

# SESSION II

# An assessment of effective, optimised schemes for source separation of organic waste in Mediterranean Districts

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## Abstract

Recent legislation in some Mediterranean Countries and Districts has given a strong impulse to the renewal of waste management systems on the whole. The European Union's landfill directive provides a further incentive to divert biodegradable materials from the municipal solid waste. Backed by information stemming from a pretty important number of schemes currently on place above all in Italy, but also in Spain and France, this Document explores the issues involved in developing an effective and cost-competitive waste management system which incorporates separate collection of organic wastes by households. Details on tools to cut costs down are also shown. The outcomes of the survey and further evaluations hold valid also for other situations, and in particular for other Mediterranean Countries.

## Source Separation Of Organic Waste In Mediterranean Countries: An Overlook

Source separation, and namely that of food waste, has recently undergone a huge growth in Mediterranean Countries, and above all in Italy and some Spanish districts.

In Italy, the main reason for that has been the issuing of the National Waste Management Law (Decree 22/97, also known as the "Ronchi Decree")

The decree clearly points out that:

- waste reduction and material recovery, re-use and recycling must be preferred to energy recovery and landfilling (which is seen as last resort)
- specific recycling targets (for each Province) are set at:
  - 15 per cent by March 1999
  - 25 per cent by March 2001
  - 35 per cent by March 2003
- landfilling is allowed only for non-recyclable or treated materials (since July 2001)
- waste collection must be organised according to efficiency, effectiveness and cost-optimisation

In order to achieve the recycling targets, source separation in Italy is now undergoing an impressive growth. Attention is focusing particularly on the predominant waste fractions (such as paper and compostable organic waste). Although source separation of organic waste (kitchen and garden waste) is not compulsory, it is becoming the real back-bone of the waste management system, yielding (particularly when operated with door-to-door systems, also worded as "doorstep" or "curbside" schemes) recycling rates as high as 20 – 40 per cent on its own. The overall recycling rate can thus reach as high as 50-60% in single Municipalities (up to 75-80% in tiny ones). Those Provinces where the system has already undergone a wide development, have already met on the whole recycling rates as high as 45% (table 1: the average in wide Districts is of course below top results in single Municipalities, as it takes into account those Municipalities where the system hasn't been implemented yet).

**Table 1: Recycling rates in some Provinces in Northern Italy**

PROVINCE	Recycling rate % out of total MSW
Bergamo	44,4
Cremona	35,1
Lecco	45,6
Lodi	34,0
Milano	37,6
Milano (without Milan town)	46,1

In general, the intensive collection of dry recyclables alone (paper, glass, metal and plastic ) cannot allow municipalities to meet the 35 per cent recycling goal for 2003. Accordingly, most regions and provinces now plan to promote source separation of food and yard waste from households and big producers (restaurants, canteens, greengrocers, etc).

By January 1999, some 600 municipalities were already running separate collection schemes for food waste. The number is steadily growing and it is likely to have overcome 1000 Municipalities to date, including highly-urbanised areas (e.g. Turin town, with some 500.000 inhabitants involved; highly populated Municipalities in Milan Metropolitan area).

Thanks to the growing number of schemes being put in place, it is possible to assess the effectiveness of these systems, in terms of:

- quantitative effectiveness. This feature is expressed as specific capture (in grams per person per day or kilograms per person per year)
- purity of the fraction collected (table 1).
- costs of the systems and tools to cut them down.

Composting is under a fast development also in Spain. The start up of pilot schemes for source segregation of "basura orgánica" (also worded as FORM or FORSU, organic fraction of Municipal Waste) dates back to some years ago and has been developed in many Spanish Districts, both rural and urban; among these latter, an outstanding scheme – if we refer to the population covered - has already long been run in Cordoba (some 300.000 inhabitants).

Nonetheless, if we consider schemes for source segregation, Catalunya is undoubtedly becoming the leading situation, in Spain. The Catalan development takes it steps from a Regional Law (Law 6/93) setting out compulsory programs for the source segregation of organic waste in all Municipalities with a population over 5000 inhabitants. This mandate affects 158 municipalities with a population of 5.3 million inhabitants, or nearly 90% of Catalunya's population. The remaining Municipalities, those with populations under 5,000 inhabitants, are not required to comply, although they may participate - and many are doing so - on a voluntary basis.

As per November 2000, 72 Municipalities in Catalunya were reported to source separate biowaste, for an overall population of some 640.000 inhabitants (see also table 2); in the Barcelona Metropolitan Area itself, they were 21 out of 33, covering 150.000 inhabitants with a forecast development to 300.000 inhabitants within the end of year 2000.

Catalan schemes were based, till a few months ago, on collection of organic waste by means of road containers, as it had been previously done in other Spanish districts. Lately – on the spur of effective outcomes reported in Northern Italy - doorstep schemes have been introduced and developed in 3 Municipalities (Tona, Tiana, Riudecanyes) with sharply different and better outcomes, thus outlining new perspectives in growth and optimisation of strategies for composting. As for recycling rates, these are showing to be impressively higher where doorstep schemes are put in place than in traditional schemes (figure 1).

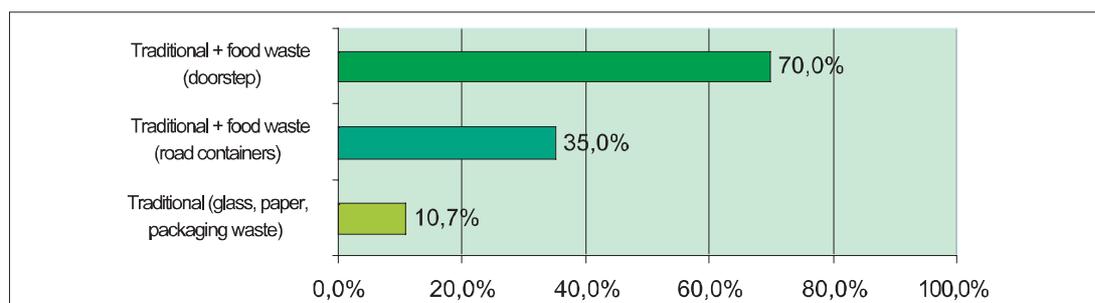


Figure 1: Average recycling rates stemming from different source separation schemes in Catalan Municipalities

Also specific captures (directly related to recycling rates) and purity show sharply different and positive trends in doorstep schemes (table 2).

These numbers are showing once again, as already shown since a long time on a broader scale in Italy, the different and much better outcomes that doorstep collection of food waste can yield. Having stressed the higher contribution of food waste to top recycling targets met in doorstep schemes, we still have to consider implications of its higher captures on the side of collection methods for restwaste, its simplified features and cost-optimisation. This can actually lead to optimised and cost-competitive schemes, as it will be shown.

Table 2: Specific capture and purity in schemes for source segregation of food waste in Catalunya. Schemes where a doorstep collection is on place are highlighted

Municipalities / schemes	Performances of source separation schemes for food waste	
	Quantity (g / inhabitant . day)	Quality (% impurities w/w )
Torrelles de Llobregat	139	1,8
Molins de Rei	116	2,1
Baix Camp	175	5,2
Igualada	125	3,8
Castelldefels	292	7,2
Castelldefels (March 2000)		4,5
Gavà	223	4,7
Viladecans	128	2,8
Viladecans		3,6
Castellbisbal	254	2,1
Vilanova i la Geltrú	239	---
Sant Cugat del Vallès (April 2000)	213	2,6
Barcelona (Major de Gràcia)	52	18,7
Barcelona (Gracia Comercial) (January 2000)		5,7
Barcelona (38 markets) (January 2000)		3,7
Tona (October 2000)	265	0,9
Tiana (August 2000)	285	4,0
Riudecanyes (October 2000)	298	1,9
AVERAGE road container	177	4,9
AVERAGE doorstep	283	2,3

Source: update on Giró, 2000

### The Quality Of Source Separated Organic Waste

Efficiency of collection schemes must also be considered under the point of view of the quality of collected organic waste, that affects its suitability to produce a high-quality composted product.

Numbers already shown on performances of Catalan Municipalities suggest that doorstep schemes allow a higher purity of collected food waste. This is easily understandable as road containers cannot perform an easy and effective control on behaviour of single households; thus the outcomes get negatively affected by wrong deliveries.

Here some numbers are shown stemming from surveys led in Italy

**Table 3: Purity (at sorting analysis) of collected food waste in Italy (sources: Provincia di Milano, 1998; Favoino, 1999; Bigliardi, 1998)**

Municipality/Area	Inhabitants	Compostable materials (percent weight)
Milan Province 17 municipalities	493.673	97.28
Monza Municipality	119.187	97.4
Area 'Padova 1' 26 municipalities	203.429	98.7
Modena Province Nonantola municipality	11.127	99.79

As Table 3 shows, random analyses of food waste, indicate the excellent quality of organic material collected in doorstep schemes. In fact usually the percentage of compostable materials inside food waste collected ranges between 97 and 99 per cent. This result is to be compared to the 95 per cent purity (5 per cent of rejects) meant to be the 'excellence' level to have high quality composted products without affording expensive pre-sorting and final refining technologies in the composting plants. This is what happens in some Central European Countries (Germany and Austria) where the purity of the material collected often varies between 93 - 98 per cent.

Good performances (as to purity and capture) of the collection of food waste in Italy and Catalunya is likely to be related to the specific features of the collection service. Among these features, the use of watertight, transparent bags (usually biodegradable) for the first delivery of the food scraps, is much appreciated by the households as a comfortable tool; this enhances "awareness" of households and their participation in the source separation programs. The watertight nature permits the delivery of most kitchen residues (including wet and/or cooked foodstuffs such as meat and fish scraps), thus reducing the percentage of fermentable waste materials inside residual waste; it strongly helps avoiding leaching and odour emissions in bins and buckets supplied to households. The transparency of the bags is meant to allow an easy quality control of the waste material and define the need for further information to be given to households (e.g. in a particular neighbourhoods).

Purity usually gets much lower (90-95 per cent and even less) where collection systems involve the use of large-volume road containers, without a door-to-door service. Anonymous delivery obviously involves a less aware behaviour by the population. See for instance the numbers referring to road container collection in Catalunya in table 2.

An evolution of the road container system is to be found with locked containers (used for instance in some districts Northern Italian Region Emilia-Romagna). In this case, each household receives a key to open the container. The overall outcome is that only most aware and



### **"Biowaste", "vgf" and "food waste": relevance of a definition to performances of the waste management system**

In Germany, Austria, and Central Europe the fraction targeted by the source separation system is referred to as "Bioabfall" (biowaste), that means a mixture of food scraps and yard waste; in the Netherlands, in Belgium (Flanders) and in many sites in Germany and Austria themselves, the definition "GFT" or "VGF" (vegetable, garden, fruit) is used, addressing a mixture of yard waste and the food waste portion before cooking (not including cooked items as pasta, meat, fish...). This choice is due to the troublesome, highly fermentable nature of cooked scraps.

On the other hand, we have to underline that the recycling of dry fractions and packaging materials (paper, glass, plastics, etc...) determines – as an undesired side-effect – the concentration of the fermentable material inside "restwaste", if food stuff is not effectively sorted by means of high-capture systems. This is what actually occurs in those Countries (Germany, Holland, Austria, etc.) even though source separation of biowaste has already gone a long way, there. That means, in those Countries separation of dry recyclables is likely to be more effective than that of food waste. For instance, in the Netherlands and Germany, food waste percentage inside "restwaste" is often reported to be at 40-50% (Wiemer, Kern, 1995; Baden Baden Amt für Umweltschutz, 1996). When transferred to warmer climates – as in the Mediterranean Area – this system would for instance keep the need for frequent collection for restwaste.

Moreover, in central Europe, in the "biobin" (bin provided to households to separate Biowaste) a large proportion of garden waste can be found (up to 80-90%, weight basis, out of the total bin content) in addition to food waste. The delivery of garden waste is much stimulated as households – even in detached houses with gardens – are provided with large-volume bins that allow the delivery of bulky materials as yard waste. This situation can also be detected in most pilot schemes in France (see table 5).

In most situations in Italy and Catalunya, source separation systems for compostable organics are often sharply different since the collection of food waste and that of yard waste are most often kept separated. One collection targets only "food waste" on the whole (including cooked scraps as meat and fish), often referred to as the "wet" fraction, by means of small volume bins and buckets; a different system targets yard waste only.

