.
Spain	Draft statutory standard for Spain and Catalunya (Division at the Environmental Ministry).
Sweden	Just started with quality assurance system for compost and digestion products (Swedish public cleansing organisation RVF together with the Swedish Standardisation Institute SP).
UK	Quality standard and QAS run by the Composting Association is in effect Note there is no substantive QAS supporting the UKROFS standards.
US	Test guidelines and 4 product standards of the US Composting Council, and some internal State standards Quality approval in the United States is a state-by-state matter, and also a private marketing matter (an example of the latter are use categories by the organic publishing company Rodale Inc). Some states, which have large volumes of yard-waste compost, have advanced compost guidelines, such as Washington and California, whilst other states, such as Pennsylvania, where agriculture is very conventional, have no compost standards at all. Compost in these states is only regulated if it falls under other laws such as solid waste, or voluntary rules, such as by the PA (Pennsylvania) Composting Association. Approximately 38 States have separate guidelines (US Composting Council, State Departments for Transportation).
Canada	National BNQ Standard for 'organic soil conditioners – Compost' (The Composting Council of Canada has renewed discussions recently to focus on end market needs, information and enhanced product performance analysis).
Australia	Australian Standard for composts, soil conditioners and mulches (Standards Australia).
New Zealand	Strictly market oriented 'standard for production and labelling of compost'.

Table 24: Participation in voluntary quality assurance systems of European plants (status October 2001)

Country	Plants with quality assurance/certification [1]	Plants with quality sign or certificate
Austria	13 (KVGO) 344 (BKAL, agricultural producers)	2 (KVGO)
Belgium (FL)	25	11
Germany	ca. 430 compost plants ca. 20 digestion plants	ca. 400 compost plants ca. 20 digestion plants
Netherlands	26	4
Sweden	2 composting plants 2 digestion plants	Just started with the system
UK	4 composting plants	0
Canada (BNQ)	2 composting plants	

[1] This figure includes plants that have applied for a quality sign or a certificate but the process is not yet finished.

4.1 Purpose and tasks of quality assurance

'The requirements should not only be set up in general as this bears the risk of a loss of confidence in the system. A more detailed set-up of the requirements increases the risk of a rigid system which cannot be optimally used by the plant operators. An adequate and flexible system can guarantee a reliable quality together with the possibility for each plant operator to choose independently the best solution for an improvement of the quality of the end product.'

This quotation is part of the last evaluation report of the Swedish Certification Organisation on recent experiences with the new certification system. This points towards a need to balance the control of key indicators with sufficient flexibility to cater for a range of production methods.

The basis for the New Zealand standards, for example, is to increase the engagement of the growing compost industry in a system which gives confidence to various actors. The voluntary system is intentionally simple. It was developed following the development of much more complex and detailed Australian standards. From New Zealand's point of view, it appeared that the complexity (and implied cost) of the Australian system had led to a low take up by producers of compost in Australia. The response in New Zealand was to develop standards which would be at one and the same time meaningful, and simple (so that no potential participant would be excluded on grounds that standards were too onerous and/or too costly to comply with) (see Supplement 17).

The main objective of quality assurance is without doubt in the area of environmental protection and soil conservation. Besides these very general targets, several practical criteria should be considered;

- pollutant penetration into the soil as a result of compost applied must be minimised;
- external control must be independent of the producer; and
- the quality of the product compost must be assured to the same standard over an area as large as possible, e.g. for a region or a country.

4.2 Elements of quality assurance systems

Quality assurance systems also tend to:

- define analytical methods and qualification of the laboratories, activities for training and monitor laboratories' performance through inter-laboratory checks on reference samples of compost;
- create a standardised procedure for obtaining compost samples and ensure that participating laboratories consistently prepare and test samples in the specified/agreed manner;
- build up a central database of all analytical results in order to be constantly in a position to document the current status of compost production and quality;

- apply sanctions in the event of non-compliance with the standards, at early or later stages (e.g. withholding initial award of the certificate and use of the quality symbol, or withdrawing certification should non-compliances creep in and persist, or a severe non-compliance occur);

- form an independent, officially-recognised organisation to assess the results of analysis, to rule on details, disputes and to further develop the quality assurance system and, in particular, to give expert opinions within the framework of the political decision-making processes.

Particularly important and not always self-evident is the following:

- The compost qualities required by law should be reproducible in the composting plant and controllable in practical operation. However, this is not the case in the Netherlands, where only one composting plant can currently produce the highest quality 'very clean compost', or in Denmark where the limits for cadmium are set so low that the quality of well-produced compost struggles to fall within such limits.

Depending on intention, philosophy, political or functional approach, the quality assurance systems for compost comprise different elements:

- approach to source-separation;
- type of raw material;
- training and qualification of the operator;
- management and operation of plants (plant inspection and assessment);
- evaluation of conformity with all requirements;
- intake control;
- limits for hazardous substances;
- quality criteria for the valuable constituents in the compost;
- process control;
- external control (of the product and/or the process);
- internal control (of process and product);
- process and product documentation;
- storage requirements;
- certificate for the plant and/or the product;
- declaration of the properties of compost;
- quality label for the product;
- recommendations for use and application;
- annual certificates;
- transportation (suitability / cleanliness of vehicles, destination, etc.).

4.3 Comparison of systems for quality assurance/certification

4.3.1 Control and monitoring system

Any certification or quality assurance system is only as good as its control and monitoring mechanisms. Market analysis in Germany, for example, showed that besides a standardised product, independent verification of quality is a basic requirement amongst compost users. Without a degree of independence in the system, a quality assurance system is not able to generate sufficient confidence in the quality of the monitored product.

Independent monitoring can consist of independent sample-taking, independent analysis by approved laboratories, independent evaluation of the results and an independent production control. There are differences in monitoring systems in the various countries. Common to all is that the analyses may only be performed by approved laboratories. Independent sample-taking is similarly organised. In the case of the UK Composting Association standards the assessment fee provides for overseeing of sampling by an independent person no more than once per assessment period (12 months). There is no significant QAS for compost producers under the UKROFS (Soil Association) system. The main difference between the countries is the extent to which additional production or process controls over and above independent sampling and analysis of the final product is deemed to be important (see Table 25).

Table 25: Types and extent of monitoring

	Production control	Product control
Austria	Compost Ordinance	Compost Ordinance and KGVÖ
Belgium/Flanders	VLACO – during the first year of operation	VLACO – beginning with the second year
Denmark	–	Plant Directorate
France	According to ISO 9000 principle in the Qualorg research project	According to ISO 9000 principle in the Qualorg research project
Germany	BGK [1]	BGK
The Netherlands	KIWA	KIWA
Sweden	RVF Certification	RVF Certification
UK	Composting Association – procedures and records checked for each assessment period	Composting Association – sampling, results, product storage and labeling checked for each assessment period
Canada	Bureau de normalisation du Quebec	Bureau de normalisation du Quebec
New Zealand	–	New Zealand Potting Mix Manufacturers Federation

[1] Only for hygiene issues.

The German BGK incorporates an external monitoring system which consists of independent sample taking and analysing by approved laboratories. Poor experiences led to the requirement that the results of the analysis have to be sent by the laboratory first to the quality assurance organisation, and then to the composting plant. This avoids 'corrections', or efforts by the composting plant to change the results through new analysis after receiving the first set of test results.

The German system concentrates on the quality of the final product, so production control is not planned, apart from the daily temperature monitoring in order to guarantee hygiene. Some regionally valid laws and the Biowaste Ordinance stipulate aspects of process control to satisfy increasing demands concerning hygiene. The philosophy behind the German quality assurance system is that the quality of the end product is far more important than the process involved. If the quality of the end product is up to scratch, the raw materials and the production technique do not matter (or, more likely, are probably, in an implicit sense, of the required standard). There are really only two exceptions to this general approach: some may require that the essential contents of raw material types be declared; or the hygienic effectiveness of the decomposition process must be assured. Considering the end product appreciably simplifies the structure and inspection scope of a compost quality assurance system. This is particularly significant in view of the fact that industrial organic residues and biodegradable plastics are increasingly likely to be composted in future.

It should also be pointed out that good raw materials do not guarantee high-quality compost. Errors during the compost production can also produce very poor quality end products, so the product is a testimony to both inputs and process.

In the Dutch system an intensive internal production control is added to the monitoring of the product. The composting plant has to carry out most of the tests itself. The results of the analyses are filed by the plant. The certification organisation KIWA monitors the results, including a large number of internal monitoring parameters carried out in every plant eight times a year. In addition KIWA takes one independent sample and performs the analysis in its own laboratories so as to cross-check the operator's own results.

A similar system where the certification organisation visits the plant – sometimes without announcement – and checks the production process, the required documentation and the products produced, forms part of the Swedish system. The Swedish system consists of elements of the Quality Management System ISO 9000. Having documentation of all steps in the process and full traceability of the material stream were the basis for introduction of this system. A similar system is planned – also on the basis of ISO 9000 – for France.

The most extended integrated quality management occurs in Belgium. VLACO, in Flanders, promotes source-separation and home-composting, manages the QAS system for the composting plants, advises about compost application and is responsible for compost marketing. In some respects, VLACO plays a similar 'market development' role to that which is envisaged for WRAP, but it concentrates on biowastes exclusively. Apart from the costs, this is the most readily recommendable system in the composting world because all elements of the organic loop are managed by one organisation, which enhances the prospects for optimisation of the whole system.

In Flanders, therefore, there is a two-year two-step system of monitoring the production process and the product. During the first year of operation, together with the VLACO experts, a compost producer has to learn about composting techniques and compost production. The product has to fulfill the basic legal standards in this period. At the beginning of the second year the monitoring activities shift towards the higher product quality (basically there is a demand for a higher organic matter content) and process control.

The Austrian quality assurance system is similar to the German one. An independent production control is not provided but will be partly introduced when the external approval procedure of the Compost Ordinance is fully implemented. However, influence on the quality of compost production is brought to bear through two avenues. The manager of the plants has to go through a certain training programme, and a very specific and technical plant operation diary has to be filled in, which requires information on more than 100 parameters. Similar documentation is required by the Austrian Compost Ordinance.

4.3.2 Independent sample taking

To give credibility to QASs, some sample-taking at least must be done by an external and independent monitoring body. If plants do the sample taking by themselves, too many opportunities for falsification arise. Professional compost users would never accept such a situation. This was made clear in Germany, where despite the fact that the German Environment Label 'Blue Angel' is well known in Germany, compost with this label was not accepted by the landscaping industry because there was no obligation for independent sample taking in the guidelines for the Blue Angel.

However, in order to keep the costs for quality assurance low the possibilities for having some sample-taking carried out by the compost plants themselves should be considered. Especially in European countries with a low population density, e.g. Scandinavia, internal sample taking must be considered (due to the distances involved in travel to plants). Thus Sweden has a regulation in its certification system that a large amount of sample taking must be carried out by the plant, albeit only after intensive training of the co-workers responsible for the compost plant. The Swedish certification committee visits the plants once or twice a year, monitors the sample taking, takes samples themselves and has them examined by selected laboratories. If the results do not correspond with the results of the internal sample taking the quality label is not (re)awarded. Experiences with these mixed systems are not, however, very positive. For this reason the Netherlands returned to external sample taking.

Another possible cost saving approach is that co-workers of the quality assurance organisation take samples on their regular visits to the compost plants (Belgium/Flanders). Alternatively, as in Germany, a system of regional consultants could be organised to take over this work.

In the Austrian Compost Ordinance a special system has been created for agricultural (on-site) composting plants who are using the compost predominantly on their own land. Farmers may take the samples following a statutory scheme if they are members of a quality assurance system, provided they have taken a course in taking random sampling, and provided they are monitored at least once a year through the QAS.

4.3.3 Type and frequency of analyses

Independent analysis by approved labs is state of the art in most of the countries considered in this report. Increasingly, inter-laboratory testing takes place across borders, e.g. in the next German 'ring test' (i.e. cross-laboratory comparison), laboratories from Switzerland, Austria, Luxembourg, the Netherlands, Sweden and Denmark may be included. On the basis of the newly issued Compost Ordinance in Austria, a separate inter-laboratory test is currently performed by the KGVÖ.

Depending on the country's specific conditions and the type of quality assurance the frequency of the tests differ considerably. For example, a plant with a 20,000 tonne capacity in the UK has to arrange for two compost samples to be tested per year, whilst an equivalent capacity plant in Germany must ensure that sixteen compost samples are tested per year. Similar differences and ranges of test frequencies can be detected for sanitisation tests.

The differences can be partly explained through reference to objectives to reduce the costs for analyses and quality monitoring (Sweden, the UK). There are drawbacks to this approach, however. For liability reasons, both the plant and the customer need security which cannot be guaranteed if the frequency of tests is too low. Germany, therefore, requires a minimum of four samples to be tested per annum (very small plants excepted) because of different raw material properties in the four seasons of the year. Flanders requires eight or twelve tests, depending on a treatment capacity lower or higher than 20,000 tonnes per year.

4.3.4 Internal monitoring

Regular tests as laid down in the voluntary QAS cannot be more than spot checks (e.g. in the UK with two compost sample analyses per year for a plant with 20,000 tonnes capacity). They reveal little or nothing about the quality of the compost quantities sold on a day-to-day basis and for which the composting plant has to guarantee the properties. Further internal analyses must be carried out on a voluntary basis by the plants. The determination of characteristics important for the application of compost and digestion residues which can be ascertained using simple techniques, such as water content, weight by volume, salt content, pH value, plant compatibility and extraneous matter in the end product, is recommended. Those investigations are the minimum basis for any defence as far as product liability is concerned. These additional internal analyses are mentioned in the QASs of Germany, the Netherlands, Denmark, and Austria, as well as the voluntary system in New Zealand.

4.3.5 Product declaration

The product declaration has to include all necessary information about the compost properties. It is not unusual for fertiliser laws to require certain parameters to be specified on labels.

In the domain of product declaration, application recommendations are more and more important. It is useless to produce high quality compost if this is not applied successfully because of the lack of information given to the end user. Increasingly, detailed application information is becoming the state of the art. Requirements for the labelling and the obligation for application recommendations are incorporated in detail in the Austrian Compost Ordinance.

Conclusion: It would appear increasingly common to require declaration of the following as a minimum requirement to inform potential end users, (note, this is definitely not to say that these should be covered by standards, more that they are the minimum information requirement for end users to make informed decisions):

- content of N, P, K;
- C:N (carbon: nitrogen) ratio;
- electrical conductivity;
- maximum particle size/screening;
- dry matter content;
- bulk density; and
- pH.

4.3.6 QASs as the basis for product specification

Special attention has to be given to the adjustment of product-related requirements and product descriptions in conjunction with the associations and organisations concerned. Recommendations for application have to be established through co-operation with acknowledged experts in the various ranges of application, who should define a product specification from the point of view of their specialist area. Each specific application area is likely to exhibit 'internal' standards too (e.g. compost mixtures for roof greening mixtures, for tobacco or asparagus) which have to be fulfilled.

Countries such as Germany, Austria and Flanders, which are already very experienced in composting, are at present at this stage of defining standards for specialist products. In Austria, some of the product specification aspects of the system have entered the statutory domain reflecting, arguably, the maturity of the Austrian scheme, and the level of confidence with which such specifications have been made (on the basis of years of experience). This is likely to be an important step for the UK to take in the establishment of successful compost products on the market.

Table 27 shows the requirements for potting soil compost in Germany and illustrates in which direction the development of these specifications is heading. These are only the requirements, and in general the product specification will be much more extensive.

It is quite obvious that specific applications need different specifications. The primary use of compost in the US is for landscaping, where in turn, the principle objectives are soil repair, soil-building and roadside use in conjunction with hydroseeding. This latter application generally requires compost be layered or air-blown onto soil at a depth of up to 2–3cm. Hydroseeding of the crops then takes place directly onto the mix. These are uses requiring high rates of application and intense levels of interface between seed and compost. Therefore, amongst other things, the compost product must be low in salt and very, very mature. For this kind of use, the important quality standards are shown in Table 26.

Table 26: Important quality standards for landscaping and soil repair

Type of use	Effective application rate	Principal determinants of success
Landscaping	100–250 m^2/ha	Salt, maturity, C:N
Horticulture	20–40% of mixes	Salt, maturity, density, C:N

Examples of compost standards that incorporate these aspects are found in all the major composting states, including Texas, California, and Washington, and are statutory within the narrow context of state purchasing contracts. Transportation agencies that handle roadside landscaping are the controllers of these standards.

Table 27: Requirements for potting soil compost in Germany

Quality characteristics	Quality requirements for potting soil compost in Germany			
Hygiene	• Proof that can be tested on epidemic-hygienic effectiveness of the decomposition process (process test) • Exclusion of germinable seeds and sprouting plant parts (free = <0.5 plants/litre compost) • Exclusion of Plasmodiophora brassicae (in vegetable growing) • Exclusion of Salmonellae			
Impurities	• Maximum 0.5 weight-% in dm selectable, species-inappropriate material >2 mm diameter • Free of impurities >5 mm (free = <0,1% in dm, plastics <0,05% in dm)			
Stones	• Maximum 5 weight-% in selectable stones of 2-10 mm • Free of stones >10 mm (free = <0,5 weight-% dm)			
Plant compatibility	• Plant compatibility in the provided area of application • Free of phytotoxic materials (volatile phytotoxic materials specifically tested, cress test in a closed vessel) • Not nitrogen immobilising			
Decomposition degree	• Rottegrad V			
Water content	• Bulky material maximum 45 weight-%, bagged material max.35 weight-% • Higher contents of water are admissible for composts with more than 40% om accord. to annex 3 of the RAL Quality and Test Regulations • 'Humid' corresponding to classification (appr. 50–60% of the maximum water concentration)			
Grain size	• In all grain sizes >50 vol.-% particle 0–5 mm • Maximum grain size 0/25 mm			
Organic matter	• At least 15 weight-% in dm, measured as volatile solids			
Content of heavy metals	Guide values [1] (mg/kg dm)			
	Lead	150	Cadmium	1.5
	Chromium	100	Copper	100
	Nickel	50	Mercury	1.0
	Zinc	Guide value will be acquired		

		Type 1	Type 2
Plant nutrients and salt content		Type 1	Type 2
	Salt content	max. 2.5 g/l	max. 5 g/l
	Min. Nitrogen (sum N03/NH4-N)	< 300 mg/l	< 600 mg/l
	Soluble phosphate P205	<1,200 mg/l	<2,400 mg/l
	Soluble potassium K20	<2,000 mg/l	<4,000 mg/l
	Soluble chloride	< 500 mg/l	<1,000 mg/l
	Soluble sodium	< 250 mg/l	< 500 mg/l
Carbonate (CaC03)	<10% in dm		
Parameter for declaration	• Substrate compost • Producer • Grain size and bulk density (volume weight) • pH-value, salt content, C/N ratio • Plant nutrients total (N, P205, K20, Mg0, Ca0) • Plant nutrient soluble (N, P205, K20) • Organic matter • Net weight or volume • Information for a suitable application		
Type 1: up to 40 VOL.-% recommended mixing component in the substrate Type 2: up to 20 VOL.-% recommended mixing component in the substrate dm = dry matter, fm= fresh matter, om = organic matter			

[1] Guide values: The above mentioned limited values for heavy metal are adhered to if the mean value of the last four analyses lies under the limit value and no analysis surpasses the limit value by >25%. This guide excludes the cadmium test.

4.3.7 Certificates, symbols and labelling

The main function of QASs is to create standardised high quality compost or digestion products which satisfy market requirements. Various measures are undertaken by the QAS organisations to reach this goal. In order to avoid the continuous explanation of all aspects of the QAS, a symbol or a certificate is awarded. It simplifies the message and can be used for advertising and public relations campaigns. In addition, it should allow the consumer to make a swift comparison between similar products.

This, of course, assumes that users are aware of the symbol and know what it stands for. So additional communication is necessary (see Section 4). There may be advantages if the symbol is part of an existing Eco-label, standardisation or certification system in the country (RAL in Germany, BNC in Canada, KIWA in the Netherlands). Only the compost-specific 'brand' of the label has to be popularised which leads to lower costs compared to the introduction of a completely new quality label. Partly for this reason, several producers in the UK are more likely at present to use Soil Association accreditation rather than the less well-recognised Composting Association symbol.

IMPORTANT INFORMATION

Ordinary garden soil and products like compost and potting mix may contain micro-organisms, some of which, on rare occasions can cause illness in humans.

Serious infection is rare. However, for older people or those with reduced immunity, infection can be life threatening*. We recommend the following precautions.

- AVOID OPENING BAGS IN ENCLOSED AREAS
- AVOID INHALING THE MIX
- ALWAYS WEAR GLOVES AND WASH HANDS AFTER USE

* See your doctor if you develop high fever, chill, breathlessness, or cough.

It is possible that the labelling requirements in Australia and New Zealand might not have the desired effect on consumers, however. The warning remarks (see above) are not likely to contribute to a positive image for compost, and its success in the market place. The one positive aspect of such labelling is that producers will be protected from liability in any claims of direct damage to human health. Producers in Australia and New Zealand have been critical of these somewhat alarmist labelling requirements. No other nations appear to require such stark warnings of hazards to human health as in Australia and New Zealand.

4.3.8 Consequences of quality assurance not being fulfilled

An elementary part of a quality assurance system has to be sanctions for composting or digestion plants which no longer fulfil all criteria or requirements. The reasons for non-fulfilment of criteria are many and may range from surpassing the limit values of heavy metals to submitting samples for analysis too late. In 1999 some form of failure regarding the requirements of the QAS was registered for more than 10% of the compost plants in Germany.

In all countries, therefore, (Germany, Austria, the Netherlands, Sweden, UK) a step-by-step mechanism for applying sanctions exists. As an example the German system is:

Step 1: Non-fulfilment is registered: After this is registered, written notification will be sent to the treatment plant, giving a 3-month time limit for improvement.

Step 2: Demands are not yet fulfilled: The quality label is suspended for a limited time, in which the treatment plant may not use the quality label/certification. The monitoring system continues and the treatment plant has to fulfil all requirements over 6 months. After this period the quality label can be re-granted.

Step 3: If there are still any problems: The Quality Label will be cancelled. If the plant wants to participate again in the quality assurance, they have to apply once more for the Quality Label and must run through the one year approval procedure all over again.

While Step 1 can be an automatic procedure, the second step will be discussed and decided within the committee of independent experts of the BGK. The quality assurance/certification has to have a kind of an official status, as withdrawal affects the economic prospects of the compost plant.

4.4 Quality assurance costs and links between QASs and statutory standards

In those cases where statutory regulations for the standard are in place, the costs for sample taking and analysis are no longer a topic of discussion insofar as the requirements of statutory regulation need to be met. Expenditure to illustrate adherence to the standards is effectively a legal obligation because it is compulsory to meet statutory requirements. These costs then automatically become a part of standard operational costs for all facilities.

If voluntary standards are established, the costs can become decisive for the acceptance of the system. The most interesting situations, of course, are those voluntary regulations which include the statutory standard and which reduce monitoring efforts (and thus save producers money to a certain extent). This is the case in Germany where the Biowaste Ordinance accepts the German QAS as equivalent to regular monitoring, and grants a reduction in the required frequency for analysis of about 50%.

In principle the costs for quality assurance are production costs. In the recycling industry where products frequently have to overcome issues of public perception, the assurance costs are continuously debated. One reason may be that those costs are usually contextualised by the sales prices for recycling products. Costs of the order €0.5-1 per tonne of compost for quality assurance compared to a sales price of €2–5 per tonne of compost appears to suggest a major cost item.

A more representative calculation in central Europe might be looking at €80–150 per tonne of compost for gate fees (€40–60 per tonne of input material) compared with €0.5-1 per tonne for quality assurance. This suggests that the costs for quality assurance are manageable in these situations.

However, the potential to levy such gate fees in the UK (where landfill disposal costs including landfill tax currently vary between £17–£35, or €27–56 per tonne of raw material) do make matters more difficult, especially in regions where gate fees are at the lower end of this range. In the context of a purely voluntary standard, the question producers will be inclined to ask is whether the costs are justified by any benefit.

In this work, we have drawn the distinction between the ‘precautionary’ (protecting health and environment, i.e. heavy metals, pathogens, impurities, etc.) standards, these usually being statutory, and the quality assurance schemes which are typically voluntary, but which support, and 'go beyond' the statutory standards. The Composting Association standard is a little like a hybrid of these standards. It covers both the 'precautionary side', which is non-statutory, and the quality assurance aspects, which are also voluntary, but part of the same 'system'.

In the Composting Association case (and this applies to other voluntary standards), the issue of whether the benefit of being in the scheme is worth any additional costs associated with being in it is likely to hinge upon the ability of the certificate or symbol awarded to confer marketing advantage. The more it does so, and the more this adds value to the product, the more producers will join the system. The other factor is that some local authorities are now looking to ensure Composting Association standards are met in the context of contracts for composting facilities.