This distinction between the two collection rounds takes into account:

- the different biochemical and seasonal feature of the food scraps as compared to the yard waste. In Italy – where a door-to-door collection for food waste is adopted, and in contrast with what is generally being done in Central Europe - collection of the garden waste, that does not stink, and does not produce leachate, adopts different schemes and tools as compared to that for food waste. This in turn makes it possible an overall optimisation of the scheme, as "intensive" features of the collection of food waste (high frequencies, watertight bags) do not apply to yard waste, that doesn't need such intensive, expensive collection patterns. It is also possible to make the total bin/vehicles volume fit to the specific production of food waste, that does not show huge seasonal fluctuations as for yard trimmings; vehicles and systems used for yard waste, on the other side, can be seasonally adapted;
- the different bulk density of yard and food waste. In case of yard waste, it compels to use compacting vehicles (packer trucks) while in case of food waste compacting vehicles can be replaced by bulk lorries that are much cheaper at an equivalent working capacity. This is one of the most powerful means to optimise the operational features and cost figures related to source separation systems.

- the troublesome features of food scraps (high putrescence and moisture content). This asks for the application of specific, intensive tools, systems and collection frequencies in order to have the system clean and 'user-friendly'; of course, when you let people feel comfortable, you enhance the overall participation. This leads to better quality and higher quantity collected; brings down the percentage of food stuffs inside the restwaste, making it possible to collect it less frequently. In effect, analytical measurements - where a door-to-door collection is adopted - report the content of food stuffs inside Restwaste at an average 15-20% and even less (Provincia di Milano, 1998 b), that is, much lower than in previous source separation programs across Europe.

Nevertheless, "easiness must have a borderline". A comfortable system that does not set any difference between food and yard waste is a system where a huge delivery of garden waste is to be expected. It is noteworthy that in Central Europe it has often been recorded an overall organic waste collection of some 150-200 kg inh<sup>-1</sup>y<sup>-1</sup> and more. This is due, above all, to the easiness of delivering yard waste to the collection service (households are allowed to deliver it in the same bins adopted for food waste collection). The general outcome is a high recycling rate, but the overall MSW production figure gets often higher, as well, as deliveries of materials that had been previously home composted gets stimulated. In such situations, it happens to record an overall MSW production of some 600-650 kg inh<sup>-1</sup>y<sup>-1</sup>. The same has been already recorded in a few situations in Italy with similar collection systems adopted (table 4; Legambiente, 1997; Legambiente, 1998)

#### **Collection schemes for yard trimmings and the importance of programs for home composting**

In normal weather and cropping conditions, lawn mowing from public and private areas yield 2 to 6 kg y<sup>-1</sup> grass clippings per square meter; these are roughly doubled by trees and brush pruning and leaves. The average (per person) recovery rate of garden waste collected in Italy (in those areas where the systems are well established) is often 30-70 kg inh<sup>-1</sup>y<sup>-1</sup>. Where garden waste is collected together with kitchen waste (in a single bin as for instance in Central European collection models), it is usual to see collection rates as high as 150 and more kg inh<sup>-1</sup>y<sup>-1</sup> (table 4). We have already underlined that such a situation makes recycling rates rise, but also increases the overall quantity of waste to be collected and treated.

A similar assessment actually stems from the evaluation of features and performances of pilot schemes nowadays being run in France. As a matter of fact, most of them (table 5) are based on the supply of medium-volume trolley bins also to single families in detached houses with gardens; this in Districts with a high presence of gardens leads in turn to very high deliveries of yard waste in the bins (see reported percentages of yard waste inside collected biowaste). The situation sharply improves - under this standpoint - where low-volume tools get used (e.g. little buckets).

**Table 4: specific captures of yard waste in 1998 (Source: Legambiente, 1999)**

Municipality	Yard waste Kg.inh <sup>-1</sup> .y <sup>-1</sup>
Forte dei Marmi	462,7
Pietrasanta	237,1
Sirtori	227,2
Seravezza	200,3
Lierna	172,3
Arese	120,5
Monticello Brianza	113,6
Rovello Porro	111,9
Burago di Molgora	108,4
San Rocco al Porto	102,5

Therefore, efforts have to be made to find suitable systems that enable high recycling rates, without implying a high delivery of yard waste and a related increase in the overall MSW collection. It is important to note that "where there are yard trimmings, there is a garden in which home composting could be performed". Our purpose is then to adopt a collection system which does not excessively promote the easiness for the households to 'get rid of yard trimmings'; nevertheless, we have to ensure the collection of yard waste by those households who have not time or conditions to run a backyard composting experience. Therefore it would be recommendable, that the collection of garden waste be kept separated from the collection of kitchen waste, as it actually happens most times in Italy and Catalunya.

The collection of yard waste should then be run through direct delivery at Civic Amenity Sites ("Piattoforme Ecologiche" in Italy, "Deixalleries" in Catalunya); in order to help people who find it troublesome to go to Civic Amenity Sites (for instance due to lack of space in their car, or whatever the problem) a door-to-door collection can be run, with a specific round ('green circuit') and a much lower frequency of collection as compared to kitchen waste (i.e. fortnightly to monthly).

We want to stress once again that a distinct collection rout for yard waste enables waste managers to plan and run a system:

- that does not involve seasonal fluctuations for the collection of food waste (that asks for much more intensive and expensive conditions)
- that is kept separated from the specific collection systems for food waste, that are fermentable, wet and with higher bulk density
- with a pretty low collection and disposal cost for the yard waste itself, thanks to simplified collection and cheaper tipping fees by composting plants
- that makes it possible to enhance home composting; as households are not provided with a specific bin, they seldom find it too easy to deliver their yard waste to the collection service, and get rather stimulated to try backyard composting, sooner or later.

### Needs and tools for the collection of food waste

Running source separation for food waste, above all by households, means to find out the best way to face the specific troublesome features of such a material: its fermentable nature and its high moisture content. In this respect, a comfortable feature of the service, where households are provided with tools to avoid nuisance, will result in an enhanced participation and will thus determine higher collection quantity/quality (Favoio, 1999).

In Italy, the answer to this problematic issue – above all where a "door-to-door" collection system is adopted – has been, typically:

- a relatively “intensive” collection schedule as compared to Countries in Central Europe; two to four times a week, seldom once weekly during wintertime in Northern Italy; it has to be noted that in Southern Italy, as in Spain, Portugal, etc. collection for mixed MSW is traditionally scheduled up to 5-6 times a week due to weather conditions; in Northern Italy the collection for MSW is usually 3 times a week
- the use, in most cases, of “door to door” collection systems so as to have them more “user-friendly” and enhance the participation rate
- the use of watertight, transparent tools to hold the waste (“Biobags”)

**Table 5: Features and main performances of pilot French schemes for source separation of biowaste (“biodechets”)**

Scheme	Covered population	Biodechets Kg/inhab.yr	Reported % of single family dwellings	Reported of yard waste inside Biowaste	% Type of tool
District des trois Frontieres	24.000	153	80	80	Trolley bins 120-240-340
District des Sud Bassin	30.500	159	88	95	Trolley bins 140-260
SITCOM Coté Sud des Landes	5.360		92		Trolley bins 240 + paper bags 15l
Communauté d’Agglomération d’Agen	1.500		100		Trolley bins 240, a few 120-180
SITCOM Nord-Allier	2.800	221	100	75	Trolley bins 120-240
SIVOM du Pont Fort de Saint Lø	13.100	178	100	75	Trolley bins 120-240
SITCOM de Buxy-Saint Gengoux-le-National	2.720	136	97	65	Trolley bins 120-240
Communauté Urbaine de Creusot Montceau	70.000	89	80	0	plastic bags 20 l
Communauté de Communes de la Region de Guegnon	9.897	72	85	98	plastic bags 50 - 100 l
SITCOM de la Region de Rambouillet	29.000	70	100	87	Double-compart trolley bins 180-260-340 l
SAN de Cergy-Pontoise	25.800	87	100	90	Trolley bins 140 l, bags 80 l
Ville de Beziers	3.000	67	100	75	Trolley bins 120-240
SITCOM de l’Ouest Audois					
SYDOM de l’Aude	2.681	28	100	10	Trolley bins 330-660 l, buckets with biodegradable bags
SYNTOMA	2.380	64	100	20	buckets 10 - 35 l
SIVOM de Coursan Narbonne Rural	4.008	107	100		Containers 660 l, buckets 15 l
Communauté de Communes du Bassin de Pompey	9.000	93	83	70	Trolley bins 120 l
SISOV	1.118	138	95	70	Trolley bins 120-240
SIVOM de Bapaume	23.667	211	100	70	Trolley bins 120 l
SIRFAG SIRDCGUTOM	57.326	155	91	80	Trolley bins 120-240
Lillé Metropole Communauté Urbaine	233.629	94	100	85	Double-compart trolley bins 180-260 l
SIRTOM du Laonnois	3.830	0	72		Trolley bins 120-240
Communauté de Communes de la Vallée de l’Oise	100	90	99	10	Bins 35 l
Communauté de Communes de la Region de la Villedieu du Clain	13.000	46	100		Aerated trolley bins 120 l
Communauté de Communes du Pays Santon	2.000	155	100		Trolley bins 120-240
Ville de Niort	32.271	140	65	90	Trolley bins 120-240
Communauté de Communes des Duyes et Bléone	270	30	100	5	Trolley bins 120 l
Communauté de Communes du Canton de Clelles	1.460	178	100	35	Trolley bins 120-240

The use of the bags:

- substantially prevents pest attraction (insects) and leachate production and keeps the bins clean. This, in turn, makes it possible to cut down the frequency for washing rounds. Actually, in many cases, bins are considered a "personal" equipment and are washed by households themselves but for a few washing rounds in the warm season supplied by the waste collection service.
- Avoids nuisances generally related to delivery of "loose" material inside the bin, makes it possible to collect even meat and fish scraps along with vegetables and fruit residues.
- Increases captures that, in turn, allow a significant reduction in collection frequency for "restwaste"
- the small bag size prevents the delivery of bulky materials (e.g. bottles, cans), allowing higher biowaste purity.

The 'bio-bag' is placed:

- directly on the roadside on the collection day, usually inside the family small bin (6.5 to 10 litres) or inside "buckets" (20 to 30 litres). This system is often under adoption in small towns and villages to reduce the pick-up time for each dwelling (loading is manual) and to prevent households from delivering garden waste inside the bins
- or in a bigger bin whose capacity usually ranges from 80 to 240 litres for 10 to 20 families depending on the collection frequency. This system is under adoption where households dwell in flats in high-rise buildings.

### **Cost analysis: a proposal**

One of the major concerns in Mediterranean Countries – as it is actually throughout Europe - is the lack of cost-competitiveness of source separation system with high recycling rates as compared to the traditional mixed MSW collection. Operators in general think that sorting food waste leads to higher costs of the overall collection scheme.

Hence, it is useful to analyse main source separation systems currently in operation. Cost analyses carried out so far have usually expressed the costs per kilogram (or per ton) for a single waste material collected. However, there is evidence that this distorts the true picture, because the more the waste collected, the lower the costs of the collection service per kg. This distortion hides some important outcomes of integrated source separation and waste management:

- the reduction of total waste delivered as a consequence of effective waste reduction policies
- the contribution of home composting programs to the overall reduction of organic waste collected

Furthermore, the evaluation of a single waste flow, does not allow one to compare advantages to collection costs for other materials, flowing from operational integration. In effect, the collection of food waste allows important changes in the collection scheme of other waste materials, by reducing, above all, collection frequencies for residual waste ("restwaste").

Moreover, it has to be stressed that the cost of the system (collection plus transport) is not paid for according to the amount of the waste collected, but to the general operational scheme (the number and frequency of collection rounds, the number of workers, vehicles, pick-up points, etc). It is therefore incorrect to express the cost of this service per unit mass, rather it should be expressed as cost per person. This permits a fair comparison of the competitiveness of different systems covering a different population (in terms of cost, quantity and quality of materials recycled).

## An overview of collection costs

In order to allow a comparison among different collection systems, our Research Group on Composting and Integrated Waste Management at Scuola Agraria del Parco di Monza led a survey on the costs of different collection systems in Italy.

The three systems might be described as follows:

- traditional source separation, based on the use of plastic bags or road containers (up to 3.3 m<sup>3</sup>) for mixed MSW and source separation through road containers only for dry recyclables (paper, glass, plastics). The food waste is not sorted and it's delivered along with the mixed waste; this holds pretty fermentable (actually, food waste gets concentrated in it due to the withdrawal of paper, board, glass, plastics) and has to be collected frequently.
- intensive source separation, including that of food waste, based on road containers (up to 3.3 m<sup>3</sup>) both for food waste and dry recyclables; collection of the residual waste through road containers. This is usually referred to as the 'double container' collection (beside that for residual waste, households find the one for food waste).
- intensive source separations, including that of food waste, with door-to-door (DfD) collection for food waste and residual waste. In general, also some high-yield dry recyclables are collected with a DfD system (usually paper and board, due to the much higher capture per person than with road containers).