Partly for these reasons, other countries' experience with QASs may be misleading, because the degree to which people join the scheme depends upon the strength of the linkage between statutory requirements and the implications of being in the quality assurance scheme. One might distinguish between three types of relationship, ranked in decreasing likelihood of producers entering the 'voluntary' QAS:

1 Statutory standard in place, linkage to QAS is strong (so QAS is 'quasi-statutory' – e.g. Austria, Flanders, Germany).

2 Statutory standard in place, linkage to QAS is weaker (QAS implies going well beyond what is required by law) (e.g. Netherlands).

3 No statutory standard in place, QAS entirely voluntary (e.g. BNQ in Canada, UK Composting Association, New Zealand standard).

In each case, the better-recognised any quality symbol becomes, the greater the likelihood of attracting producers into the scheme increases.

To sum up, in the current situation in the UK, at present, there must be a marketing advantage associated with attainment of the standard if existing producers with established market outlets are to pick up the Composting Association standard, otherwise, they may feel they will simply incur additional costs with no improvement in their revenues. New producers (without established markets) might see more logic in joining, especially where local authorities require this as a condition of their contracts.

One other possibility is that compost producers might seek to join as part of their own wider environmental management/quality management approach.

If the situation regarding the Composting Association standard was to change such that, for example, the heavy metal limits, sanitisation requirements, and limits on physical impurities were made statutory, then of course the existing standard would begin to look more like a QAS in support of a statutory standard (so that the situation becomes a 'case 1/2' rather than a 'case 3' in the characterisation outlined above). Whether this became 'case 1' or 'case 2' would depend upon the degree to which (a) compliance with the law could be demonstrated at lower cost than through taking up the Composting Association standard and (b) the Composting Association standard conferred insignificant benefits.

This analysis partly echoes experience in Canada and New Zealand, where uptake of voluntary standards has been low (though the New Zealand standard has only recently been established). Only two of the 350+ facilities that exist in Canada have BNQ certification. These two are based in Quebec. If producers do not see that there is a good payback associated with the use of the quality seal, they will not 'play or pay'. This is a real issue in Canada. The cost of the BNQ certification is high and the brand recognition of the BNQ seal is practically zero. There has been little attempt to market recognition of the seal and this has been limited to Quebec only (this being related to funding issues).

This discussion emphasises, therefore:

(a) the significance of links between the voluntary QAS and the statutory system; and

(b) the need to promote recognition of the quality symbol and what it stands for whilst ensuring that (through proper specification of products for end users) the quality symbol is backed up by the presence of reliable, high-quality products well-targeted to specific end-uses.

The latter, of course, requires adequate resources for such an exercise. This leads neatly into consideration of marketing issues.

4.5 QASs and compost marketing

There is a strong connection between quality assurance and marketing. Marketing of compost requires a standardised quality product. Composts and digestion residuals which have been quality-tested in accordance with the procedures stipulated by the QAS fully meet these requirements and can be marketed under a 'quality label' brand. The analyses carried out enable an objective assessment of the compost which forms the basis for the product declaration and the application recommendations. The net result is a product of defined quality which is therefore marketable and saleable on a large scale.

Further marketing activities of the compost plants are a necessity, for even compost with a quality label or a certificate does not sell by itself. The quality label should be able to give the compost and digestate enterprises an excellent start. The elements of the quality assurance system and the associated confidence that this can convey to users are effectively part of the overall marketing strategy of every compost producer, from market research through the introduction of measures to penetrate markets, right up to public relations, advertising and even the labelling of packaging.

It should be stressed that there is no magic formula for 'compost quality label marketing' by the individual enterprise. The quality assurance organisation, however, should assist its member plants through various means at its disposal (see Table 28).

Table 28: Marketing activities in the framework of some quality assurance organisations

Country	Marketing activity
Austria (KGVÖ)	• Common strategy is in preparation • Compost application leaflets for the main application ranges are published • Monthly newsletter
Belgium/ Flanders (VLACO)	• Country wide common marketing on behalf of the plants is done by VLACO with advertisements in newspapers, posters, stickers etc. • Continuous information about application researches (collected in two handbooks) • Quarterly news brochure
Denmark (DAKOFA)	• Product sheet which gives sufficient information about the compost
Germany (BGK)	• Marketing aids like stickers, posters, banners are provided • Series of compost application brochures are developed at the moment in very close co-operation with experts and organisations in the different application ranges which include product specifications • Quarterly news brochure
Sweden (RVF)	Series of compost and digestate application brochures are in preparation

5 Standards and quality assurance schemes for anaerobic digestion

Germany and Sweden integrate the end products of a digestion process of biowaste into their quality assurance efforts.

In Sweden the combined QAS for composts and digestion residuals is totally voluntary. In Germany the system is part of the statutory Biowaste Ordinance. This Ordinance includes standards for source-separated biowastes and it does not matter if these wastes are treated by a composting or an anaerobic digestion process. In addition a voluntary QAS system was developed by the German Compost Quality Assurance Organisation BGK in 2001 with similar principles to the one which already exists for compost.

Only those quality requirements and monitoring which differ from those for compost and composting are shown below. Note that in Austria, guidelines exist for the anaerobic digestion process.

5.1 Introduction

The German RAL Quality Assurance for products from biowastes has been extended to cover secondary raw material fertilisers. Besides compost (RAL-GZ 251), digestion products (RAL-GZ 256/1) can also now be quality assured. The Federal Compost Quality Assurance Organisation (BGK) is the organisation acknowledged by the RAL-German Institute for Quality Assurance and Labelling for the performance of the quality assurance of digestion products.

The purpose of the RAL Quality Assurance is to guarantee stipulated standards and the reliable labelling of the properties of digestion products towards the customer.

For the moment Sweden has no statutory standard for the treatment and quality of biowastes. In 1996 the Swedish National Association of Waste Management (RVF) and the Swedish EPA initiated a project in order to develop voluntary quality assurance systems for compost and digestion residuals from organic wastes. The project is ongoing and at the moment the certification system is being tested prior to implementation.

5.2 Raw material

The German statutory regulations regarding raw material used for the production of digestion products state that it must be fit for purpose and generally recognised as safe. In Annex 1 of the Biowaste Ordinance a list of acceptable raw materials is given.

The Swedish regulations for the voluntary certification of compost and digestion residues are based on purely source-separated organic waste with special concern for the acceptance of raw material, the suppliers, the collection and transportation, the intake, treatment processes, and the end product together with the declaration of the products and recommendations for use. As distinct from Germany, Sweden allows animal residues as a raw material for digestion and composting.

5.3 Process requirements

In Germany, there are no special requirements for hygiene above and beyond those which apply to compost. The way in which they are to be met is, however, specific to the digestion process (see Section 5.6). Treatment in Sweden must be carried out with a high level of expertise and with a fully functioning biological treatment technology. The following operational digestion parameters have to be observed and documented continuously:

- type and amount of raw materials and additional materials;
- temperature and pH value in the reactor;
- period between filling;
- hydraulic retention time;
- combined time and temperature in the hygienisation tank;
- organic load;
- volume load;
- measures against re-contamination;
- possible interruption of operations.

5.4 The German Quality Assurance procedures

Each German plant which applies for a quality label for 'digestion products' at the BGK must undergo a test procedure that is stipulated in the Quality and Test Regulations. The procedure is divided into two parts, an 'acknowledging procedure' and a 'monitoring procedure'. In order to be awarded the quality label, producers must fulfil all the necessary requirements during the acknowledgement phase.

Table 29: Number of necessary tests in the frame of the acknowledgement and monitoring procedure of the BGK for 'digestion products'

Acknowledgement procedure (1 year)	Monitoring procedure
One examination at the commencement of each 1,500 tonnes input [1] per annum	One examination at the commencement of each 2,000 tonnes input [1] per annum
Minimum of 4 examinations, maximum of 12 examinations per annum	Minimum of 4 examinations, maximum of 12 examinations per annum

[1] Total input, e.g. biowastes and other materials (e.g. liquid manure).

After successful testing and the awarding of the quality label for 'digestion products' (i.e. acknowledgement procedure), the monitoring procedure begins. External monitoring assures a continuously high quality of the digestion products.

5.4.1 Self-monitoring

Besides external monitoring, the user of the quality label is obliged to ensure the treatment process is effective as regards hygiene through regular self-monitoring that can be documented and checked. Furthermore, in carrying out this self-monitoring, the producer is to assure that the digestion products always correspond to the requirements of the quality and test regulations. The results of self-monitoring are documented and presented to the external monitor.

5.4.2 Award of the quality label

A precondition for the award of the RAL quality label for 'digestion products' (RAL GZ 256/1) is membership of the BGK or another combined regional Quality Assurance Organisation. The quality label shown below will be awarded to the relevant plant after completion of the acknowledgement procedure (following examination through the Federal Quality Assurance Organisation).

Figure 6 – Quality label 'Digestion Product'

5.5 The Swedish Quality Assurance procedure

The Swedish systems for the certification of compost and digestion residues begin with an application phase, in which inspections are carried out by the certification institute and the organisation charged with overseeing the certification procedure. In the second phase, the introduction phase, the introduction of the certification system is carried out over a period of 1 year, the so-called qualification year. Before the label can be awarded, a preliminary judgement concerning the product must be made, and continuous monitoring during the year of qualification must be carried out.

Any treatment plant which applies for certification must report on technical data, which must include the following information: a declaration of the properties and contents of the compost/digestate; recommendations for use; an analysis report in which the plant demonstrates that technical requirements are fulfilled; and a process description, in which the plant operator describes the specific process, e.g. which materials are accepted and how the treatment works.

Those plants with products which pass through the qualification year successfully have the right to use the label 'Certified Recycling'. This does not distinguish between compost or digestion residues.

Following this, the continuous operation phase starts. In this phase, ongoing monitoring ensures that certified products continuously fulfil the requirements of the certification regulations. This monitoring is carried out through an internal control procedure, which is carried out by the plant operator, and a continuous independent external monitoring procedure. The continuous control should be carried out as agreed by the operator and the certification institution. Required frequencies for analysis are given in Table 30.

Swedish label 'Certified Recycling'

Table 30: Analysing frequency

	Internal control (analysis/year)		External control (analysis/year)
Total amount for biological treatment (t/year)	**Qualification year**	**Minimum frequency at continuous control**	**Minimum frequency**
<5,000	2	1	1
>5,000	4	2	1
>10,000	8	4	2

5.6 German hygiene requirements

The Biowaste Ordinance prescribes the treatment for the sanitation of biowastes in paragraph 3, article 1. For digestion residues, sanitisation to an 'irreproachable level' can be assured by the following measures:

- **Heating of the input material according to the Biowaste Ordinance (BioAbfV).**
  Thermal pre-treatment of the input material to at least 70 °C for a minimum period of 1 hour.

- **Direct and indirect process examination according to the Biowaste Ordinance (BioAbfV).**
  Direct process testing (through input of 4 test organisms) for digestion plants has to be undertaken on three successive days. When the indirect process examination is performed, it must be demonstrated that the input materials in digestion plants have been exposed to a minimum temperature of 55 °C at least for a period of 24 hours at a hydraulic dwelling time of at least 20 days. Lower operation temperatures or a shorter time of influence must be followed by either a heating of the input materials (see above) or an aerobic post-maturation of the separated digestion residues.

- **Input–output control (leaflet of the Association of Waste Water 365).**
  If, in exceptional cases, an input of test germs for an examination of processing is not possible due to the technical design of the system, the efficiency of the process can be proven by a definition of the microbiological parameters in the output material and in the end product.

- **Heating of the output material according to the Biowaste Ordinance (BioAbfV).**
  Thermal post-treatment of the output material at a minimum of 70 °C for at least one hour.

5.7 Scope of German special examinations

The external examination of the digestion products covers many parameters. Besides the standard quality criteria for compost, such as dry matter content, organic substance, bulk density, grain size, pH value, heavy metal content, plant compatibility and germinable seeds and sprouting plant parts, the following special digestion parameters are analysed (see Table 31):

- alkaline substances (quoted in CaO (lime) equivalent);
- homogeneity and levels of foreign matter;
- degree of digestion (through the total content of organic acids – in the 'trial phase');
- odour (through a three-step classification schedule with 2 litres of a test substrate);
- Salmonellae (to be absent in the end product);

- precaution-use-index in which the digestion product is evaluated according to its efficiency (precaution-use-ratio). The valuable ingredients (nutrients, organic substances and alkaline effective components) play an important role here.

Table 31: Special digestion quality requirements for solid (= SDP) and liquid (= LDP) digestion products

Quality criteria	Quality requirements	
Organic matter	At least 40, will be declared	% dm
Dry matter	SDP: At least 20, compact and spreadable LDP At least 12, pumpable	% fm
SDP: Grain size LDP: Homogeneity	SDP: Will be declared LDP: visually homogenous, free from impurities	
Degree of digestion	Organic acids <4000	mg/l fm
Odour	Free from annoying odours	graduation
Plant compatibility	Suitable for the use in growing plant cultivation without posing risk to above ground plant parts	
Hygiene	(a) Heating of the input material on ≥70 °C for at least one hour, or	
	(b) Proof of test on hygienic effectiveness of the process or the treatment, according to article 3 and article 4 no. 1 and 2 BioAbfV, or	
	(c) Influence of a minimum temperature of 55 °C over a period of 24 hours and a hydraulic dwell time in the vessel of at least 20 days (compare addition 2 no. 2.2 article 1 sentence 1 BioAbfV), or	
	(d) Input-output control or	
	(e) Heating of the output material by heating on to ≥ 70 °C for at least 1 h or	
	(f) Other procedures of hygienisation	
Germinable seeds and sprouting plant parts	no (<0.5)	per litre fm
Salmonellae	Salmonellae are not detected	not detectable in 50 g fm
Precaution-Use-Ratio Efficiency value index	1 : >4 >4	

5.8 Swedish hygiene and sanitisation requirements

The Swedish system to guarantee hygiene is very complicated. It includes assessment of the origin and risk associated with the raw material, the plant type (which covers four different systems) and classification of the digestate for agricultural use (Level 1 for food protection areas and Level 2 for non-food production areas). The quality and monitoring requirements are related to the different combinations of these factors. Doubts are expressed about the ability of this system to work well in practice (since many producers find it difficult to comprehend).

Waste of animal origin (food industry, animal manure, etc.), which is accepted by the Swedish Certification System in the list of inputs, is the main potential source of infections. In order to minimise risks, a lengthy catalogue of requirements and criteria for hygienisation relating to raw material, treatment processes and the use of the end product is included in the certification system.

To define different risk classes, plants are classified depending on the raw material used as:

- **Plant Category A:** treats organic waste including low risk waste from animals and applies product on possible food production areas (= Level 1).
- **Plant Category B:** treats organic waste without low risk waste from animals and applies product on possible food production areas (= Level 1).
- **Plant Category C:** treats organic waste without low risk waste from animals and applies product on non-food production areas (= Level 2).

For the different plant categories the following process requirements for sanitisation exist:

Digestion and composting in plant category A: Low risk waste from animals must be subject to: 'an enclosed heat treatment of at least 70 °C during at least one hour. Temperature and time is valid for total waste. After treatment the waste has to undergo a process such as digestion or composting which guarantees that the processed waste cannot be used as food for animals.' (SJVFS 1998, p.34)

Digestion in plant category B and C: The process must be carried out under the following conditions:

- the incoming waste material must be documented;
- temperature/time must be at least 55 °C over at least 10 hours;
- hydraulic dwelling-time must be at least 7 days; and
- a total re-stacking must be guaranteed in the reactor, together with sufficient temperature distribution; if this is not realised higher temperatures and more time is required.

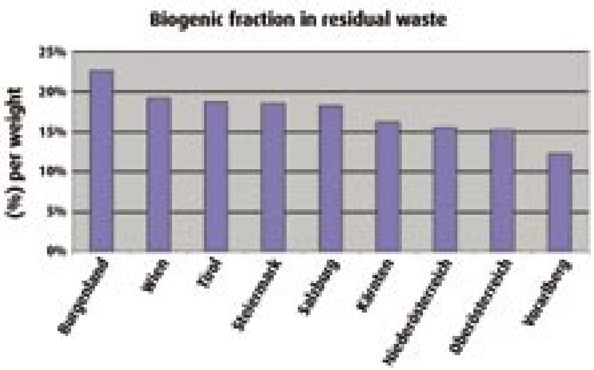
Hygiene is monitored using two different indicating organisms, faecal Streptococcus (FS) and Enterobacteriae.

6 Mechanical-biological treatment

The role of mechanical-biological treatment in European municipal waste management is increasing and represents something of an evolution from earlier periods where not-so-dissimilar techniques were considered as 'composting'.

The emerging trend is for source-separation systems to aim to minimise, as far as possible, the biodegradable fraction, or better still, the fermentability of residual waste. Source-separation of kitchen and garden waste fractions of municipal waste (for composting or digestion) is the primary step for achieving this reduction. Even in the best performing collection systems, however (which appear to be Italian systems with an intensive focus on food waste, and those Austrian systems which both collect biowaste and have high participation rates in home composting programmes), the biodegradable fraction of residual waste is not zero. Furthermore, where source-separation of dry recyclables occurs simultaneously, the remaining biowaste in residual waste can still constitute a significant fraction of residual waste (see Figure 7).

Figure 7: Biowaste fraction as percentage of residual waste in Austria



Suppose that a relatively high performing municipality, with a starting composition of putrescible material of the order 35–40%, and a dry recyclables fraction of the same order, achieves a rate of source-separation of 60%. If this is achieved by means of – among others – a capture of 30–35% compostable waste, this would imply that of the 40% of the original material which is residual waste, 5–10% of the original material remains and is compostable. In other words, the concentration of compostable material in residual waste is likely to be between 13% and 25% even in well-functioning systems. Only seldom have percentages around or below 10% been reported in Northern Italy, with Austria averaging 15–20%.

Countries which were already carrying out high levels of source-separation of biodegradable municipal waste (principally paper and compostable fractions) before 1995 face quite different challenges where the Landfill Directive is concerned. Since the targets for reducing the amount of BMW sent to landfill are based upon quantities being landfilled in 1995, it could be argued that whilst the absolute levels of diversion required are smaller, it was more difficult to meet these targets through source-separation (because this was already being done).

Only intensive schemes tackling food waste (such as the ones run in some regions in Italy and recently under development in Catalunya) can, on their own, reach the targets of the Landfill Directive. Nevertheless, in the wake of source-separation, the fermentability of residual waste to be disposed of might still be a problem.

Consequently, both countries with long-running source-separation systems for biowaste, and those with more recently implemented intensive schemes, have set in place legislation concerning the landfill of waste in order to try to achieve the requirements of the Landfill Directive.

In Austria, the Landfill Ordinance set in place the restriction that 'No material may be landfilled if it has a higher organic carbon content than 5% /m/m)'. In itself, this would imply that municipal waste had to be incinerated prior to landfilling. Hence, an exemption was explicitly designed for waste 'originating from mechanical-biological pre-treatment, that is disposed in separated areas within a mass waste landfill site, if the upper calorific value gained by combustion of the dry matter is below 6000 kJ/kg. The mixing of waste originating from mechanical-biological pre-treatment with materials or waste of low calorific value in order not to exceed the limit value, is not admissible.'

In order to determine criteria for an environmentally sound process design and the suitability of MBT material in accordance with the requirements of the Austrian Landfill Ordinance, a Guideline for the Mechanical Biological Treatment of Waste[18] was elaborated by a working group chaired by the Ministry for Agriculture and Forestry, Environment and Water Management. For obvious reasons, the focal points for this guideline are different to those for compost. In particular, attention is given to the characteristics which represent a desirable treatment from the point of view of the end-point – the landfill – in particular, the respirometric index (Supplement 1, Section 4). Equally, as made clear in a report for the Umweltbundesamt, the lower limit on calorific value has the potentially positive implication that the biodegradable fraction of waste is split from higher calorific fractions which can be used for thermal recovery[19].

In Germany, similar developments have occurred. The TASI (Technical Data Sheet for Urban Waste) limits the volatile organic solids content of waste for landfilling to 5% (assessed by loss on ignition) as of 2005. So residual waste has to be treated and the organic fraction has to be collected (the TASI also lays down that biowaste should be collected separately). From a technical standpoint, this 5% limit would only have been achievable by incineration. However, since 2001, mechanical-biological treatment has been officially accepted as an adequate treatment procedure (in comparison to incineration) to reach the target of a stable landfilling material via a so-called 'law of equivalence'. In 2001 over 20 pre-treatment plants were processing more than 1 million tonnes of residual waste and several more are presently under construction.

Italy looks set to follow a similar approach with respect to requiring waste that is to be landfilled to be pre-treated (see Supplement 9, Section 1.2). In the last draft (April 2000) of a decree concerning bio-stabilised materials, two types of 'Biostabilizzato', also known as 'Stabilised Organic Fraction' (SOF), were defined (the Veneto region already has such an approach in place):

1st Quality SOF, to be used as an amendment in land reclamation projects (therefore, an agronomic use);

2nd Quality SOF, to be landfilled or to be used as a daily cover material (according to the expected need to 'treat' waste before landfilling).

These materials are defined through the parameters shown in Table 32 and Table 33.

Table 32: Limit Values for 1st Quality SOF

Parameter	Limit value[20]
Cadmium	3 ppm dm
Chromium VI [21]	1 ppm dm
Mercury	3 ppm dm
Nickel	100 ppm dm
Lead	280 ppm dm
Copper	300 ppm dm
Zinc	1000 ppm dm
Plastics	0.5% w/w
Inert materials (including plastics)	1% w/w

Table 33: Limit values for 2nd Quality SOF:

Parameter	Limit value
Moisture	less than 65%
Respiration index (UNI method)	less than 400 mg 02/kg VS.hour

Furthermore, some microbial limit values are listed but these are still hotly debated, due to the lack of reliable reference test methods. Therefore, limit values are currently focusing on the fermentability issue.

First quality SOF can be used, under permitting procedures, in one-off applications in landscaping and land reclamation projects. The maximum load in the draft decree is 100 tonnes/hectare dry matter. Second quality SOF can be used, under permitting procedures, as a partial or total substitute for inert materials used as a daily cover, according to 'good practice' in the management of landfilling sites. Similar provisions are actually already enacted in some regions, such as Veneto.

The features which the regulations in Austria, Germany and Italy have in common are that:

1. They seek to implement the requirement for pre-treatment (under the Landfill Directive) in a manner designed to reduce the potential of biodegradable materials to continue to pose problems in landfills. The stabilisation process should lead (with or without prior digestion phases) to a stabilised material, whose potential for methanogenesis is vastly reduced, and whose contribution to the chemical strength of leachate is also significantly reduced.

2 In all these examples, the material is unequivocally designated as waste, although in Italy, some materials may be used for one-off uses under permitting procedures.

3 The role of MBT in the context of both developing and better established waste management systems is being recognised. This has been important where recycling strategies are still being implemented because MBT is more flexible than incineration and can be upgraded into composting at a later date (the process technology is similar). MBT can also be integrated with thermal treatment. Plants have already been integrated with gasification/pyrolysis facilities, as well as (often smaller) incinerators and/or industrial power generation following refuse derived fuel (RDF) manufacture. Whenever RDF production is being sought, MBT of the concurrent waste stream (putrescible

waste mechanically sorted out in order to increase the calorific value of the oversieve fraction, i.e. the fraction which fails to pass through a screen) is performed to avoid any 'concentration' of fermentability in the material to be disposed of. Strong evidence exists – above all in those countries where the system has long been in place – that this can be implemented at a net cost saving against incineration, though clearly this depends upon the underlying costs of incineration (relating to regulation of air emissions, payments for energy generated, and the costs of treatment/disposal of ash and air pollution control residues).

It seems possible that other countries implementing restrictions or bans, where they do not already have large incineration capacity in place, may follow this type of approach. Possible candidates would be Flanders, where four MBT plants are planned, the Netherlands, where two plants exist, France and Finland.