Outcomes of the survey follow.

### Traditional collection systems

Table 6 reports on the costs of such a collection. The data shows that the total waste management costs (including disposal) fluctuate widely because of the different disposal fees charged in different regions. Therefore, in order to evaluate the competitiveness and draw reliable conclusions it is necessary to focus on collection and transport costs, disregarding disposal costs, at least until the National and European Regulations (e.g. the lately issued EC landfill Directive) will affect evenly the cost of disposal in different sites.

The results also indicate once again that data expressed in cost per unit mass (ITL/kg, with 1 Euro = some 2000 ITL) penalise municipalities with less waste production. The average collection and transport costs of the three municipalities with waste arisings below 350 kg.person-1year-1 is ITL 253/kg, while municipalities with more than 500 kg.person-1year-1 have costs of ITL 134/ kg. But in absolute terms, these must dispose of more waste; overall waste collection costs tends to be higher. The per capita cost collection + transport (without disposal) averages some ITL 66.000.

**Table 6: Municipalities with a 'traditional' source separation system only for dry recyclables**

Municipality/ District	Population	Average annual MSW production (kg/inh)	Collection + transport cost (ITL/inh. year)	Disposal cost (ITL/inh. year)	Total cost (ITL/inh. year)	Collection + transport cost (ITL/kg)	Total cost (ITL/kg)
VE 4 District (3 municipalities)	n.a.	408	62.157	46.286	108.443	152	266
TV Cons. Priula (3 municipalities)	36.575	412	45.064	54.203	99.267	109	241
VR province (38 municipalities)	n.a.	439	61.090	51.287	112.377	139	256
VR town	254.000	470	n.a.	n.a.	159.123	n.a.	339
Caravaggio (BG)	14.180	453	112.065	75.609	187.674	247	414
BG province (3 municipalities)	8.224	536	63.405	96.095	159.499	118	298
Cinisello B. (MI)	78.000	n.a.	59.751	n.a.	n.a.	n.a.	n.a.
Pescara	122.236	436	73.743	48.006	121.749	169	279
Cepagatti (PS)	7.870	478	65.082	51.970	117.052	136	245
Popoli (PS)	5.855	443	44.309	18.043	62.352	100	141
Vasto (CH)	5.000	409	45.000	n.a.	n.a.	110	n.a.
Cupello (CH)	3.500	275	63.000	n.a.	n.a.	229	n.a.
Macerata	41.936	407	63.338	40.101	103.439	156	254
Termoli (CB)	30.100	520	65.620	18.765	84.385	126	162
Campobasso	51.518	412	79.310	34.532	113.842	193	277
Alghero (SS)	40.477	508	104.726	54.352	159.078	206	313
Quartu (CA)	61.500	505	87.138	46.732	133.870	172	265
Guspini (CA)	13.400	349	45.522	20.896	66.418	130	190
Montagnareale (ME)	1.800	194	52.633	9.779	62.412	271	321
Librizzi (ME)	2.020	379	73.855	12.376	86.231	195	227
S. Piero Patti (ME)	3.664	396	62.901	15.881	78.782	159	199
AVERAGE		421	66.485	41.272	112.373	156	261

NOTE: the average of the sums (average total cost) doesn't match with the sum of average values (average collection and transport + average disposal cost), as they are slightly affected by data not available.

### Collection systems with source separation of food waste

As mentioned above, these systems can be grouped into two categories:

- door to door (DtD) - or "doorstep" - collection systems
- road collection systems

The study focused on mature experiences (run for at least two years), mainly concentrated in Northern Italy. Tables 7 and 8 summarise the costs of the service. As previously noted, what matters is the average cost for collection + transport per person; we have highlighted it in both tables with a bigger letter body.

The results also indicate that collection schemes based on the use of road containers (whether for mixed MSW or separate food waste) show a higher specific waste production than schemes where small waste bins and buckets are given to single households (DtD collection). Many other surveys are focusing now on this trend – mainly due to tipping of industrial waste inside road containers - that has been corroborated by many more numbers (Tornavacca, Favoino, 2000).

**Table 7: Systems with source separation of food waste by means of road containers**

Municipality/ District	Population	Average annual MSW production (kg/inh)	Collection + transport cost (ITL/inh. year)	Disposal cost (ITL/inh. year)	Total cost (ITL/inh. year)	Collection + transport cost (ITL/kg)	Total cost (ITL/kg)
VE 4 District (6 Municipalities)	n.a.	445	54.417	44.060	98.477	122	221
VR Province (7 Municipalities)	41.167	447	66.407	47.369	113.776	149	255
AVERAGE		446	60.367	45.714	106.126	135	238

**Table 8: Systems with DiD separation for food waste**

Municipality/ District	Population	Average annual MSW production (kg/inh)	Collection + transport cost (ITL/inh. year)	Disposal cost (ITL/inh. year)	Total cost (ITL/inh. year)	Collection + transport cost (ITL/kg)	Total cost (ITL/kg)
VE 4 District (4 Municipalities)	n.a.	321	53.733	31.558	85.291	167	266
VR Province (7 Municipalities)	63.697	310	61.389	25.013	86.402	198	279
PD 1 Bacin (26 Municipalities)	206.000	322	52.500	25.182	77.682	163	241
Province Bergamo (7 Municipalities)	20.013	n.a.	45.821	62.954	108.775	n.a.	n.a.
Calcio (BG)	4.765	393	31.266	61.032	92.298	80	235
Caravaggio (BG)	14.181	n.a.	38.079	n.a.	n.a.	n.a.	n.a.
Cinisello B.. (MI)	78.000	422	55.620	n.a.	n.a.	124	n.a.
Treviglio (MI)	25.294	457	n.a.	n.a.	158.310	n.a.	346
Cameri (NO)	9.567	382	n.a.	n.a.	83.521	n.a.	219
Castiglione (LO)	4.691	234	48.658	n.a.	n.a.	208	n.a.
Cupello (CH)	3.500	275	52.000	n.a.	n.a.	189	n.a.
AVERAGE		346	48.401	41.148	98.897	161	264

The traditional collection systems based on separation of dry recyclables by means of road containers (table 6) surprisingly shows a higher cost per inhabitant than systems with a source segregation of food waste; this is partly due to higher collection frequencies in Southern Italy (up to 6 times weekly) that affect average costs in table 6, as many case studies from Southern Italy are included, there. But the most surprising outlet is that the average collection and transport costs (per person per year) tends to be lower in schemes where source segregation of food waste uses doorsteps systems, than where road containers are used; this goes against what is generally expected, due to the much higher number of pick-up points in doorstep schemes.

### Cost comparison in homogeneous areas

One might think that lower costs of the DiD systems are due to the relatively small number of councils examined; and this could in turn be important in the evaluation of specific features related to weather conditions (e.g. more frequent collection or bin washing), type of dwelling etc.

Therefore, in order to get further evidence, costs of different collection systems run in the same area have been evaluated. Data from district "VE4", close to Venice (Figure 3), also show that source segregation of food waste with DtD schemes can be run with no substantial increase in overall cost, and sometimes costs are even lower than with traditional collection (no segregation of food waste) or with food waste segregation by means of road containers.

To understand the unexpected outcomes of the survey, we must underline that if source separation of food waste is added to, with no modification in the previous scheme for MSW collection, total costs are bound to rise; this actually happens with food waste segregation by means of road containers. But this does not happen when food collection is integrated into the overall collection scheme: namely, when DtD schemes are implemented.

The trick is that intensive DtD schemes for food waste yield high captures. This brings down the percentage of food waste in the residual waste, which can then be collected less frequently. Furthermore, food waste on its own needs no compaction – letting operators use cheaper collection vehicles.

### Tools to optimise costs

#### Collection frequency for residual waste

Obviously collection frequencies for residual waste can be cut only when an effective separation of foodstuffs, yielding high quantities is run. Under such a viewpoint we have to mention (See Table 9) that DtD schemes enable much higher performances. Some 170-250 grams per person per day have been reported for food waste. Large road containers yield much lower quantities; well, their capture is sometimes similar, but a high percentage of yard waste contributes, and actual capture of food waste is low.

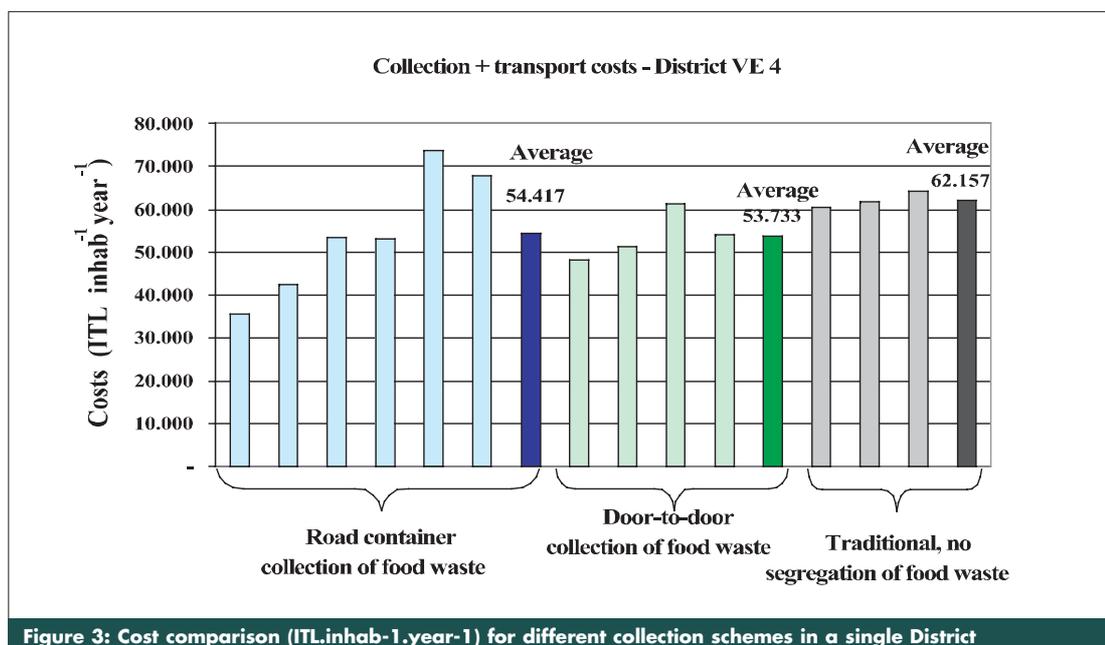


Figure 3: Cost comparison (ITL.inhab-1.year-1) for different collection schemes in a single District

**Table 9: Performances of different collection schemes for biowaste in Italy**

System	Overall yield (typical)	Yard waste %	Yield: food waste
Door-to-door	170-250 g.inhab <sup>-1</sup> day <sup>-1</sup>	0% (where delivery is banned) –10 % (maximum, due to low available volumes)	160-220 g.inhab <sup>-1</sup> day <sup>-1</sup>
Road containers	150-200 g.inhab <sup>-1</sup> day <sup>-1</sup>	40-70% (seasonal)	60-120 g.inhab <sup>-1</sup> day <sup>-1</sup>

Sources: Favoino, 1999; Provincia di Milano, 1998; Cocchi, 1997

We could assume that “collection using road containers results in a lower participation rate”.

Cutting down collection frequencies for residual waste constitutes in itself one of the most important tools to optimise schemes for source segregation of food waste. Its use is particularly effective in those areas where high collection frequencies are in place for traditional, mixed MSW collection (above all Southern Europe).

### Diversifying the fleet of collection vehicles

Where DtD schemes for food waste is in place using small bags, to be then delivered in bins (for high-rise buildings) and small buckets (for single families in houses with gardens), a material with a high bulk density (0.5-0.7 kg.litre<sup>-1</sup>) is targeted, which can be collected using non-compacting vehicles.

These are suitable only when schemes effectively prevent delivery of yard waste along with food waste. So it is advisable to limit the size of containers supplied to households where gardens are available (6-10 litres for a single family; up to 30 litres for groups of 3-4 families); bins (80-240 litres) have to be supplied only to high-rise buildings.

Households can manage yard waste through:

- home composting, promoted effectively by the municipality
- delivery to local recycling centres (Civic Amenity Sites, frequently named “Piattaforme Ecologiche” or “Ecocentri” in Italy, “Deixalleries” in Catalunya)
- DtD garden waste collection with low frequencies (e.g. 1-2 times per month, only in the growing season, in general April through October).

### An evaluation of mature and optimised schemes

We have to underline once more that with a cost assessment in cost per kg, the comparison would not be fair to evaluate the collection of food waste. This is because the quantity collected is obviously lower than that of residual waste (60-80 kg per person per year, versus 100-200 kg per person per year); but this latter (residual waste, also referred to as “restwaste”) gets collected at a much lower cost than with traditional mixed collection, thus the overall cost of the integrated sorting scheme is similar or lower.