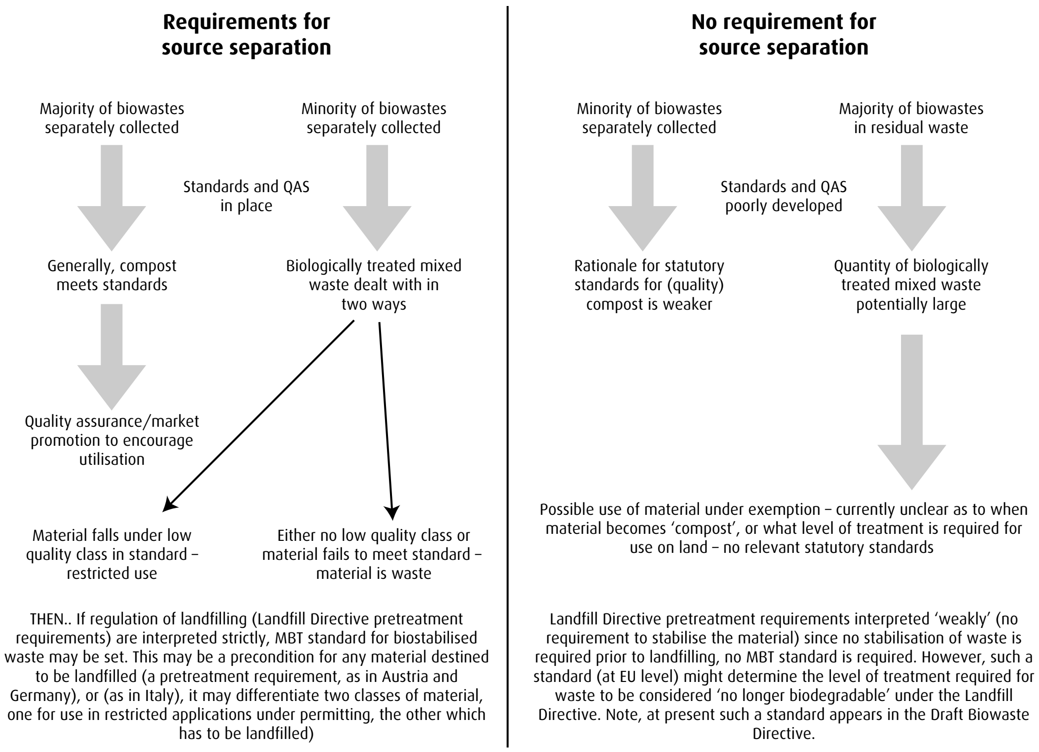
Conclusion

The rationale for establishing a standard for MBT has to be considered in the context of wider waste management policy objectives (and interpretations). In the UK, the interpretation of the Landfill Directive requirement for 'pre-treatment' (for waste destined to be landfilled) is relatively weak (i.e. most processes qualify as pre-treatment), so that (subject to the Landfill Directive Article 5 targets), biodegradable waste will continue to be landfilled without any requirement for stabilisation.

As such, the rationale for an MBT standard as a 'pre-treatment' requirement appears to be absent. On the other hand, if it were deemed desirable to specify a 'standard' for materials derived from mixed municipal waste, it would, make sense to establish this as a standard for stabilised biowastes as opposed to a composting standard. This would define the conditions under which treated wastes could, under certain conditions, be applied to (non-agricultural) land. This explicitly draws a distinction between lower quality products with 'waste-like characteristics' and those which are less likely to cause build-up of PTEs in the environment. This is also in line with proposals in the Second Draft Working Document on the Biological Treatment of Biowaste.

Figure 8 depicts the contrast in approach between countries which target source separation (left-hand side), and the current situation in the UK (right-hand side). It should be noted that were a Biowaste Directive to be passed in its current form, the UK would immediately be required to transform itself into a country of the type represented on the left-hand side of the figure.

Figure 8: Contrasting policy frameworks for biowastes



Not only would such a Directive mandate separate collection of biowastes, but in its current form, it states:

> 'If residual municipal waste undergoes a mechanical/ biological treatment prior to landfilling, the achievement of either a Respiration Activity after four days (AT4) below 10 mg O2/g dm or a Dynamic Respiration Index below 1,000 mg O2/kg VS/h shall deem that the treated residual municipal waste is not any more biodegradable waste in the meaning of Article 2 (m) of Directive 1999/31/EC.'

In other words, mechanical biological treatment – even where the resultant material is landfilled – becomes a legitimate route for local authorities to pursue in seeking to meet their Landfill Directive targets.

7 Key conclusions

The legal framework around standards differs widely in the composting countries of the world. In any one country, standards generally relate to the level of development of the recycling of organic residues from households, parks and gardens.

For reasons to do with environmental protection and precautionary approaches, biological treatment is increasingly being covered, to a greater or lesser degree, by statutory regulations setting standards for, for example, PTEs, hygiene requirements, and level of impurities acceptable. Where statutory standards exist, these criteria appear to be the minimum list of parameters which are covered by statutory regulations.

Some countries go much further in implementing requirements on a statutory footing. The examples of Germany and Austria, with some 50 published pages of regulations in their biowaste ordinances, and another 100 pages or so of supporting explanations, are not examples which should be copied by other countries as they embark on this process.

If, in the long run, composting is to be successful in the marketplace (and in large quantities), it has to be established like any other product, and it has to fulfil the requirements of the users. Thus, product specifications must be developed in conjunction with end users.

The choice as to whether or not to implement any statutory standard appears strongly linked to the desire to develop useful products from waste materials. In this context, it is important to understand the significance of the wider-policy context in driving matters in one or other direction with greater or lesser force. It is hardly a coincidence that those countries which are most successful in composting (measured as a percentage of the overall potential) are those which have encouraged the process through legislative means in addition to statutory standards for compost products. Indeed, Flanders, the Netherlands, Austria and Germany all have in place legislation or agreements which effectively require source-separation of organic wastes. In Flanders, as in the Netherlands, putting a ban on organic waste going to landfill and setting an obligation for source-separation, as well as financial support for recycling activities, were the main driving forces. Furthermore, a combination of relatively tight regulation of residual waste treatments, as well as taxes on landfill (and incineration in Flanders and Denmark) makes the separate collection of biowastes and their treatment in composting facilities a cost-effective approach to municipal waste management in those countries.

The significance of this 'background policy context' should not be underestimated. If residual waste treatment is cheap, and if the availability of funding for waste management is constrained, the development of 'composting' might not only be slowed, but may even be compromised by the prevalence of low quality materials in the market place. This is made more likely in the UK given the lack of any definition of 'compost', and the lack of any requirement to source-separate organic wastes. Clearly, in England, for example, the implications of statutory targets for 'recycling and composting' are quite different depending upon whether compost is defined (either explicitly, or implicitly through setting standards for 'compost') as the product of source-separated materials.

The following are some of the key observations based upon the comparative analysis undertaken:

1 **Statutory or non-statutory?** The UK is in a declining minority in its lack of statutory standards for compost. Ireland, Portugal and Sweden are others without such standards, though the French and Greek standards are not focused at the quality end of the compost market. Outside the EU, the tendency in the US and Australia has been to establish standards related to 'biosolids' (sludge) regulation. However, state legislation increasingly sets more appropriate standards. In Canada, statutory standards now exist, whilst in New Zealand, the voluntary standard is being developed with reference to Department of Health standards, again in relation to sewage sludge. Those EU Member States currently without compost specific standards are increasingly looking to implement such standards (and some, such as Ireland, are making the transition through the licensing process). Biowaste treatment in the UK would benefit from being placed on a statutory footing, at least with respect to precautionary aspects (see point 5 below). The exact shape of this arguably depends upon what the scope of any given legislation is intended to be and the degree to which other aspects of the biowaste collection and treatment regime are altered.

2 **Input materials.** With regard to input materials, the most common approach appears to be one of listing those materials which may be included, as well as those which may be used in mixing (though dilution should be treated separately to production, with reference to the specific classes of materials in any standard). Care has to be taken in drawing up lists of materials for inclusion/exclusion for statutory approval. Since formal legislation is necessary to enforce such restrictions, if mistakes are made, these can be difficult and time-consuming to rectify in retrospect because of the need to revise legislation.

3 **Number of compost classes.** The question as to whether to include more than one standard has to be considered in the context of:

(a) The scope of the standards: For example, the extent to which one includes, say, sludge in the scope of the standard, can be dealt with in one of two ways. Either one quality standard can be set such that (clean) sludge composts fall under the scope of the legislation. This approach has the merit of simplicity. Alternatively, more than one standard can be defined, probably such that these implicitly relate to individual feedstocks. The potential advantage of this approach is that application restrictions could be set on the basis of the different classifications. Either approach could be used through existing instruments in the UK. Typically, in other countries, a very high standard is set for products suitable for use in organic agriculture.

(b) The approach to regulation of mixed municipal wastes/materials with higher levels of contamination : Again, there are two possible approaches. On the one hand, a sharp distinction could be defined between waste and product, with all materials not achieving the (lowest) statutory standard being considered as waste. On the other hand, standards could be set which effectively regulate the processes and the fate of the materials much more rigorously than for source-separated materials from uncontaminated sources. As with quality materials, these standards would have to incorporate measures to ensure sanitisation and hygiene of the material. In our view, however, in the absence of specific legislation supporting source-separation of municipal wastes, the risk of adopting this second approach is that the emphasis might fail to shift towards quality composts, with the result that attempts at low-cost compliance with the Landfill Directive and with local-authority specific recycling targets may be pursued through the creation of large quantities of low-grade material. This is exactly the problematic situation that prompted other countries to implement source-separation and comprehensive systems of standards and QASs in the past.

The approach favoured by countries where composting is in an advanced state of development is a clear distinction between product and waste which places materials derived from mixed municipal waste and those with higher levels of contamination outside the definition of compost. This could be achieved either through establishing statutory standards for compost, or through amending the exemptions under the Waste Management Licensing Regulations, or (for Local Authorities in England) through enshrining the definition of composting under Best Value as composting based upon source-separated materials, or (as happens in Ireland) through the 'interim' measure of specifying standards in licenses for compost plants. Experience in Germany, for example, suggests that it is difficult, in the longer term, to positively market anything which is a waste (see Appendix 2). Lower quality materials could (in line with what has been proposed in the European Commission's Second Draft Working Document on the Biological Treatment of Biowaste Directive) be dealt with through a standard for mechanical biological treatment (see point 6). The number of compost classes should be kept small so as not to confuse, and it would seem necessary to establish a standard for organic farming.

4 **Statutory standards for processes.** Standards for processes are rather difficult to establish. The most frequently used standard is the 'temperature–time' regime, used to assure hygienisation. Austria sees this as unnecessary (based on extensive experience), preferring instead to test end-products for the presence of pathogens. It remains the case that there are relatively few process parameters which can be 'measured' to ensure end-product quality. As such, the control of processes seems more likely to occur through ensuring processes are carefully managed. Given that the key aim is to produce quality products, however, the emphasis for testing purposes is likely to be the product. Clearly, processes can be adjusted to make the production of quality products more likely, and it is these that seem likely to become the focus for quality control in the process phase. It is not clear that this can easily be stipulated in statutory legislation given the range of processes now available. One possibility may be to require 'process diaries' to be maintained (as in Austria) in which water regimes are monitored, and practices for screening, turning, aeration, addition of materials etc. are recommended in order to ensure end-product quality. However, such aspects are frequently dealt with through QASs rather than statutory standards or regulations.

5 **Scope of statutory product standards.** At a fundamental level, the line which should be drawn between the statutory and 'voluntary' aspects of standards needs to consider the basic fact that any statutory instrument is more difficult to change. As such, the statutory standard should be limited as far

as possible in the context of regulation which seeks to ensure protection of the environment and health (of humans and livestock).

With regard to PTEs, aspects of product standards are increasingly set on the basis of a desire to protect soil quality, and this should be a main focus of the precautionary standards. Levels should be set with tolerances in place (i.e. acceptable 'bands' of variation around the guide value), the tolerance band being determined by the strictness of the standard (the percentage tolerance should be greater the tighter is the standard, given the inability of producers to exercise complete control over feedstocks). The standards set should be achievable through applying good practice composting methods to suitable input materials. Attention should be paid to testing regimes; specifically, to their cost and the desired frequency of testing (given the potentially high frequency for errors in sample-taking and testing). Clearly, the range of PTEs which one might wish to see tested for should be influenced by the nature of the materials which fall under the scope of the standard. Limits for most organic contaminants should not be relevant for green waste, biowaste and bark compost.

The presence of pathogens should also be tested for. Such testing is done in almost all countries examined and provides some 'back-up' to the 'temperature-time' process standards.

As regards impurities, the details of the approaches taken vary across countries. It is clear, however, that at least one such standard is desirable in the UK. Furthermore, depending upon the number of classes in the standard, there may be more than one threshold set. Equally, further delineation could be left to the more market-oriented standards with specific end-uses seeking to either make use of, or go beyond, the statutory minimum requirements.

The same could be true of the presence of weeds. This is likely to be far more important in some applications than in others.

It is important to recognise that in some quarters, there are concerns that the 'environmental' characteristics of compost are attracting so much attention that the quality of the product in use is becoming less significant. Both stability and the related parameter of phytotoxicity are important for this reason (they are more closely related to the product's value 'in use'). In some contexts (e.g. for determining stability of mixed waste where biological treatment is used as a pre-treatment to landfill, or one-off landscaping applications), it seems desirable to make stability a statutory requirement for the material treated (because the end-use of the material is likely to be restricted, and therefore, the need to allow for different levels of stability is absent). This process of stabilisation should be linked to sanitisation requirements given the likely heightened significance of pathogen kill in the mixed waste context.