An effective segregation of food waste allows an overall number of collection shifts (for different waste fractions) that tends to equal the previous schedule (for mixed collection). For example, one can collect food waste twice weekly and residual waste once per week in Northern Italy - where mixed MSW collection used to be run three times per week.

The following scheme shows typical collection frequencies for mixed MSW collection and for "integrated" collection systems that sort food waste in Italy. Frequencies applied in Southern Italy could perfectly work in many Spanish situations, as well, where mixed collection is traditionally run 6 times weekly.

Frequencies for the collection of:				
AREA	Mixed MSW	Food waste (both with DtD schemes and road containers)	Restwaste in DtD schemes (frequencies cut down, thanks to high capture of food waste)	Restwaste in road container schemes (no difference from previous mixed collection)
Northern Italy	3 times weekly	2 times weekly (sometimes once weekly during wintertime) <sup>&lt;</sup>	1-2 times weekly	3 times weekly
Southern Italy	6 times weekly	3-4 times weekly	2-3 times weekly	6 times weekly

Also schemes run in Spain (above all in the Catalan situation where the strategy is being fully developed and can thus well be said to be pretty "mature"), show same trends in the comparative assessment of doorstep schemes and schemes with road containers:

Frequencies for the collection of:				
AREA	Mixed MSW	Food waste (both with DtD schemes and road containers)	Restwaste in DtD schemes (frequencies cut down, thanks to high capture of food waste)	Restwaste in road container schemes (no difference from previous mixed collection)
Medium to big towns <sup>29</sup>	Daily	6-7 times weekly	No example to date	3 times weekly
Small towns <sup>30</sup>	3-4 times weekly (up to 6 times weekly)	3-4 times weekly (up to 6 times weekly)	1-2 times weekly <sup>31</sup>	3 to 6 times weekly

Furthermore we could say that some collection shifts – namely those aimed at collecting food waste - will have costs reduced through the use of tiny vehicles. In our surveys, we calculated and found out that a two-shift scheme for food waste collection using bulk lorries tends to equal the cost of a single-shift collection for residual waste with packer trucks.

Table 10: Costs of collection routes (ITL.inhab<sup>-1</sup>.year<sup>-1</sup>) for food waste and restwaste in Door-to-door schemes

Municipality (Province)	Population (inhabitants)	Cost for collection of food waste (once per week, with compactors)	Cost for collection of Restwaste (twice per week, with lorries)
Calcio (BG)	4.765	9.956	8.143
Caravaggio (BG)	14.181	10.578	11.635
Consorzio Cremasco (CR)	63.751	17.000	16.000
Sommacampagna e Sona (VR)	26.036	14.100	17.195

<sup>29</sup> Information from Cordoba and Barcelona was available

<sup>30</sup> Catalan schemes

<sup>31</sup> Tona, Tiana and Riudecanyes in Catalunya

This is due to two main reasons:

1. the lower cost of use of tiny lorries instead of packer trucks
2. the possibility to have a much faster specific loading time where food waste is not mixed up with yard waste, and therefore low-volume, hand-picked tiny buckets request a much faster time for each pick-up point. Mechanical loading will of course still be kept for trolley bins supplied to high-rise buildings and big producers, but there the longer specific loading time is meant to serve many families and/or high quantities at a single pick-up.

Cost evaluation is for instance confirmed, as we consider numbers reported for Consorzio Cremasco and some municipalities in Bergamo and Verona Provinces (table 10). Amazingly enough, the cost of twice weekly collection for food waste (using non-compacting vehicles) is comparable to a weekly collection of residual waste with compacting vehicles.

## Conclusions

According to the numbers shown, it is clear that the main mistake made when planning sorting schemes, is the added feature of the scheme. That means, a new collection scheme is run in addition to the previous mixed MSW collection, and cannot therefore yield savings to fund a new scheme. It is vital – on the contrary – that the new separate collection is integrated into the established waste management system, e.g. changing frequencies and volumes to collect residual waste.

In turn, we have to consider that collection frequencies of Restwaste can be cut only where a high capture of food waste reduces the fermentability of Restwaste. From such a standpoint, the use of comfortable tools such as door-to-door schemes and biodegradable bags have proven to be very effective. This is why an “intensive” collection, run through door-to-door schemes, notwithstanding a much higher number of pick-up points, has unexpectedly shown to be less expensive than collection of food waste through road containers, thanks to the integration of the system and much lower collection costs for restwaste.

Moreover, door-to-door collection of food waste allows Municipalities to perform much higher recycling rates (topping even 60% and more in Municipalities with around 10.000 inhabitants, 50% in Monza, 120.000 inhabitants) and a much better quality of collected food waste.

A further tool to optimise the scheme is the use of suitable vehicles to collect food waste, due to its high bulk density when yard waste is kept away from the collection scheme. One of main lessons to be learned from these astonishing outcomes is that “the more flexible and varied the fleet of collection trucks, the better it is”. This goes against some tendencies that we have unfortunately recorded across Europe (and in some Italian and Spanish Regions themselves), where huge expenditures have lately been done to buy only packer trucks for side-loading road containers. This is fighting against optimised schemes for high-yielding collection of food waste; the lack of flexibility doesn't allow optimisation at all.

In such respect, we also have to consider the troublesome situation regarding smaller municipalities with direct responsibility for MSW collection (a situation still much diffused in Mediterranean Districts), as they often own a single collection truck, that constitutes a problem when planning changes and “integration” of the system. Nevertheless, higher institutional levels (e.g. the Districts or Provinces), can help. They could, for instance, buy appropriate vehicles and lend, or lease them to single municipalities. Such a system is already being run in two provinces in Central Italy (Chieti and Pescara).

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# Success Stories on Composting and Separate Collection. Only a Question of Luck?

(Simon Aumonier Environmental Resources Management Oxford)

## Introduction

In 1999, the Directorate General for the Environment of the European Commission commissioned a study into success stories on composting and separate collection. The objectives of the study were to provide information to local authorities across Member States to assist in introducing cost-effective home composting and biodegradable waste-separation schemes. The dissemination of information from successful separation and home composting schemes will help other local authorities and municipalities meet the diversion targets for landfill.

This presentation is structured as follows. I will firstly describe some background to the project, including the drivers for composting and separate collection. I will then outline the structure and approach to the study and what key success factors have been identified. I will finish with conclusions on whether composting and separate collection really is just a 'question of luck'.

## Key Drivers for Composting and Separate Collection

The European Community waste strategy sets out the 'Waste Hierarchy' for waste management options. The top of the hierarchy, or the preferred waste management option, is the minimisation of waste at source. This is followed by material or waste reuse, recycling, energy recovery and finally waste disposal. In some European Countries, a substantial proportion of waste is landfilled and it is necessary to move up the hierarchy to more sustainable waste management practices.

The Landfill Directive was introduced in 1999. It has two broad aims: firstly, to ensure high standards for the disposal of waste in the European Union and secondly, to stimulate more sustainable waste management practices. It specifically includes provisions to reduce the volumes of biodegradable waste which is sent to landfill. Biodegradable waste which is landfilled causes environmental damage as it decomposes by releasing landfill gas, containing methane, and leachate.

A key driver for increasing composting is the avoided waste disposal costs which are incurred when waste is landfilled. Increasing public awareness of waste and recycling issues is resulting in an increase in public demand for more composting facilities and services. Public acceptability for composting schemes is high compared to other technologies such as incineration or landfilling of waste.

A key driver for separate collection is that clean feedstock material produces high quality compost products. Although the biodegradable fraction of waste can be extracted from mixed waste this is expensive and produces a lower quality feedstock material for the composting process.

## Constraints to Separate Collection

There are a number of issues which constrain the ability to collect biodegradable waste separately. The public need to be involved and need to be motivated to separate their waste in the home. Overcoming inertia is a constraint which needs to be overcome at the beginning of

any scheme and maintaining levels of public participation is fundamental to the success of any separate collection schemes. Other issues are outlined below.

*Waste Management Industry Failure.* The waste management industry needs to be ready to adapt to the new challenges and changes in their market place. The key role to be played by industry is the provision of facilities and services for local authorities and the community. Clearly, there is no point separately collecting biodegradable waste if there are no composting or biodegradable waste treatment plants to accept it.

*Institutional Failure.* Local authorities may need to innovate or change practices which have existed in a local community for many years. They need the support of national government and clear and practicable strategies to move forward waste management thinking.

*Lack of Infrastructure.* Separate collection of biodegradable waste may require investment in new vehicles or modification to refuse collection vehicles. New collection receptacles also may be required. Facilities for the treatment of biodegradable waste need to be planned to ensure their size and location are suitable for the incoming waste materials.

*Perceived Costs.* Establishing a new system for treating biodegradable waste is likely to require capital outlay at the beginning. There are inherent risks in changing waste management services and the costs may appear prohibitive, but it is important that the long-term view is taken. Costs of alternative scenarios, including the 'business as usual' scenario, need to be compared.

*Low Participation Rates & Public Awareness.* The public play an extremely important role, and their participation, or lack of participation, can be a constraint in ensuring the success of any scheme. If the public are not educated and informed of the benefits and reasons for the scheme, a scheme can fail. Engaging the public throughout the process and maintain awareness of the service will help ensure a successful scheme.

### **Member States Covered**

The study covered a range of initiatives found throughout the Member States and is reported in the form of case studies. The case studies are taken from countries which have relied predominantly on landfill as a waste management option.

The study has identified a number of successful centralised and home composting initiatives in six Member States: France, Ireland, Italy, Portugal, Spain and the UK. A search for successful schemes in Greece was also carried out although this work had limited success.

### **Type of Scheme**

The initiatives highlighted in the study cover a range of different scenarios, yet each has been successful in increasing the volumes of biodegradable waste which is composted in their area.

*Home composting* is demonstrated successfully by Arun District Council in the UK.

Separate Collection and Centralised Composting is carried out by a large number of local authorities across all six member states.

Central Collection, Shredding and Composting requires members of the public to take their separately collected biodegradable waste to a central collection point. In Cork, Ireland, the

local authority runs a mobile shredder service which allows residents to drop off their garden waste for shredding.

The success of a scheme is not dependant on the number of participants. The case studies highlight a range of initiatives which have from 2000 to 200 000 inhabitants. Likewise, the volumes of waste collected in the schemes range from 250 tonnes by the small Wyecycle scheme in the UK, to 36 000 tonnes by the Gironde scheme in France. As a result, the volumes of composted product varies from 70 tonnes to 24 000 tonnes per year.

### **Success Criteria**

In establishing any new composting or source separation schemes the following criteria do need to be met.

Reliable waste management route - Is there a reliable route for the waste once it is separately collected? Is the facility suitable for dealing with the type and volumes of waste. For home composting schemes this is not an issue, as the householders themselves provide the waste management route.

Diversion of Wastes from Disposal Routes - There will be a reduction of waste which requires disposal and, as a result, collection and disposal costs will be reduced. In the planning stages, it is important to consider the impact on the general refuse collection services.

Affordable Management Costs - Whilst capital and operational costs associated with setting up and running the scheme cannot be avoided, opportunities to minimise costs should be pursued wherever possible. For example, many composting schemes share collection vehicles (and associated costs) with schemes to collect dry recyclables.

Participation Rates - In all of the case studies, the overriding factor of importance for a successful scheme is good publicity and information which maximises acceptance and ensures high participation rates. Composting schemes tend to be popular with the local population, creating jobs and a 'feel good' factor. Publicity campaigns can emphasise these key points.

Plans for Continuation or Expansion - In planning a new initiative to separately collect biodegradable waste from householders, it may be appropriate to begin at a small or pilot scale with a small number of residents. However, plans for expansion need to be in place in terms of additional properties, additional waste and additional compost product.

Product Use or End Market - Ensuring the composted waste material can be sold or supplied as a viable new soil conditioner or compost product is vital to the success of a scheme. Standards for compost material derived from waste are being developed in some countries and in the European Commission's biowaste paper. It may not be necessary to meet a standard if a local outlet can be found for the material.

### **Common Themes Behind Success (1)**

The case studies have highlighted some common themes for successful composting initiatives.

Publicity and Information. The general public need to be involved from an early stage to help maximise acceptance and increase participation rates. The message must be clear and consistent, and, where possible, provided continuously. Using a range of media channels has shown to increase awareness - this includes TV, radio, newspapers and leaflets. Many schemes have been running for a number of years and commitment is shown to grow over time: clearly patience is important. Clean source-segregated material will result in a clean feedstock which is more readily marketable. The general public need to understand the positive impacts such as jobs, reduced waste pollution, reduced costs etc. The use of local champions and local community events have helped spread the message.

### **Publicity Material from Padova**

In the region of Bacino Padova in Northern Italy, the municipalities formed a consortium which deals both with waste and waste water management. The consortium runs a door-to-door collection scheme for biodegradable waste. It is a very convenient service for local residents. Householders now receive a bimonthly publication - Pollution. It contains information on performance of the scheme and new projects which are being developed. It also encourages two-way communication by requesting feedback from residents.

### **Common Themes Behind Success (2)**

Successful schemes can also combine the collection of biodegradable waste with other recyclables. In the Montejurra scheme in Spain, the scheme combines the kerbside collection of biodegradable waste and two different containers for the collection of plastics, paper and metal packaging. The scheme was one of the first schemes in Spain. It started in 1986 with the composting plant coming on stream in 1993.

Flexibility and convenience will help a scheme succeed. In the Gironde scheme in France, householders can voluntarily deliver their garden and green wastes to public areas or can have their waste collected directly from their household on a weekly basis.

Composting is a robust, viable and flexible management technique for biodegradable wastes. All schemes target the biodegradable waste fractions of household waste, which can include kitchen waste, such as vegetable and fruit peelings, and garden waste, such as grass and plant clippings. Some schemes also allow card and newspapers.

### **Common Themes Behind Success (3)**

Established end markets will help schemes succeed. Sales of the end product can provide revenue to assist in funding the scheme. Obtaining a recognised standard for the product, while not necessary, can increase customer confidence in the compost. In Italy, the compost produced in the case studies all comply with the Italian law on fertilisers and in the Padova scheme farmers were also encouraged by offering free samples of the product.

The Cork Shredder Scheme in Ireland is successful partly due to the fact that public demand for the service is high and other schemes have been able to sell compost back to the residents.

Commission. However, many of the schemes highlighted have realised substantial cost savings through avoided disposal costs and taxes.

### **Conclusions**

In conclusion, the case studies showed that Success in Separate Collection and Composting was not only a question of luck, but was dependant on the influence of a number of important, and manageable, factors, as follows:

**Infrastructure and Convenience.** The whole chain from waste producer to composting plant needs to be easy and convenient.

**Product Quality.** Ensuring the compost is of a high standard requires good quality feedstock, but will help sell the product at the end of the treatment process.

**Waste Management and Planning Context.** Successful schemes require detailed planning and design, incorporating local market conditions and specifications. The separate collection and composting scheme needs to complement the other waste management services offered in the municipality.

**Avoided Costs and Revenues.** The costs and revenues need to be balanced and it needs to be recognised that 'up front' costs can be balanced with long term revenues and cost savings from avoided disposal.

However, above all, public education and awareness raising is critical. Public participation needs to be fostered through clear, consistent and sustained communication.

### **The Report**

A full copy of the report including all the case studies can be obtained from the European Commission.

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## Compost quality and market perspectives - the case of Portugal

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### Summary

Only 11% of arable land in mainland Portugal is well provided with organic matter (OM), while around 87% is at risk of erosion. This situation is a result of unsound farming practices and climatic and topographical conditions.

Using analyses of the soil from six of mainland Portugal's seven agricultural regions and statistical data from 1997 it is possible to estimate the amount of dry organic matter needed to increase the OM content of arable land in classes "Very low" and "Low" to levels which would put them in the "Medium" class. It has been calculated that around 116 million tonnes of dry organic matter would be required.

In order to combat this depletion sound cultivation practices need to be introduced, as well as incentives for the recovery of organic waste which could be used to enhance soil quality, such as animal waste (livestock excreta), the organic fraction of municipal solid waste and sewage sludge from urban waste water treatment plants. We have estimated the amount of organic matter these types of waste could provide.

In Portugal, composting plants have, generally speaking, been marketing everything they produce, even though the quality of some compost is poor. However, it is expected that in the near future competition will increase and the quality of the products will improve.

A proposal for a standard has been drawn up relating to the use of compost in agriculture which defines classes of quality and lays down certain restrictions.

### The importance of stabilised organic matter or humus in the soil-plant system

The current state of knowledge leaves us in no doubt that organic matter (OM) improves the soil characteristics and plant growing (Allison, 1973; Russel, 1961; Soltner, 1986; Stevenson, 1982; Mustin, 1987; Wallace and Terry, 1998).

The benefits basically derive from the stabilised fraction of OM in the soil - humic compounds - the structure and characteristics of which can explain some of their effects on soil properties and plant growth, namely:

- The fact that the aromatic nuclei of humic and fulvic acids do not bond linearly - thus giving rise to structures which are more or less compact and homogeneous but which constitute relatively big, approximately spherical basic units (Allison, 1973; Dudas and Pawlick, 1970; Schnitzer and Kodama, 1975; Senesi and Loffredo, 1998) - makes humus porous (enabling it to absorb and retain water).
- The contribution of humic compounds to the formation of aggregates is due to their colloidal properties and, more specifically, the action of the salts they constitute with soil cations, which, when they precipitate, form stable aggregates with the mineral particles of the soil (Allison, 1973; Kononova, 1966).
- Their very high specific surface (between 600 and 800 m<sup>2</sup> g<sup>-1</sup>), much higher than that of montmorillonite (175 m<sup>2</sup> g<sup>-1</sup>), makes them extraordinarily reactive, so they promote most of the reactions that occur at the solid-liquid interface (Sequi, 1983).
- The presence of many functional groups, such as COOH and OH, on the side chains of humic compounds gives them the following properties: i) high cation exchange capacity (higher than that of type 2:1 clays) which enables them to adsorb some mono and bivalent cation nutrients, such as Ca<sup>2+</sup>, Mg<sup>2+</sup>, K<sup>+</sup> and NH<sup>4+</sup>, keeping them available for plants; ii) the ability to form chelates with polyvalent metals such as iron, zinc, copper and manganese, preventing precipitation or occlusion of these nutrients (Kononova, 1966;

Schnitzer and Skinner, 1963); iii) the ability to bond, across cation bridges, such as calcium and iron, with clays (Stevenson and Ardakani, 1972; Tisdall and Oades, 1982), forming clay-humic complexes.

- Their ability to form phospho-humic complexes minimises the retrogradation of phosphorous (Mustin, 1987).
- They are rich in polyphenols, which act as reducing agents, and this may explain their effect on the mobilisation of iron, reducing it from Fe (III) to Fe (II).
- The capacity of humic colloids to retain, like clays, hydrogen ions, aluminium ions and other cations, enable it to act as a buffer, protecting the soil from sudden variations in pH, caused by the uncontrolled application of fertilisers and phytosanitary products.
- The dark colour, due in particular to quinone-nitrogen compound bonds on the aliphatic chains, helps the soil absorb and retain heat (Stevenson, 1982; Soltner, 1986).
- Because they are rich in energy and mineral nutrients, they support a diverse and beneficial microbial population, which improves the physical and chemical characteristics of the soil, helps plants absorb nutrients and can even protect them from some diseases caused by pathogenic microorganisms and parasites whose vegetative cycle takes place in the soil (Hoitink et al., 1996; Mustin, 1987).
- With regard to the effect of organic matter on plant physiology, the humic and fulvic fraction affects the permeability of the cellular membranes, the active transport of ions and mineral nutrition as well as activity relating to protein synthesis, (Benedetti et al., 1996); it also promotes the production of plant enzymes and regulates osmotic pressure, thereby increasing resistance to drought (Kononova, 1966).

Once any farming system/soil combination tends to reach a certain balance with regard to humus content, it is not possible to establish universal optimum (or critical) levels for this important component of the soil (Johnston, 1993). However, the relevant literature contains references to desirable levels, depending on the characteristics of the soil, especially texture, clay content and percentage of carbonates.

In Portugal, the Instituto Nacional de Investigação Agrária/Laboratório Químico Agrícola Rebelo da Silva (INIA/LQARS) has defined five classes of OM content for two different soil types (Dias et al., 1980): Very Low (VL), Low (L), Medium (M), High (H) and Very High (VH), as follows:

Class	Coarse textured soil	Medium and fine textured soil
VL	OM ≤ 0.5%	OM ≤ 1.0%
L	0.6% ≤ OM ≤ 1.5%	1.1% ≤ OM ≤ 2.0%
M	1.6% ≤ OM ≤ 5.0%	2.1% ≤ OM ≤ 7.0%
H	5.1% ≤ OM ≤ 7.0%	7.1% ≤ OM ≤ 10.0%
VH	OM ≥ 7.1%	OM ≥ 10.1%

### The organic matter content of soil on mainland Portugal

The organic fraction of decomposing waste (especially in the soil) behaves differently depending on the characteristics of the organic compounds it is made up of. In animal and vegetable waste with a low carbon/nitrogen ratio (such as "green manure"), the organic matter is mineralised in a short time, contributing little to humus production; in waste which does not easily biodegrade (with a high ligno-cellulose content) the organic matter decomposes more slowly, adding a large amount of stabilised material to the humus in the soil. This, in turn, is very slowly mineralised, the mineralisation coefficient (k<sub>2</sub>) depending on several factors, in particular temperature, humidity and aeration of the soil.

In Portugal, especially in the south, climatic conditions favour high humus mineralisation coefficients. The Mediterranean climate, with hot summers and mild winters, enables the microorganisms responsible for mineralisation to carry out their activity with a high level of production the whole year round, provided there is enough moisture in the soil. The mineralisation coefficients might, often, be over 2%, especially in irrigated areas and areas where there are greenhouses or other types of shelter.

Climatic and/or topographical conditions combine with farming practices to deplete the OM content of the great majority of Portuguese soils. Such practices include the failure to systematically incorporate organic soil improvers into the soil, the practice of monoculture instead of crop rotation which puts organic matter back into the soil, the reduction of wooded areas, the extension of irrigated areas, deeper ploughing, increased use of mineral fertilisers, etc.

These factors have contributed to the current situation: only 11% of Portuguese soil has an optimum OM content, while 87% is at risk (high or intermediate) of erosion, and, also, to the reduced soil formation rate (between 0.3 and 1.5 mm per year<sup>1</sup>) (DGA, 1994). The risk of erosion is generally higher in the south and in the interior of the country.

The impoverishment of Portuguese soils is underlined by studies carried out using the results of soil testing for fertiliser recommendation purposes. We refer to those carried out by Dias et al. (1989), Leandro et al. (1989) and Gonçalves et al. (1995 n.p.). The first study summarised the general state of fertility of arable land in the agricultural regions of Beira Litoral, Beira Interior, Lisboa e Vale do Tejo and Alentejo. The second and third studies looked at the soil of Entre Douro e Minho and the Algarve. The results for the organic matter parameter are summarised in table 1. The classes of OM content were defined using the INIA/LQARS criteria, set out above.

**Table 1: Percentage distribution by class of OM content of soil in six agricultural regions.**

AGRICULTURAL REGION	Number of samples	Class				
		VL	L	M	H	VH
Entre Douro e Minho*	29 245	0.8	2.9	59.0	36.8	0.5
Beira Litoral**	36 365	4.1	20.2	63.0	12.1	0.6
Beira Interior**	13 773	11.1	39.8	41.3	7.4	0.4
Lisboa e Vale do Tejo**	44 189	27.4	50.9	20.8	0.8	0.1
Alentejo**	24 988	24.1	53.8	21.3	0.7	0.1
Algarve***	4 379	26.8	44.5	28.7	0.0	0.0

VL: Very low; L: Low; M: Medium; H: High; VH: Very high.

Sources: \* Leandro et al. (1989); \*\* Dias et al. (1989); \*\*\* Gonçalves et al. (1995, n.p.).

The table shows that the OM content of 24.5% of arable land in the Beira Litoral is below critical levels (classes VL and L) and the same is true for 50.9%, 78.3%, 77.9% and 71.3% of the soil in the Beira Interior, Ribatejo e Oeste, Alentejo and Algarve respectively.

The level of depletion of the OM content of arable land is significant in the Beira Litoral, worrying in the Beira Interior and it reaches alarming proportions in the southern half of the country, where the Mediterranean climate has a more marked influence.

### Estimating the OM requirements of soil in mainland Portugal

Using the results obtained from the studies we have been interpreting, available statistical data on the occupation of the soil in the agricultural regions concerned (INE, 1998) and several presuppositions (which are of course debatable), it is possible to estimate the amount of organic matter needed to correct the soil in the regions concerned. Clearly, in principle, the larger the area considered, the more the results will diverge from the true values: an estimate

for a region with a uniform climate, soil characteristics and agricultural history - knowledge of the latter is important for calculating the humification coefficient (K1) representing waste returned to the soil by crops - will correspond more closely to real needs than an estimate for a large area encompassing different climatic conditions, land cover and soil types, with a varied agricultural history. However, if we assign average values to the variables which come into play, we can at least estimate approximately how much organic matter needs to be applied to arable land on mainland Portugal.