In other cases, it is probably not necessary to make stability part of a statutory requirement. There are two reasons for this:

1. In some agricultural applications, the use of fresh compost may be desirable. Generally, the stability required might be established through discussions with end users (in the context of quality assurance systems); and

2. Since no clearly accepted approach for measuring stability exists, to specify such a test in statutory standards risks ossifying the approach (it becomes awkward to change the standard).

The latter point appears to have particular significance in the UK at present, where a period of experimentation and learning in this regard might be highly desirable (at least for composts derived from specific source-separated materials). On the other hand, there may well be a temptation for producers to generate unstabilised compost. A 'middle way' might be to specify minimum retention times but this has the drawback that certain fresher materials may no longer be available.

The logic for requiring testing for phytotoxicity at the statutory level also deserves consideration in the context of the development of a system of standards. Arguably, the logic of requiring this at the statutory level can only be judged in the context of an understanding of the development of the structure of any standard (i.e. the way in which compost classes, if there is more than one, are to be differentiated). For similar reasons as discussed above (in respect of stability), however, it may be desirable to specify tests through quality assurance in the context of specific end-use markets (so whether these should be statutory of set on a voluntary basis can only be judged with a better understanding of what the standard seeks to achieve).

Lastly, statutory standards could also consider establishing minimum levels for organic matter content.

Dilution with soil may lead to 'blends' being offered as composts. For this reason, a statutory minimum organic matter level may be useful. Equally, a restriction on adding excavated soil could be considered. The organic matter content, however, is closely related to the issue of stability so that care should be taken in setting such a minimum level in statutory legislation, and it may indeed be better to leave this to one side in the development of statutory compost standards.

6 **Mechanical biological treatment.** The rationale for establishing a standard for MBT has to be considered in the context of wider waste management policy objectives (and interpretations). In the UK, the interpretation of the Landfill Directive requirement for 'pre-treatment' (for waste destined to be landfilled) is relatively weak (i.e. most things qualify as pre-treatment), so that (subject to the Landfill Directive Article 5 targets), biodegradable waste will continue to be landfilled without any requirement for stabilisation.

As such, the rationale for an MBT standard as a 'pre-treatment' requirement appears to be absent. On the other hand, if it were deemed desirable to specify a 'standard' for materials derived from mixed municipal waste, it would make sense to establish this as a standard for stabilised biowastes as opposed to a composting standard. This would define the conditions under which treated wastes could, under certain conditions, be applied to (non-agricultural) land. This explicitly draws a distinction between lower quality products with 'waste-like characteristics' and those which are less likely to cause build-up of PTEs in the environment. This is also in line with proposals in the Second Draft Working Document on the Biological Treatment of Biowaste.

It should be noted that were a Biowaste Directive to be passed in its current form, not only would such a Directive mandate separate collection of biowastes, but in its current form, it states:

'If residual municipal waste undergoes a mechanical/biological treatment prior to landfilling, the achievement of either a Respiration Activity after four days (AT4) below 10 mg O2/g dm or a Dynamic Respiration Index below 1,000 mg O2/kg VS/h shall deem that the treated residual municipal waste is not any more biodegradable waste in the meaning of Article 2 (m) of Directive 1999/31/EC.'

In other words, mechanical biological treatment – even where the resultant material is landfilled – becomes a legitimate route for local authorities to pursue in seeking to meet their Landfill Directive targets. The Directive seeks to ensure, however, that this is a treatment for waste which is genuinely 'a residual component' (i.e. that which remains after attempts to capture the biowaste fraction separately) rather than being a treatment applied in the absence of any serious attempt to capture materials separately. This would significantly affect the development of biological treatment (since much greater quantities of source-separated material would be available than would otherwise be the case).

7 **Quality assurance systems (QASs).** To convince potential users of the value of composted materials and their consistency, quality control is essential. Compost producers need a quality assurance system with continuous internal and external quality control to standardise the production of compost that meets the necessary standards. In this way, compost can be considered and be sold as a useful product, and no longer as a waste (see Appendix 2).

QASs seem to have played an important role in ensuring positive marketing of quality compost products in many countries. In a context where the absence of statutory legislation gives no reason for producers to engage in voluntary systems, there is less likelihood of them doing so if the quality symbol fails to confer significant value/marketing advantage to their product.

With the possible exception of Sweden, the most successful QASs operate against the backdrop of statutory standards, and more or less close links to that standard. Given that the rationale behind the scope of statutory standards is to enable a flexible development of markets in conjunction with end users (which might require 'learning by doing'), links between the statutory and the 'voluntary' seem desirable precisely because the voluntary standards can fulfil the role of developing products tailored to end-user specifications.

Two possibilities arise:

(a) Require, or encourage (through exempting producers in specific recognised QASs from some of the statutory testing requirements) producers to be members of QASs; or

(b) Make the declaration of a specific list of variables a statutory requirement (but do not enforce statutory limits).

A suitable list of parameters required under (b), and required for any QAS to be recognised under (a) might include (in addition to those discussed in (5) above): content of nitrogen (N), phosphorous (P), and Potassium (K), Carbon: nitrogen (C/N) ratio, electrical conductivity, maximum particle size/screening, dry matter content, bulk density, pH, and quality class if there is more than one (at the very least, an indication is needed as to whether the compost is applicable in organic farming/landscaping). In addition, it is worth considering statutory minimum requirements for labelling of the input materials which have been used (biowaste, green waste, sewage sludge or any other industrial sludge; other industrial waste). This is important due to private contracts with food chains and increasingly, for organic farming and other environmental programmes in agriculture.

In this way, one seeks to overcome the potential for (for example) 'salty' compost (with high electrical conductivity) from being marketed in hobby gardening where the private consumer uses it for potting mixtures, for which it is not suitable.

In order to be fully subscribed QASs should ideally be linked closely to statutory standards. This provides a mechanism for promoting participation in the scheme in addition to the marketing advantage for producers, which in isolation may not be sufficiently great for them to consider the additional costs of joining.

8 **Development of end-user specifications:** Generally, it is most important that quality requirements such as organic matter, stability, nutrients, conductivity, readily available moisture content, porosity and its speciation, etc. (which might be collectively worded as 'agronomic' features) take into account specific needs, the views of purchasers, local cropping techniques, and the evolution thereof. This means that standards on such parameters should be made flexible and mostly left up to sector-specific, voluntary agreements. It might be therefore advisable to include in statutory standards – besides health and safety issues – only some fundamental agronomic features which constitute a common background to define what is really beneficial in any single sector, while most agronomic standards ought to be left up to voluntary agreements such as:

(a) QASs

(b) regional labels, or

(c) similar systems.

The choice depends on the historical background; the need to promote quickly and widely the system (which requires a centralised control/certification/labelling system, the reason why QASs are so widespread in EU); the need to have a voluntary system which also performs controls under the scope of regulations; and so on.

9 **Compost markets:** Regarding markets for compost, the nature of these is likely to lend itself to classical market development strategies, i.e.:

- ensure bulk markets are functioning well so that demand runs ahead of supply; and
- seek to establish niche markets alongside these with the emphasis on establishing higher value-added markets.

However, the application of compost has to respect environmental parameters. For this reason, as well as ensuring product specifications for specific end-uses (see the next section), the ability of the receiving medium to absorb compost applications must be carefully considered. The efforts to generate quality composts with low PTE concentrations is intended to ensure environmental protection. Loading limits are the direct counterpart of the precautionary product standards for compost, and these have to take into account not just heavy metals, but nutrient content (in field applications, not least since such issues are covered by legal commitments in European countries).

Some consideration should be given to the nature of nitrate in compost as opposed to nitrate in synthetic mineral fertilisers and manures. Application rates for good quality compost tend to be limited by implementation of the EU Nitrate Directive. Yet nitrate in compost is less freely available than nitrate in other forms. Hence, consideration should be given to the possibility for establishing different application rates for nitrate which relate to the form in which the nitrate is applied. This is possible within EU legislation where proper justification is given.

Complete recycling, i.e. the use of the compost, is the key issue, not composting as such. Compost is useful for a wide range of applications, but it is necessary to convince potential users of the benefits and value of using compost.

10 **Compost marketing.** Marketing is required. One aspect that is highly important is product recognition. As there are a lot of different kinds of fertilisers, soil

conditioning products and growing media, potential consumers often do not know what kind of product is to be used for what kind of application. Compost should be used because of its high organic matter content. The availability of nutrients is generally low (though higher with sludge composts for example). Information on compost quality and composition data, nutrient availability and recommendations for use is valuable to the user. In this respect, it is good to have only a limited number of compost types with standard or known characteristics. Too many different compost types make marketing and application complex.

The overall marketing activities should be supported not only by the government, but also by the municipalities, compost producers and all others involved in the market.

These are general lessons based on the experience of other countries. There is no unique system, and indeed, in the UK, a comprehensive system will have to fit within and around existing legislation. Already, the basis of what might be a relatively comprehensive quality assurance system has been developed by the Composting Association in its voluntary standard. There are also standards for inputs used under organic farming systems which cover compost, and these are effectively governed by the UK Register of Organic Food Standards (UKROFS). HDRA, in putting in place a certification scheme for organic landscaping and amenity horticulture, is establishing a similar standard for organic products for use in these areas. However, there is no statutory or even quasi-statutory reference point for these standards other than the EU Regulations on organic farming, and hence, outside the organic sector, voluntary standards currently operate in a context in which a) there is potential for producers to produce and market low quality products with negative effects on both the environment, and on public perception of compost, and b) some producers of quality composts who have already established markets perceive that little will be gained from entering standards where costs are incurred in doing so. The organic standards have greater force from the perspective of end-users by virtue of being supported by organic certification bodies.

WRAP has already started a process by which a Publicly Available Specification for compost is being developed, this being a staging post on the way to the development of a BSI standard for compost. This is a positive step in the current circumstances.

One can also point to other peculiarities of the UK composting system. This includes the relative significance of community composting (and there are few parallels to this in Europe). Standards should take into account the activities of this aspect of compost production which may have an important role to play in the sustainable management of waste materials within communities, especially within more remote areas, and also in awareness raising. It may be that some lessons can be learned from the experience of Austria with quality assurance schemes for on-farm composting. On-farm composting is another area of production which (given the potential for income diversification in agriculture through such production) should be closely examined in the context of considering the development of a system of standards (and regulation of biowaste treatment more generally).

Lastly, we have stressed the need to consider flexibility as far as possible in any system of standards which moves towards a statutory footing. Whilst this characteristic is desirable, it would be foolish to ignore developments at the European level, in particular, the Second Draft Working Document on the Biological Treatment of Biowaste. It would seem sensible to ensure that whichever system is considered, it does not fall completely out of line with the proposals therein (which themselves, are not without their merits). To do so risks establishing a system today which has to be overhauled as soon as it has been established. From a purely pragmatic standpoint, this would not be especially wise.

Appendix 1:
Measurement of odour at german compost plants

Few of the countries apply specific standards to control odours. There are (olfactometry) tests which exist to measure odours. However, most countries probably recognise that this is better dealt with on a case-by-case basis, depending on the circumstances and the location. Odour is a problem at some plants in, for example, Flanders, where planning legislation requires compost plant to be located in industrial areas which are often very densely populated. Equally, one finds mechanical-biological treatment processes in countries such as Italy with much warmer climates where odour control is extraordinarily good. Hence, the location may determine the requirement for odour control processes/equipment (biofilters, etc.).

The authors of this report are not aware of countries which set emissions standards for compost. In any case, this might be expected to occur through specifications on plant design. Germany has set standards for emissions of volatile organic compounds (VOCs) from MBT plants in its permitting process. It is not felt that this is necessary at quality compost sites, but it may well be at sites treating mixed waste (as MBT plants do). Principal (chemical) emissions from compost plants dealing with source-separated wastes are carbon dioxide, small amounts of methane (potentially) and ammonia. The ammonia can be treated through drawing exhaust gases into control systems at enclosed plants. VOCs may be emitted at compost sites, but these are frequently more benign forms associated with the use of biofilters (especially where, as is now increasingly popular, woody materials are used as the filter medium – WRAP may like to note that some compost plants are suppliers of materials for biofilter media).

Odour and emission problems are features which are immediately obvious in the plant surrounding and to the population living in the region. Besides the compost product itself, the emissions, and most especially the odours, are the most important aspects affecting the image of composting and digestion plants. It is difficult to explain to customers that a plant emitting strong and/or offensive odours produces compost with a lean smell like that of the soil in forests. The plant image is strongly connected with the quality and image of the source-separation of organic residues and with the composting process and industry as a whole.

For end products of biological waste treatment processes, only Germany shows a voluntary 3 level odour standard in the BGK regulations for digestion residuals.