We are not including the region of Trás-os-Montes and Alto Douro, since the data available (Martins e Coutinho, 1988) does not allow us to perform the type of calculation used for the other agricultural regions. However, it should be noted that this region, with a utilised agricultural area of 462 230 ha (INE 1998), has a significant percentage of soils with a low and very low OM content, and is also an area with a high risk of erosion.

The estimate covers the area comprising the regions of Entre-Douro-e-Minho, Beira Litoral, Beira Interior, Lisboa e Vale do Tejo, Alentejo and the Algarve (figure 1). The details are as follows:

#### Area considered

We consider, as the basis for our calculation, the utilised agricultural area (UAA), that is the crop covered area, in each agricultural region, in accordance with the publication "Inquérito às Explorações Agrícolas do Continente" [Survey of agricultural holdings in mainland Portugal] (INE, 1998).

#### Areas with class VL and L soils in each agricultural region

The areas with class VL and L soils are estimated by multiplying the UAA of each agricultural region by the percentage distribution of OM content for those classes of soil (see table 1). For example, in the Entre-Douro-e-Minho region, the area occupied by class VL and L soil is as follows:

- Class VL soil:  $243\,451 \times 0.8\% \approx 1\,950$  ha
- Class L soil:  $243\,451 \times 2.9\% \approx 7\,060$  ha

#### Average OM values in classes VL and L and values to be attained (assigned for the purposes of the calculation)

As stated above, the INIA/LQARS has established OM content classes and their limits for different types of soil: for coarse textured soil, classes VL, L and M correspond to soil with an OM content lower than 0.5%, between 0.6 and 1.5% and between 1.6 and 5%, respectively; for medium and fine textured soil, classes VL, L and M correspond to soil with an OM content lower than 1.0%, from 1.1 to 2.0% and from 2.1 to 7.0%, respectively. Since we do not know the percentage of the two different soil types for each agricultural region, we choose, for calculation purposes, to use the following average values for OM content: 0.3% (class VL) for coarse soils and 0.6% (class VL) for medium and fine soils; 1.0% (class B) for coarse soils and 1.5% (class B) for medium and fine soils. Generalising, for both soil types, this gives an average value of 0.45%  $[(0.3 + 0.6)/2]$  for class VL soils and 1.25%  $[(1.0 + 1.5)/2]$  for class L soils. Similarly, the minimum value for class M (which we aim to achieve) is:

$[2.1$  (lower limit for class M for medium and fine soils)  $+ 1.6$  (lower limit for class M for coarse soils) $]/2 = 1.85\%$ .

#### Depth of the arable layer

Let us suppose that the arable layer of the soil is 20 cm deep.

### Bulk density

Since we do not have detailed knowledge of the characteristics of the soils concerned and considering that the great majority are poor in organic matter, we opt for an average apparent density of 1.3.

### Humification coefficient ( $K_1$ ) of the organic matter applied

Let us suppose that the humification coefficient of the organic matter applied is 40%.

From the variables given it is possible to estimate, grosso modo, the amount of organic matter that would have to be added to raise the OM content of the soil in each agricultural region to 1.85%.

To do this, we calculate as follows:

#### 1) Dry OM requirement per ha

- Class VL soils

$$\text{OM: } \frac{10000 \text{ m}^2 \times 1.3 \times 0.2 \text{ m} \times (1.85\% - 0.45\%)}{40\%} = 91 \text{ t}$$

- Class L soils

$$\text{OM: } \frac{10000 \text{ m}^2 \times 1.3 \times 0.2 \text{ m} \times (1.85\% - 1.25\%)}{40\%} = 39 \text{ t}$$

#### 2) Amount of OM (dry material) needed to raise the OM content of the soil in the agricultural regions concerned to 1.85%:

E.g. for the soil in the Entre-Douro-e-Minho region:

- Class VL soils:  
243 451 (UAA)  $\times$  0.8%  $\times$  91 t  $\approx$  177 232 t
- Class L soils:  
243 451  $\times$  2.9%  $\times$  39 t  $\approx$  275 343 t
- Total: 452 575 t

For the Beira Litoral: 2 088 425 t; Beira Interior: 11 147 337 t; Lisboa e Vale do Tejo: 22 142 913 t; Alentejo: 75 413 590 t and Algarve: 5 332 501 t.

In view of the above, we can conclude that, theoretically, approximately 116 million tonnes of dry organic matter are needed to correct the soil in the six agricultural regions.

This is an enormous amount, so it would have to be added to the soil over a period of many years. We also have to consider the humus mineralisation coefficient ( $K_2$ ) which, for the regions concerned, should be around 2% per year, which corresponds to a soil OM loss of about 2.3 million tonnes/year. This coefficient was not taken into account in the estimate because the return of organic waste to the soil by crops was not considered either. However, it is important to mention that the amounts of humus lost through mineralisation were greater than those produced by the return of OM to the soil by crops and this is proved by the fact that the humus content of the soil continues to decrease.

In order to counteract the depletion of organic matter in the soil, in addition to alternative growing practices which could help, we should promote the use of organic waste whose characteristics allow it to be used as corrective material, such as municipal solid waste (MSW,

sewage sludge, livestock waste and agro-industrial waste. MSW could, in the next few years, provide around 600-800 thousand tonnes of organic matter per year, if the entire organic fraction were recovered, and sewage sludge could provide up to 100 thousand tonnes per year, if the entire mainland population were served by waste water disposal systems and treatment plants. We have also estimated that in 1999 the amount of organic matter contained in livestock waste (cattle, pigs, sheep and poultry) on mainland Portugal is around 3 million tonnes. Up to now, it has not been possible to estimate the quantities of other types of organic waste which could be biologically treated for agricultural use. However, the incorporation into the soil of the above mentioned waste (properly treated) could at least compensate for the OM loss resulting from the annual mineralisation of the above estimated amount of OM to be added to correct the soils from the crop covered area of Portugal.

### Potential agricultural market and quality of compost

Given, as shown above, the depletion of the OM content of most arable land in mainland Portugal and farmers' awareness of the benefits, for the soil and crop production, of organic soil improvers use, composting plants in Portugal have, generally speaking, been marketing everything they produce, although many of the composts sold (mostly deriving from solid municipal waste or the co-composting of sewage sludge and agro-industrial waste) are of poor quality. However, soon it will probably become more difficult to market poor quality compost because:

- (i) farmers are becoming increasingly aware of environmental protection and public health;
- (ii) there will be increased competition between composts and several kinds of non-composted soil improvers which are not regulated in Portugal;
- (iii) the supply will increase, since one of the priority aims of the Instituto dos Resíduos for 2006 is to promote the use of biologically treated organic waste (Gonçalves, 1999; INR, 2000).

With regard to MSW compost, annual production is currently around 65 000 - 70 000 tonnes (table 2) but is very likely to rise by 150% in the near future, for the reason given in (iii) above. In order that composts may be used in agriculture without harming the soil, plants, humans,

**Table 2: MSW biological treatment plants in operation or scheduled to start operating in the near future**

Treatment plant	Location	Type of biological treatment (system)	Compost production (t/ha)	Situation
LIPOR**	Ermesinde	Composting (Windrow)	19 000	In operation
AMTRES	Trajouce	Composting (Agitated bed / Koch)	12 000	In operation
C.M. Setúbal - Koch	Setúbal	Composting (Agitated bed / Koch)	5 000	In operation
AMAVE	Riba de Ave	Dano type + windrow	29 000	In operation
A. M. Cova da Beira	Fundão	Composting (Agitated bed / Siloda)	15 000 (scheduled)	Will start in 2001
VALORSUL*	Amadora	Anaerobic digestion followed by composting	15 000 (scheduled)	Tender selection
LIPOR*	Ermesinde	Composting	24 000 (scheduled)	Tender selection

\*Will process organic waste from selective collection.

\*\* Will close as soon as the new plant begins to operate.

animals or the environment in general, the INIA/LQARS has prepared a proposal for a standard establishing specifications for compost, defining classes of quality and laying down restrictions on its use.

In preparing the proposal, we took account of the present situation, in particular the fact that the percentage of MSW waste selectively collected is still very low, and that in the near future only good quality compost should be allowed on the market. We begin with specifications imposing a minimum permissible level of quality. After 8 years, stricter requirements are introduced for certain parameters so that only compost of appropriate quality can be used for the intended purpose. This eight-year period will give producers time to improve the quality of their composts. The document will be presented for examination by the parties concerned (composting plants, State laboratories, universities, the Ministries of Agriculture and the Environment) and some amendments may be made.

Contamination of the soil by heavy metals in compost is the most controversial item and the relevant specifications, quality classes and restrictions on compost use are set out below (tables 3, 4 and 5):

**Table 3: Maximum permissible values for normalised total heavy metal content (dry matter basis) in compost.\***

ELEMENT	CLASS I	CLASS II
CADMIUM (MG/KG)	1,5	5
LEAD (MG/KG)	150	400
COPPER (MG/KG)	200	500
CHROMIUM (MG/KG)	150	300
MERCURY (MG/KG)	1,5	5
NICKEL (MG/KG)	50	200
ZINC (MG/KG)	500	1500

\* standardised to a basis of 40% organic matter.

note: until 31 december 2008 the marketing of both classes of compost will be permitted; from 1 january 2009 only the marketing of class i composts will be permitted for crops intended for human and animal consumption. this standard may be amended in the future to include new quality classes (high quality), and the laying down of maximum permissible levels of organic micropollutants.

**Table 4: Maximum permissible values for total heavy metal content in soils to which compost will be applied.**

ELEMENT	Maximum permissible values (mg/kg)		
	5 ≤ pH < 6	6 ≤ pH < 7	pH ≥ 7
cadmium	0.5	1	1.5
lead	70	70	100
copper	20	50	100
chromium	30	60	100
mercury	0.1	0.5	1
nickel	15	50	70
zinc	60	150	200

note: compost may only be applied to soils with a pH < 5 if authorisation is obtained from the competent authorities.



Figura 1: Regiões agrícolas de Portugal continental

**Table 5: Maximum quantities of heavy metals which may be applied to the soil per year**

ELEMENT	MAXIMUM QUANTITIES (G/HA/YEAR)	
	UNTIL 31/12/2008	FROM 1/1/2009
CADMIUM	50	25
LEAD	5000	2250
COPPER	5000	3000
CHROMIUM	5000	3000
MERCURY	50	25
NICKEL	1500	900
ZINC	15000	7500

\*Some stakeholders' representatives have suggested deleting this table and specifying a maximum annual application rate of 10 t/ha for class B compost and 25 t/ha for class A compost.

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# From Waste to a Valuable Product - Quality Assurance Schemes for Compost Production

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## Abstract

Investigations in Europe indicate that quality and marketing of the end product are the most crucial composting issues. Both producers and users are of the opinion that sustainable recycling of organic wastes demands clear regulations with regard to what is suitable to be recycled and how it should be managed and controlled. Around 15% of the estimated total recoverable potential of 60 million Mg of organic waste is presently treated biologically in Europe. The re-use has to meet environmental and market requirements. Therefore, the trend in Europe goes definitely towards source separation of the organic residues from gardens and households. Quality requirements for composts regarding heavy metals, organic pollutants and hygiene allow no other alternative. There is no longer a market for mixed-waste compost. The introduction of source separation and composting must go hand in hand with the introduction of a quality assurance system for compost plants. Assuring compost quality entails more than just fulfilling a number of heavy metal limits. Levels and ranges of the quality criteria for compost differ very much in Europe. In most countries, independent monitoring of sampling and analysis takes place or is in preparation. A quality label or certificate will be given to compost, which meets the monitored quality criteria.

Keywords: Compost application, European compost production, quality assurance, quality criteria, source separation, waste policy

## Introduction

Recent years have seen a phenomenal increase in the biological waste treatment in Europe. Looking ahead, we must assume that at least 32% of urban waste and a large proportion of industrial waste - approximately 40% of the total waste production in Europe - could be biologically treated via composting and anaerobic digestion. The final products from the treatment are usually used as soil improvers or as fertilisers. They have to meet environmental and market requirements which will lead to an improvement of the compost quality produced in Europe in the future.

## Waste quantities and source separation in the EU member states

The collected and treated amounts of organic material differ much in the EU countries. Around 34 percent representing 17 million Mg (table 1) of the estimated total recoverable potential of the 50 million tons bio- and green waste is presently separately collected. This results in a compost production of around 9 million Mg in Europe.