Odour problems are only to a certain extent connected to plant management and this affects the degree to which odours can be avoided by process control. Normally a reduction or avoidance of odours requires technical means, so it makes sense to integrate standards for odour in the permission for the plant, as is done in Germany.

The German federal emission control law (BlmschG) regulates the odour emissions from waste treatment plants in such a way that an official permit of the authorities is necessary for:

'Treatment plant parts and process steps which may have important implications for:

(a) the arising of harmful effects on the environment,

(b) the provision of harmful effects on the environment or

(c) the generation of considerable nuisance.'

Apart from these preventive measures against odour annoyances via permit procedures the BImschG also provides subsequent measures for existing plants by means of a monitoring procedure.

The BImschG allows a reduced permit procedure for small composting plants under 0.75 tonnes per hour or 6,750 tonnes per year (after 2002, under 3,000 tonnes). In order to obtain a plant permit, there are three steps that plants must go through (see Figure 2):

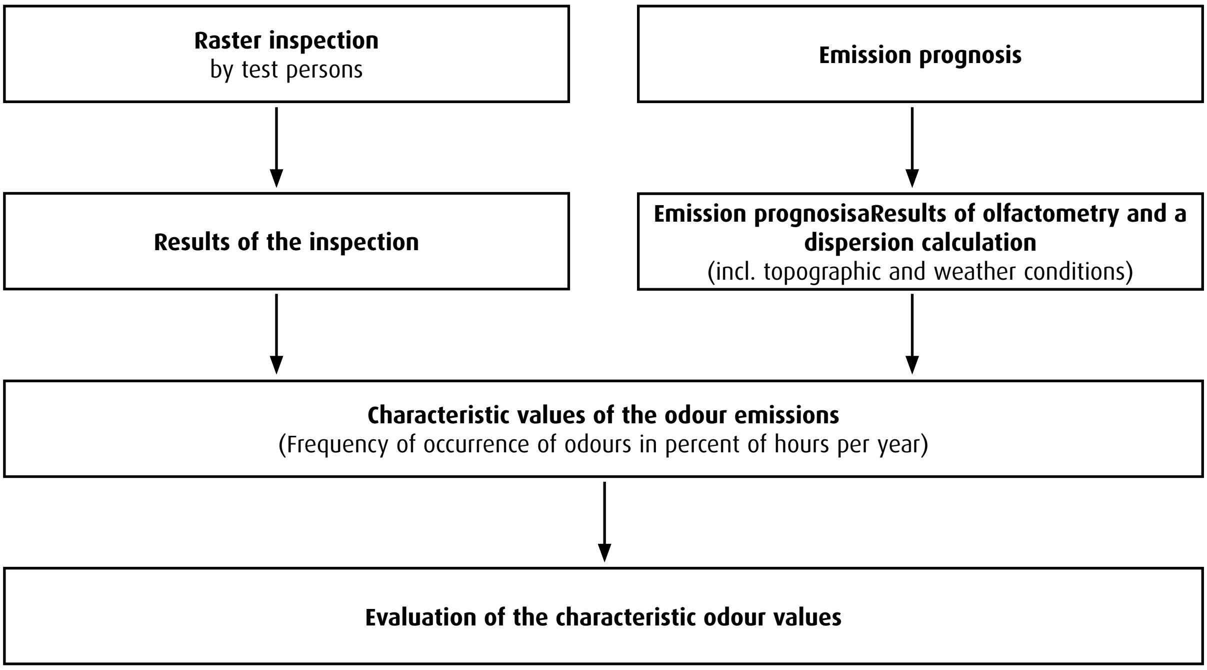
Step 1 (preventive): The emission prognosis should comprise the collection of all odour emitters situated in the wider and more immediate neighbourhood of the planned site (= pre-load) under all weather conditions. It should be guaranteed that the planned site will not cause intolerable additional charges through odours in industrial or residential areas.

Step 2 (subsequent): Official acceptance measurements of the plant approximately 6 months to 1 year after initial operation.

Step 3 (subsequent): Over three to five years, recurrent measurements, relating to the approval permit, help to prove whether the odour evaluation has been carried out in a correct manner and/or whether the plant and its operation can be continued within the maximally admissible odour emission values.

For an evaluation according to Steps 2 and 3, those odour emissions shall be considered which can be determined on account of their frequency of occurrence over a certain period. This can be checked as laid down in the odour emission guideline, GIRL, for the judgement and assessment of odour emissions.

Figure 2: System for detection evaluation according to GIRL



As odours are perceived via the human senses and because odorous material has no distinct chemical characteristics, olfactometry, as a measuring procedure, has been generally accepted for odour measurement. This measurement is carried out using human volunteers, through a controlled application of odour molecules to the nose.

The odorous air samples to be tested are contained in an olfactometer, and are labelled and diluted with neutral air. Odour tests are carried out by test persons, using different levels of dilution (starting with high dilution). If 50% of the test persons show a subjective odour sensation a detection threshold is defined at this stage of dilution.

So-called 'odour units' are used for the measurement. An odour unit (OU) is that number of odour molecules in the loaded air, distributed in 1 m3 of neutral air, which causes an odour sensation at the test person. The German, Dutch, French and Danish and the CEN 'odour units' are comparable.

At the moment waste treatment plants in Germany obtain an approval without exception with the help of the GIRL and are assessed according to the following two steps:

1 Determination of the **existing odour load, IV**, from the environment. This is determined by experienced test persons. The frequency of occurrence of odours over the year is established. An existing odour load is not to be considered in calculations if it occurs in less than 2% of the annual hours.

2 Determination of the **additional odour load, IZ**, through the waste treatment plant. A dispersion calculation and assessment through the calculation of odour emissions (OU/m3) from the emission of the odour material (GE/h) and its destination, and the frequency of occurrence over the year.

3 The sum of the existing load IV and the additional load IZ results in the **total emission load, IG**, on the environment of the plant.

IG = IV + IZ

If the total load IG does not exceed the following frequencies of odour occurrence the waste treatment plant is allowed to operate. The limit values are 10% of the annual hours for residential and mixed areas, and 15% of the annual hours for industrial areas. So, in only 10% (in residential areas) and in 15% (industrial areas) of the hours per year the odours may exceed the German odour threshold of one odour unit at the point of emission.

Appendix 2:
Quality assurance as a means of product qualification of compost – the German approach to the EC legal requirements

Compost: waste or product? The legal point of view

Discussions about the legal status of composts suitable to specifications as 'products' or as 'wastes for recycling' are still running in many countries – especially in Germany and Austria through the compost ordinances.

Biowastes which are treated in a utilisation process could actually lose their waste status and as a result of the treatment be seen as a product. The German government has been asked by an inquiry of the European Commission, dated 13 August 1999, to give an opinion on this matter. In a letter dated 17 December 1999, the Federal Republic responded that in their opinion the waste characteristic of compost ends when it is actually used, which means not after it is put into circulation, but with its actual application on the land.

The German Environmental Ministry made the following points:

Waste property until an environmentally compatible utilisation: According to Article 1 (a) of the EC Directive 75/442/EWG (the Waste Framework Directive) all materials or objects are defined as 'waste' if they fall under the list in Annex I, and if the owner wants to dispose of them. Doubtless to say that the biowastes which arise at the 'primary producer' (Article 1 (b) of the Directive 75/442/EWG) are fulfilling this waste definition.

The directive, however, does not regulate the length of time for which the material retains the characteristic of waste. Article 4 says that human beings and the environment have to be circumstantially protected against dangers and injuries which might arise from the improper handling of wastes. Hence the waste property of a material or an object persists until it is applied in an environmentally compatible manner.

Waste until the very end of the utilisation procedure: A precondition for materials to lose their 'waste characteristic' is the end of the utilisation process. The definition of the utilisation process must be realised in accordance with Article 1 (f) of the Directive 75/442/EWG with the utilisation processes named in Annex II B. The end of a preparatory utilisation process does not mean that materials lose their status as waste. The question here is whether the procedure R3 of Annex II B of the Directive (regarding biowaste utilisation) is just a preparatory procedure, or actually a terminating utilisation procedure (which results in the material losing its waste status).

Compost is not listed in the European Waste Catalogue EWC: An indication that composting is a terminating utilisation process could be that the produced compost is not distinctly listed in the European Waste Catalogue (EWC). All that is named there is 'compost that does not apply to specifications' (EWC 19 05 01). However, it must be said that the EWC does not define the waste property of a material. Furthermore, the EWC is not a complete index. From this fact alone, it could not be deduced that compost is not a waste.

Market value of compost: The fact that compost has an objective market value and/or is an item of trade agreements or acceptance contracts can be another argument for removing the waste status. This would indicate the potential for utilisation of compost as a 'secondary raw material' which is specifically named in Article 3, paragraph 1 (b),(i) of the WFD as the target of material utilisation. This point could be contradicted, however, with the argument that wastes can also have a positive trade value. Equally, a positive market value for composts can be subject to regional or periodical fluctuations.

Definition as secondary raw material comparable to primary goods: The classification could be terminated with the production of compost if it could be defined as a 'secondary raw-material' (see Article 3, paragraph 1 (b),(i) of the WFD). This means that the compost has properties which can be compared with those which substitute for primary raw materials. It would be the case if corresponding product standards could be established, so that compost could be put in circulation or used like a corresponding product that is produced from primary raw materials. For this reason, standards for fertilisers or soil improving means should be adopted.

Controlled application with no risk potential: This depends upon whether the produced compost still possesses waste-specific dangerous potential. Composting processes alone cannot remove a waste-specific dangerous potential. Biowastes are hygienised, yet they still contain harmful matter and impurities. As a rule, harmful matter in biowastes cannot be completely eliminated.

An enrichment of harmful matter in soil and in the human food chain cannot be avoided by meeting the limit values stipulated in the Biowaste Ordinance. Such an enrichment of harmful matter is rather dependent on the actual load. So it is necessary to define maximum quantities during certain time intervals for the application on soils (see paragraph 6, article 1 of the German Biowaste Ordinance). Furthermore, an application of compost can only be carried out if certain limits of harmful matter in the soil are not exceeded before the compost is applied (see paragraph 6, article 1 of the Biowaste Ordinance). Following from this compost must only be utilised in a controlled manner (see analysing, documentation and filing obligations in the Biowaste Ordinance).

Summary

The German Environmental Ministry concludes that on account of the typical waste properties of composts coming from treated biowastes, dangers and impacts may arise (especially through excessive application and thus increased fractions of harmful matter) through inexpert application. This must be prevented. In the frame regulated by the Biowaste Ordinance, compost is the result of a treatment process R 3 of Annex IIB of the WFD. Thus it is not a product but a waste according to Article 1 a) of this directive. The status of waste is not terminated before it is applied on the land (procedure R10 of the Annex II B of the Directive 75/442/EWG).

The German Environmental Minister Conference UMK from October 1999 also shares this point of view and raised the question of the termination of waste properties of waste material: The UMK is of the opinion that waste properties in wastes which are treated are terminated ‘when the utilisation of the treated wastes takes place’. The UMK goes on to state: ‘Where these are wastes fulfilling the properties of a product that was produced from primary raw materials for the same purpose and no waste-specific impacts do arise for the public welfare, the waste property terminates already after the treatment is finished’. Thus quality assured compost could be also looked upon as a product.

What makes compost a product? The German QAS concept

The quality assurance process labels high-quality products from which no waste-specific impacts for public welfare will arise, and allows the quality and effectiveness of composts to be compared with products from primary raw materials. Quality assured composts readily fulfil the legal requirements necessary achieve the status of product. The reasons for this are as follows:

General attitude towards compost as a product:
The general attitude towards compost as a product is based on the RAL procedure for the introduction of the QAS for the product group ‘compost’.

RAL, the German Institute for Quality Assurance and Certification as a national federation and holding company is carrier of all the quality symbols in Germany. The purpose of the RAL is the dissemination of the quality idea, fairness in trade and commercial intercourse, and the improvement of consumer protection.

When a RAL quality sign is created for a product group under the guidance of the RAL, the trade associations, business circles, experts and public authorities take part in the decisions. If agreements between the parties concerned are achieved, and a quality assurance organisation has been founded, the corresponding quality sign is acknowledged by the RAL and officially announced in the Federal Gazette by the Ministry of Economics. More than 100 concerned parties (trade associations, experts, authorities and business circles) took part in the decisions when the RAL quality sign for compost was created. The specifications of the quality standards agreed upon are stipulated in the Quality Guidelines and are continuously improved.

The RAL introduction procedure is a process for an objective definition of composts, corresponding to a high-class product in line with producer and consumer expectations. Composts which are subject to the RAL Quality Assurance and which correspond to the Quality Guidelines are certified as products. Composts of specifications remain wastes in the sense of the European Waste Catalogue (EWC 19 05 01).

Objective market value of compost products:
The production of composts from separate collection of biowastes has increased enormously during recent years. Today nearly 5 million tonnes of raw material are composted in more than 400 compost plants, all of which are subject to RAL Quality Assurance. However, the rate of increase in compost quantities over recent years has fallen.

Markets for compost products exist in a sufficient number to meet the output of the business, and have the potential to be developed further. Thus the market price is dependent mostly on the product quality, the marketing measures and the market conservation.

Recent market analyses for composts show that the markets are increasingly stable and the producers of mature composts receive payment for their product. Only in the case of coarsely screened fresh composts, or a low compost quality must a small payment be paid. Plants receive revenue continuously for most composts produced (see Table below).

Price situation for compost products

Compost type	Proceeds on the market
Fresh compost	1.5–4 Euro/t
Mature compost	2–16 Euro/t
Mulch compost	5.5–8 Euro/t
Soil mixtures	2.5–6.5 Euro/t

Source: Adapted from survey of the German Federal Humus and Soil Association (Bundesvereinigung Humus- und Erdenwirtschaft BHE), 2000

Equality with other fertilisers

According to the Fertiliser Law (DüMG) composts are secondary raw material fertilisers. The admission of compost as a fertiliser is through the Fertiliser Ordinance (DüMV) (since 1997). There, specific secondary raw material fertilisers were defined and standards stipulated for their labelling as a fertiliser complying with legal standards. As a rule composts correspond to the admitted fertiliser type 'Organic NPK-fertiliser'.

Composts are usually applied for fertilising and for soil improvement over a period of several years. This leads (at typical application quantities of 20–30 tonnes of dry matter per hectare in three years) to a fertilisation of, for example, 300 kg N, 150 kg P2O5 and 250 kg K2O and 1000 kg CaO per hectare. This is a common fertilisation method using compost in practical operation, and is comparable with those for other fertilisers which were produced from primary raw materials.

Composts which as a result of low contents of plant nutrients do not correspond to a permitted type of fertiliser can be marketed as a soil additive. Soil additives are materials which influence the soil in a biotic, chemical or physical way in order to improve its condition.

The RAL Quality Assurance Compost guarantees that

- the labelling according to fertiliser law and the declaration of goods according to the Fertiliser Ordinance are stipulated and indicated;
- the requirements for hygienisation of the products are fulfilled; and
- the limit values of the waste regulations are met.

In order to compare secondary raw material fertilisers such as farm manure, digestion residues and biocomposts the German Quality Assurance Organisation introduced in 2001 a new quality parameter. Besides other parameters the digestion product is evaluated according to its efficiency (precaution-use-ratio). This new parameter will further help to establish compost and digestion residues as products on the market because it shows comparable benefits (the intention is to generate a similar parameter for composts later this year, i.e. 2002).

Conformity to standards

The RAL Quality Assurance takes into account further legal regulations and standards besides the fertiliser and waste laws. The following laws and ordinances are involved: Closed Loop Waste Management Act (KrW-/AbfG), Biowaste Ordinance (BioAbfV), Fertiliser Law (DüMG), Fertiliser Ordinance (DüMG), Federal Soil Protection Act (BBodSchG), German DIN Norms and Technical Standards of the Landscaping Association.

This proves that the RAL Quality Assurance fulfils a variety of different requirements. This will also be valid for future European regulations. Thus the ability to make use of quality assured composts as 'secondary raw materials' in the sense of Article 3, paragraph 1,(b) (i) of the Directive 75/442/EWG is given.

Guarantee of application safety and user protection

The Federal Compost Quality Organization BGK issues annually an external monitoring procedure for each product which is subject to the RAL Quality Assurance. The external monitoring serves as evidence of quality for the customers and as evidence of a regular quality monitoring for the authorities in charge.

The external monitoring covers:

- the labelling of the product with the RAL Quality sign;
- the legal marking required under the Fertiliser Law;

- the orderly product declaration according to the Fertiliser Law;
- examination for compliance with waste legislation;
- the marking of the admissible application quantity according to Biowaste Ordinance;
- the quality properties of the product including possible variations of the individual quality parameters;
- recommendations for the application of the product according to best fertilising practice including basis for calculating fertilising schedules and for soil improvement.

In the frame of the quality assurance the recommendations for application are determined for each product of each manufacturer and reported annually in the external monitoring documents.

Dangers or impacts through inappropriate utilisation of the compost in the sense of Article 4 of the Directive 75/442/EWG are effectively prevented through these mechanisms.

Conclusion

Over the years the RAL Quality Assurance for Compost has established itself in Germany as the product certification and standard for compost products. The quality and test regulations and standards are co-ordinated with the trade associations, experts, authorities and business circles. Composts with a RAL quality sign fulfil the requirements of the users, are subjected to an independent external monitoring, are hygienically tested and guarantee a high degree of safety in application.

The Biowaste Ordinance defines compost as 'wastes' in the legal sense, the utilisation of which is subject to substantial requirements. In the Biowaste Ordinance, however, a possible way of exempting quality assured compost products from certain obligations is offered (e.g. exemption from soil investigations before the application, exemption from a utilisation proof (bill of delivery)), so that they can be treated and marketed in a manner similar to products.

This exemption from certain market restrictions must be appreciated. The loss of the status of waste for compost products which meet a generally acknowledged product certification is also legally necessary. This does not mean that an amended new Biowaste Ordinance should include no product requirements and load limits to assure harmless utilisation.

It should, however, include an option according to which the waste properties of quality assured products no longer apply so that they can be treated like other comparable products in the market.

The legal arguments for waste properties of composts mentioned in the first part are not relevant for certified products from the RAL Quality Assurance of Compost because:

- Compost products with the RAL quality sign are distinctly specified on account of the standardisation and specification method which include all trade associations, experts, authorities and business circles concerned with compost.
- The general attitude of compost with an RAL quality sign as a product is stipulated in the RAL introduction procedure.
- Compost products with RAL quality sign correspond to the product standards for fertilisers, and other non-statutory standard requirements, as are applied to other comparable products.
- Dangers concerning amounts applied exceeding statutory limits are unfounded on account of the positive prices received from compost products with RAL quality sign.
- Dangers and impacts arising from incorrect application of compost products with an RAL quality sign are unfounded on account of the extensive demands for product declaration and on account of an expert application.

A suitable instrument for the qualification of composts as a product is a product certification system as has been successfully established during recent years through the German RAL Quality Assurance. Compost producers desire, and need, the opportunity to make their secondary raw material fertilisers a genuine alternative and to establish a profitable market for their products. In the long run, the marketing of 'wastes' will not be possible.

Source: Kehres, Dr. B: Vom Abfall zum Produkt – RAL-Gütesicherung als Instrument der Produktqualifikation von Sekundärrohstoffdüngern und Bodenverbesserungsmitteln, in Humuswirtschaft & Kompost 03/2001 – (summarised and modifed).

Footnotes

1 The term 'heavy metals' (HMs) will be used in this report to denote heavy metals specifically. 'Organic contaminants' will be used throughout this report to refer to chemicals such as dioxins, polychlorinated biphenols (PCBs), absorbable organic halogens (AOX) and other organic chemical contaminants such as phthalates. The term 'potentially toxic elements' (PTEs) will be used throughout this report to denote both heavy metals and organic contaminants.

2 See later in this document. See also Bidlingmeier, W. (1982) Schwermetalle in verschiedene Hausmüll-komponenten (Heavy Metals in Household Wastes), Research Report Ministry for Environment Baden-Württemberg; Bidlingmeier, W. (1987) 'Schwermetallen in Hausmüll – Herkunft- Schadwirkung, Analyses' ('Heavy metals in household waste-origin, harmful effects and analysis'), thesis paper; Kraus, P. and Grammel U. (1992) 'Die Relevanz der Schadstoffdiskussion bei der Bioabfallkompostierung' (Relevance of contaminant discussion for bio-waste composting'), Abfallwirtschaft 9, MIC Baeza-Verlag Kassel; Kraus, P., and Wilke, M. (1997) 'Schadstoffe in Bioabfallkompost' ('Contaminants in bio-compost'), Müll und Abfall 4-97, 211-219; Wiemer, K and Kern, M.(eds) (1989) Kompostierung International (Compost International), Abfall, Wirtschaft, (Technical Series), University of Kassel, MIC Baeza Verlag, no.2, pp.400,; Wiemer, K. and Kern, M. (eds) (1991) Bioabfallkompostierung (Biowaste Composting), Technical Series 6, University of Kassel, pp. 800.

3 Here, it ought to be pointed out that the fate of nitrate from compost is not so well understood. It is, however, recognised that nitrate in compost is less freely available than when in synthetic mineral fertilisers so that legislation should take account of this when considering, for example, the relative potential for leaching from the different sources.

4 The Kompostverordnung runs into 57 pages of legislative text (see Bundesgesetzblatt fur die Republik Osterreich (2001) Ausgegeben am 14 August 2001, Teil II. pp.1723-78).

5 Amlinger, F., Chr. Weissteiner and W. Stark (2000) Estimation of the Distribution of Pollutants in the Environment as Related to Different Scenarios of Organic Waste Recovery in Austria, Final Report to the Austrian Ministry of Agriculture and Forestry, Environment and Water Management, Vienna (in German).

6 For a review, see Brinton, W. (2000) Compost quality standards and guidelines: an international view, Final Report to the New York State Association of Recyclers, Woods End Laboratory.

7 See, for example, Armstrong, W. (2001) 'Progressing the preparation of New Zealand guidelines for the beneficial use of biosolids, issues and options', Paper for the New Zealand Water and Wastes Association, 11 May 2001.

8 McGrath, S.P., Chang, A.C., Page, A.L. and Witter, E. (1994) 'Land application of sewage sludge: scientific perspectives of heavy metal loading limits in Europe and the United States', Environmental Review 2, pp.108-118.

9 EPA (1989) Proposed Rule. Sludge Guidelines, Federal Register, CFR-40 Chapter 503, September 1989; revised and published as Final Rule, CFR-40 Chap 503, February 1993.

10 Giller, K.E., Witter, E. and McGrath, S.P. (1998) 'Toxicity of heavy metals to microorganisms and microbial processes in agricultural soils: a review', Soil Biology & Biochemistry, vol.30, pp.1389-1414. McGrath, S.P., Chang, A.C., Page, A.L. and Witter, E. (1994) 'Land application of sewage sludge: scientific perspectives of heavy metal loading limits in Europe and the United States', Environmental Review, vol.2, pp.108-118. McBride, M. B. (1998) 'Growing food crops on sludge-amended soils: problems with the US Environmental Protection Agency method of estimating toxic metal transfer', Environmental Toxicology and Chemistry, vol.17, pp.2274-2281.

11 Brinton, W. (2000) 'Compost quality standards & guidelines: an international view', Final Report to the New York State Association of Recyclers, Woods End Laboratory.

12 The European Commission's 2nd draft of a Biowaste Directive uses the term 'threshold values' in association with organic pollutants and incorporates 'allowed deviation from statutory limit.'

13 Note that the meaning of 'mixed' in this context does not imply 'unsorted waste', but to the various categories of source-separated materials included in the starting mix.

14 SEPA (1997) Compost Quality and Potential for Use, Swedish EPA., AFR- 154, Stockholm, Sweden.

[15] Research undertaken at Woods End Laboratory.

[16] Brinton, W .and E. Evans (2001) 'How maturity affects performance of container grown plants', Biocycle, vol:1.

[17] Brinton, W. (2000) 'Compost quality standards & guidelines: an international view', Final Report to the New York State Association of Recyclers, Woods End Laboratory.

[18] Federal Ministry for Agriculture and Forestry, Environment and Water Management (2001) 'Guideline for the mechanical-biological treatment of waste', delivered for notification to the European Commission, 12 October 2001.

[19] Lahl, Uwe, Barbara Zeschmar-Lahl and Thomas Angerer (2000) Entwicklungspotentiale der Mechanisch-biologischem Abfällbehandlung, Monograph M-125, Wien, June 2000.

[20] Many people from research centres and institutions are asking that the limit values for heavy metals be increased by at least 1.5 (e.g. zinc: 1500 ppm; copper 500 ppm), which would be much more consistent with limit values to allow sludge application on croplands (zinc: 2,500; copper: 1,000; nickel: 300 – see also later concerning the regulations issued by region Veneto).

[21] Many technicians and institutions are proposing that total Chromium be considered as a more prudential approach and the final regulation seems likely to reflect this.