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

Country	Sep. collected + treated organic waste [in Mio Mg]		Recovery potential of organic waste [in Mio Mg]		Theoretical potential <sup>1)</sup> Total [in Mio Mg]
	Biowaste	Greenwaste	Biowaste	Greenwaste	
A (1996)	0,88 +0,58 industrial organics	0,85	1,22	1,02	2,24 in 2000
B (1998) Flanders	0,33	0,39			1,3
A potential of 0,9 Mio Mg can be collected and composted in reality					
B (1994) Wallonia	0,12				0,16 in 2002
D (1998)	7,0				9
A potential of 8 Mio Mg can be collected and composted in reality					
DK (1997)	0,028	0,49	0,05	0,55	0,6 in 2004
F (1998)	0,08	0,76	5,25	3,5	8,75
Fi (1998)	0,1				0,6
GR (1995)					1,8
I (1999)	1,5				9
IRE (1998)					0,44
Lux (1998)	0,03				0,06
NL (1996)	1,5	0,8	2,5	1	3,5
P (1995)		0,01			1,3
ES (1998)	0,06 (Catal.)				6,6
S (1997)	0,13	0,15	0,98	0,53	1,5
UK (1998)	0,039	0,86			3,2 in 2006
Sum	12,4	4,3			50
Treated Bio- + Greenwaste 16,7 Mio. Mg			Theoretical recovery potential 50 Mio. Mg		

<sup>1)</sup>In most of the European countries no statistical data about the home composting are available, so an estimation of the full extent of the potential of organic waste is very difficult.

The composting of mixed municipal solid waste (MSW) is no longer state of the art and becomes more and more unusual and can be seen only in the few countries in southern Europe. In these countries, however, a change in the waste management also begins because it is obvious that in future there will be no market for composts with bad qualities - such as e.g. mixed municipal solid waste composts. Compost products based on source separated organic waste show only 10 to 20 percent of the heavy metal contents compared to MSW compost and can reach the same quality level as the one produced in private gardens. This suits the requirements especially to those of professional compost users.

### Waste policy in Europe

Concerning their organic waste activities Europe can be divided into 4 categories (Figure 1). In Austria, Belgium (Flanders), Germany, Switzerland, Luxembourg, Netherlands, Sweden, Italy the policy is nearly countrywide implemented. These countries of the first category recover more than 80 percent of the, at present, separately collected and treated (mostly by composting) organic waste fraction in the EU. Digestion plays a minor part at the moment. Denmark, Spain (Catalonia) and Norway form the second category of the implementing states.

These countries have built up parts of the political, quality and organising framework for separate collection and composting. Finland, France and the United Kingdom form the third category. These countries have developed strategies and are at the starting point. In the fourth category we find countries where no effort on composting of source separated organic waste can be detected like parts of Spain, Greece, Ireland and Portugal. These countries still compost mixed urban wastes.



Figure 1: Development of source separation and composting in Europe

As a summary the policy in Europe shows an extensive trend and a fast development towards source separation of organic waste. In most countries home composting is part of this policy.

### Compost quality and quality assurance

Many investigations in Europe indicate that quality and marketing of the end product is the most crucial composting issue. Both producers and users are of the opinion that a sustainable recycling of organic wastes demands clear regulations regarding what is suitable to be recycled and how it should be managed and controlled. A well-founded quality assurance programme would definitely increase sustainable recycling of organic wastes.

Marketing analysis over recent years shows that all users of compost demand a standardised quality product that is supervised by independent organisations. A study in the south of Germany showed that 94% of the commercial users made this a precondition. In another German study among citizens of Cologne and Düsseldorf 80% of the participants would have

a more positive attitude towards compost and food grown on arable land with compost application, if they were sure that a quality control system for compost exists.

The introduction of separate collection and composting must therefore go hand in hand with the introduction of a quality assurance system. Assuring compost quality is more than just fulfilling a number of heavy metal limit values. It plays a central role and influences all stages of the treatment of organic residues:

- Separate collection

Quality assurance can be used to draw conclusions on the quality of the source separation and can introduce measures for improvement.

- Plant engineering

Errors in the plant engineering can be quickly identified via quality controls. In the hygienic sector quality assurance also serves to guarantee worker protection.

- Compost production

Only constant quality and product checks avoid errors in compost production.

- Marketing

Consumers want a standardised quality compost. Only a quality assurance system guarantees this. The quality sign as a symbol helps the marketing efforts.

- Public relations work

A good image for compost can be built up with assured quality and a quality label.

- Application

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

- Product range

Only by precisely knowing the constituents and their width of fluctuation several compost products can be developed.

- Politics/legislature

Through statistical evaluation of the test results the legislator is familiar with the present standard of compost and the possibilities of the composting plants and he can issue directives that are appropriate for the current practical situation of the compost quality.

- Certification

A quality assurance system is a pre-condition for certifying the composting plants to e.g. the EU-Standard EN ISO 9002.

The central role of quality assurance is seen in the countries with developed composting system like Austria, Germany, Denmark, the Netherlands and Belgium. These countries have established extensive quality management for the composting plants, in which around 400 composting plants take part at the moment. Several other countries like Sweden, Norway, Italy and France are at the stage of the conceptual design.

#### *Elements of quality assurance systems*

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

- Raw material
- Intake control
- Limits for harmful substances
- Quality criteria for the valuable constituents in the compost
- Composting production
- External control (product and/or production)

- In-house monitoring
- Quality label for the product
- Certificate for the plant and/or the product
- Declaration of the properties of compost
- Recommendations for use and application
- Training and qualification of the operator
- Management and operation of plants (plant assessment)
- Annual certificates

### *Quality of compost and quality management*

When considering the introduction of composting, the end product should merit equal or even more attention than the composting process and the composting technique. Quality assurance of compost plays therefore a central role. It links the end product to all the elements of the organic treatment and cycle and forms the first step to a comprehensive quality management of the composting plants.

**Table 2: Survey on compost quality efforts in various countries**

Country	Status of quality assurance/certification of compost
Austria	Fully established quality assurance system
Belgium	Fully established quality assurance system in the Flanders region, the Wallonia and the Brussels region will probably follow the Flanders example.
Denmark	Just started with quality assurance system for compost (Criteria, standardised product definition, analysing methods)
France	Proposal for quality criteria, research program for a quality management system
Germany	Fully established quality assurance system
Italy	Successful source separation system
Luxembourg	Some plants according to German Quality Assurance System
Netherlands	Fully established quality assurance and certification system
Spain	Proposal for "Bill on the Quality of Compost" in Catalonia
Sweden	Just started with quality assurance system for compost
UK	Proposal of quality standard by the Composting Association TCA
Finland	No official efforts until now
Greece	No official efforts until now
Ireland	No official efforts until now
Portugal	No official efforts until now
Other Countries	
Norway	Criteria and requirements for 3 quality classes
Switzerland	Product definition and analysing methods
USA	- Published analysing methods - Plans for product definitions for MSW compost
Canada	Final step of discussion of a quality assurance system for source separated organic waste
Australia	Proposal of quality criteria and analysing methods

*Status of Quality assurance in EU*

**Table 3: Status of quality assurance of European composting plants (1998)**

Country quality assurance 1)	Plants with quality sign or certificate	Plants with
Austria	ca. 18	2
Belgium (FL)	ca. 21	5
Germany	ca. 340	ca. 300
Netherlands	22	2

1The table includes plants that have applied for a quality sign/certificate but the process is not yet finished

*Type of control systems*

An essential difference between the European countries lies also in the amount in which the compost production is included into quality assurance. The RAL-quality sign of Germany has the philosophy to assess the quality of the end product. In the Netherlands and in Belgium there is an aspect of two different attitudes. Here the control of the end product is combined with a production control. In Belgium the period for application of a new compost plant for the quality sign is two years, whereas in the first year a continuous production monitoring is made. The second year of application follows only the control of the produced compost. The certification for the quality sign in the Netherlands describes a very large internal quality monitoring of the compost production with weekly tests of parameters from each compost charge. Similar tendencies can be observed in Austria where the quality sign demands a product/process diary with nearly a hundred positions.

**Table 4: Range of control systems**

Range of Control Systems for Composting Plants in Europe		
	Production control	Product control
Austria	Indirect	Austrian compost quality association KGVÖ
Belgium (FL)	Compost promotion organisation VLACO in the first year of production	Compost promotion organisation VLACO in the second year of production
Denmark	-	Plant Directorate
Germany	German compost quality assurance organisation on hygienic issues BGK	German compost quality assurance organisation BGK
Netherlands	Certification organisation KIWA	Certification organisation KIWA

*Quality criteria*

The quality criteria for compost vary in the European countries concerning the amount, the requirements and the limited values. Direct quality classes based on heavy metal limits exist only in Austria (class I and II such as the types "A" fresh and "B" matured compost) and in the Netherlands (Table 5). The Dutch requirements for the class "very good compost" are so high that they can only be reached in exceptional cases; thus the compost plant association is trying to obtain an alteration of the parameters. A quality standard with two steps in Belgium, with composts for arable land and for other areas, did not prove to be practicable, thus composts can be distinguished only on a raw material basis. Evidence has been made by diversified compost qualities based on heavy metal content that only the best will be asked for. The large quantity of good quality compost which is sufficient for various uses will fail to be used in most cases.

Quality classes based on raw material (Belgium/FI), on the properties or the ranges of utilisation (Germany) will more effectively meet the requirements of the compost market.

**Table 5: Classification of compost quality in Europe**

Country	Type of compost/quality class
Austria	Quality Class I and II, Type A (mulch) and B (matured) compost
Belgium/FI	Yard and Vegetable, Fruit and Garden VFG Compost
Denmark	Organic household waste compost with no classification up to now.
	No quality criteria for green/yard waste compost necessary.
Germany	Fresh and matured compost, mulch and potting soil compost
Netherlands	Compost and very good compost

### Heavy metal content

With the stipulation of the quality criteria various philosophies are to be observed. Here we have countries such as Austria or the Netherlands with relatively severe guidelines e.g. concerning heavy metals on the one hand and on the other hand relatively high deviations (40 to 50%) from the guide values which are allowed for the single case. These are confronted with the German guide values with relatively moderate values, but relatively little deviations of only 15%.

**Table 6: Heavy metal limits and allowed deviations (mg/kg dm)**

Country	Chrome	Nickel	Copper	Zinc	Cadmium	Mercury	Lead
Austria							
Class 1	70	42	70	210	0,7	0,7	70
+ 50 % <sup>1</sup>	105	63	105	315	1,05	1,05	105
Belgium							
Agri. Min.	70	20	90	300	1,5	1	120
Denmark							
Stat. Order No. 823	100	30	1000	4000	0,8 <sup>2</sup>	0,8	120 <sup>3</sup>
Germany							
RAL and Biowaste	100	50	100	400	1,5	1	150
Ordinance							
+ 25 %	125	75	125	500	1,875	1,25	187
Netherlands							
High quality	50	10	25	75	0,7	0,2	65
x 1,43	72	14	36	107	1,0	0,3	93

<sup>1</sup>Basis: 30% organic matter; To compare these values with others based on dry matter, they have to be reduced by 10%.

<sup>2</sup>0,4 mg/kg dm after the year 2000

<sup>3</sup>60 mg/kg dm in private gardens

The guide values have been proved in practice to be more efficient than the stipulation of absolute limited values resp. cut-off values. Compost plants have little influence on the input material so that a certain deviation of the quality criteria in the single case and after control should be allowed. Especially with very low limited values the compost plants are producing a compost quality which is ranging at the limit. After the composting is finished it can be analysed finally whether the compost end product fulfils the requirements or not. Only a possible deviation for the single case gives the compost plant a certain security for their production.

### Organic pollutants

At the moment only Denmark is worried about organic pollutants in compost and has fixed limits. The other countries have detected very low levels, so they don't analyse the contamination

(Netherlands, Belgium) or they do a kind of observation in suspicious cases (Austria) or on a voluntary basis (Germany).

#### Hygienic requirements

In Austria the composting process has to be controlled after the first running of the plant and after each essential change of the equipment. During the regular decomposition process the temperature in the composted material has to reach 64°C over 4 days. In Germany the selected decomposition process must lead to a sanitised, hygienically irreproachable product and assure the exclusion of germs. The compost plant must be able to prove the hygienic effectiveness which is normally done by a daily temperature recording. The temperature level has to show in open composting systems more than 55°C over two weeks or 65 °C over one week, in closed systems one week with more than 60°C is sufficient. With the new German Biowaste Ordinance (BioAbfV – Oct. 98) the epidemic and phytohygienic clearance of products from biological waste treatment are stated by a direct and an indirect process control together with end product tests (on salmonella).

No hygiene standards exist until now in Belgium. Denmark defines two standardised process types which should guarantee sanitation. Controlled composting has to show the over 55°C during more than two weeks, controlled deactivation takes place after one hour at 70°C. Because of the variations in the technology of the composting plants a new regulation for hygiene aspects was laid down in the Netherlands in 1998. The former standardised general process parameters (minimum 8 weeks composting, and from these 4 weeks intensive with aeration and re-stacking twice, 50 - 60°C temperature) which guarantee hygiene efficiency are replaced by an individual solution for every composting plant. The Dutch independent certification organisation KIWA strongly supervises the strict adherence to the therefore required process parameters.

In future an extension of the hygiene requirements in Europe can be expected. Thus the latest draft of the new German compost ordinance asks for a hygiene process test of the total compost plant every two years. Austria is likely to follow this example and plans according to a draft version of the new Austrian compost decree an additional hygiene control of compost bags at the point of sale.

#### Additional quality aspects

The fulfilment of the requirements for heavy metals, organic pollutants, hygiene requirements and further characteristics are the preconditions for the award of a certificate (Netherlands) or of a compost quality label (Austria, Belgium/FL, Germany, Sweden).

These additional quality criteria concern impurities (plastics, metals, glass, stones), organic matter, plant compatibility, degree of decomposition, salt and water content. The detailed declaration of the contents of the compost to be sold is of a great importance in all countries. Only with the exact knowledge of the characteristics compost can be used successfully.

#### **Actual compost qualities in Europe**

Table 7 shows the results of compost analysis executed in Austria, Belgium/FL, Denmark, Germany and the Netherlands. Not all results are fully comparable because of different analysing methods in the countries.

Table 7: Comparison of the current compost qualities (1997 – 1998)

Parameter	Unit	A	Belgium	D	DK	NL			
		Median	Median	Median	Mean	Mean			
		Bio- and Greenc.	VFG- <sup>1)</sup> ccompost	Green-compost	Bio-and Greenc. compost	VFG-compost	Green-compost		
Organic matter (dry)	% dm <sup>2)</sup>	38,7	35	35	36	55	20	38	27
pH (H <sub>2</sub> O)	-	7,6	8,5	8,0	7,7	8	8	7,7	7,8
		(CaCl <sub>2</sub> )							
Total Nitrogen (dry)	mg/kg dm	1,5	1,9	1,3	1,35	2,3	0,7	1,59	0,57
Total P <sub>2</sub> O <sub>5</sub>	% dm	0,9	0,57	0,30	0,66	1,1	0,7	0,66	0,32
Total K <sub>2</sub> O	% dm	1,5	0,83	0,53	1,1	-	-	0,88	0,74
Total CaO	% dm	9,9	1,93	1,42	4,06	-	-	2,12	2,20
Total MgO	% dm	2,2	0,30	0,25	0,71	0,7	0,6	0,29	0,42
Soluble N	mg/l	-	476	113	230	600	100	-	-
Soluble P	mg/l	-	492	277	918	800	500	-	-
Soluble K	mg/l	-	4107	2271	3344	2200	900	-	-
Soluble Ca	mg/l	-	4250	2995	-	-	-	-	-
Soluble Mg	mg/l	-	524	354	266	-	-	-	-
Cadmium	mg/kg dm	0,7*	0,9	0,9	0,5*	0,4	0,4	0,3	-
Chrome	mg/kg dm	28,5*	17	14	24*	12	9	17	19
Copper	mg/kg dm	66,5* <sup>44</sup>	33	44,7*	44	50	29	28	-
Mercury	mg/kg dm	0,2*	0,2	0,1	0,15*	0,13	0,12	0,12	0,1
Lead	mg/kg dm	60,5*	66	61	53*	36	27	57	49
Nickel	mg/kg dm	22,5*	12	8	14,3*	10	7	7	9
Zinc	mg/kg dm	229,5*	237	183	190*	165	141	157	134
Arsine	mg/kg dm	5,7*	-	--	--	3,6-	3,3-5	4	-
Impurities > 2 mm Ø	% weight	-	0,1	0,1	0,09	0,1	0,06	0,19	0,06
Stones > 5 mm Ø	#/l	-	0	0	0	0	0	0	0
Germinating seeds									
Decomposition:									
- Rotting degree	-	-	-	-	V	III - IV	-	IV - V	IV V
- NO <sub>3</sub> -N / NH <sub>4</sub> -N	-	28	0,4	1,0		IV			
		(CaCl <sub>2</sub> )	(H <sub>2</sub> O)	(H <sub>2</sub> O)					
EOX	mg Cl/kg dm	0,6							
AOX	dm	67,0							
DEHP	mg Cl/kg dm					22,2	0,29		
LAS	dm				72,5	-			
NPE						2,9	-		
Sum of PAH						0,5	0,7		

<sup>1</sup> VFG compost = Vegetable fruit and garden compost

<sup>2</sup> dm = dry matter

\* Basis: 30 % organic matter; To compare this values with others based on dry matter, they have to be reduced by 10 %

Sources of information:

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Belgium: Personal information of VLACO, April 1998

Germany: BGK, B. Kehres, Personal information May 1998

The quality of composts can not be improved that much in these countries. Statistical data from the German Compost Quality Assurance Organisation FCQAO show a reduction of e.g. the heavy metal content of zinc and cadmium only of two or three percent over the last six years despite composting plants' many efforts. So it can be expected that the compost quality has reached the inevitable background level.

### **Compost quality and marketing/public relations**

Public relations and marketing of compost requires a standardised quality product too. Composts which have been tested in a quality assurance system meet these requirements because:

- Quality assurance is a good basis for sales promotion, for public relations work and a good argument for the building up of confidence in compost.
- The quality label allows the establishment of a branded "quality-tested compost" and a positive compost image.
- Regular analyses during compost production guarantee a quality-assured product.
- Standardised analyses carried out in accordance with specified methods enable a nation-wide objective assessment of the compost.
- The investigation results form a basis for the product declaration and the application recommendations.

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

Further marketing activities are necessary, as compost with a quality label or a quality certificate will not be sold by itself. With this qualification, however, the compost plants have an excellent start because quality products always have advantages in the market. In order to compete with the activities of the peat-, soil- and bark industries the compost plants need to undertake common efforts in their marketing activities on a similar level.

The quality assurance organisations (e.g. the compost quality assurance organisation in Germany, KGVÖ in Austria, VLACO in Belgium, VVAV in the Netherlands) support the compost plants in their joint marketing activities. It is neither necessary nor financially sensible that each compost producer develops its own marketing instruments.

The marketing measurements in the individual EU countries vary decisively in size and volume. There are only actions in countries with a developed compost management. An advantageous start of a marketing strategy is to build up a quality assurance/certification with recommendations for the use of compost for the most important ranges of product sales. (User brochures of the German Compost Quality Assurance Organisation, 2-volume guidelines for practical use of compost of VLACO in Belgium, 6 user information sheets of the KGVÖ in Austria). The Belgium VLACO supports additionally a row of tests for the use of compost.

### **Compost use and markets**

Significant differences on the market situation are to be recognised also in the EU countries. Generally it can be recognised that even in the developed countries with a circumstantial compost production like Germany the feared problems with compost sales did not occur. In all the countries hobby gardening, horticulture and landscaping is a successful market and has a good chance of developing.

**Table 8: Market shares of compost sales and market size**

Market shares in selected EU countries (in %) 1998						Market size
	Austria					
	Belgium					
	Germany					
	Denmark					
	Netherlands					
Landscaping	30	24	33	19	30	Large
Landfill + Restoration	5	5	4	13	-	Small
Agriculture	35 <sup>1)</sup>	5	21	10	40	Very big
Horticulture	5	6	7	3		Medium
Earth works	5	33	10	-		Medium
Privat gardens	20	18	19	48	20	Large
Export		9	-	-	-	Very small
Miscellaneous		-	6	7	10	

<sup>1)</sup>60% of the Austrian VFG and green waste is on-farm-composted

Compost marketing shows several trends in Europe. Green compost is an organic fertiliser and soil conditioner accepted by the markets all over Europe. It can be produced in a good quality without much technical equipment. The biocompost market shows two contrary developments: By means of the decreasing or low tipping fees, some of the composting plants try to minimise their treatment and marketing costs which results mostly in delivering the compost free of charge to farmers without additional marketing efforts. On the other hand a lot of composting plants start to add value to their compost products and produce mixtures or special products according to customers' needs and market requirements. They co-operate with earth-works or build one by themselves. The quality assurance organisations support these tendencies in organising research projects for compost application and for new compost products.

## Conclusion

The European compost market requires best quality like the development in Belgium, Denmark, Germany, Netherlands, Austria and Switzerland show, as these countries already have a highly developed compost management. The quality standard of the composts must stand the competition on the market with peat-, earth- and bark products. This is only possible with organic raw materials from separate collection and via a distinct quality assurance programme to be handled by the compost sites.

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# Use of sewage sludge in agriculture Presentation of an opinion from the Economic and Social Committee of the EU

(Staffan Nilsson Member of the ESC, Member of the Board of the  
Federation of Swedish Farmers (LRF))

## Introduction

First of all, I want to express my thanks for the invitation and the possibility for me, as member of the EU Economic and Social Committee, to present our opinion, adopted on 19 October 2000 under the title "Use of sewage sludge in agriculture". Let me also express my real estimation for this initiative between the Commission and the Italian Environment Protection Agency.

## The role of the ESC

I want to briefly explain the role of the Economic and Social Committee (ESC). The Rome Treaty set up the ESC. We have an institutional role beside the Parliament and the Committee of the Regions. We can express our role in three different ways:

- To advise the three big institutions (European Parliament, Council and Commission);
- To promote a greater commitment/contribution from civil society to the European venture;
- To bolster the role of civil society organisations and associations in non-Community Countries and, to this end, foster structured dialogue with their representatives and promote the establishment of similar bodies in the CEEC, Turkey, the EUROMED, ACP and MERCOSUR countries etc ("institution building").

To achieve these objectives, the Committee can issue three different kinds of opinion:

- Opinions on matters referred by the Commission, the Council and from the European Parliament. The Treaty provides for Committee referral in a wide range of areas; these are thus "automatic" referrals based on proposals from the European Commission;
- The Committee may also draw up exploratory opinions;
- The Committee may also express own-initiative opinions.

The 222 members of the ESC represent organisations for workers, employers and other groups like farmers, consumers, environmentalists and others from the organised civil society.

## The ESC opinion on sewage sludge

This opinion on sludge is an own initiative of the ESC, and the intention is to influence the Commission in their work to renew the Directive from 1986.

The focus is expressed in the title: the view is from the agricultural side and in full respect and harmony with the consumer, agrifood-industry and agri-co-operatives. The document describes the sewage system for collecting waste from urban areas and the possible use of sewage sludge in agriculture. Sludge and other organic waste contains nutrients for plants, which are a key resource for sustainable agriculture and society. However, in urban sludge the nutrients are mixed with numerous metals and organic pollutants.

## Background

The organic waste produced by society mainly comes from the country's own farm produce or imports of plant or animal origin. This waste naturally contains the nutrients plants need. They are a major resource for agriculture. In addition to organic waste containing nutrients, other substances are introduced as a result of domestic use. A large number of different chemical substances are also added. These substances have no place in agriculture or food production and compromise the sustainability of arable soil and food quality. Researchers and environmental and farmers' organisations also question whether, under the current system, the waste

water treatment plant manages to remove both metals and hazardous organic substances sufficiently when purifying the waste water. In the years ahead more waste water treatment plants will be built, and more sludge produced. Often this is accompanied by the introduction of taxes and bans in order to stop the deposit of organic waste on landfill sites. As a result waste producers will step up their efforts to persuade agriculture to use larger quantities of sludge. The precautionary principle, the "polluter pays" principle (PPP) and pro-active measures are the guidelines to be followed for reuse of nutrients for plants in agriculture. The ESC particularly stresses the importance of applying the PPP to sewage and to the production of sewage sludge. Regulations should be adopted to promote new systems which facilitate the use of non-pollutant forms of waste in agriculture, and the recovery of valuable components in waste water and other organic waste.

### **Nutrients**

Among the nutrients for plants, phosphorus has a special signification. Phosphorus is an element contained in the Earth crust, which is currently extracted from phosphorus-rich calcium phosphates. It is vital to plants and must be added to the soil if harvests are to produce optimum yield. The growing need for food over the next fifty years can clearly be expected to boost demand for supplies of phosphorus for crop cultivation purposes. In this sense this element can become no longer economically viable and must be managed prudently by society and recycled with a view to promoting sustainable agriculture and a sustainable society.

There is also a solidarity dimension. The Member States will probably be able to afford to buy the phosphorus they need even in fifty years' time. When costs rise, the poorer countries are the ones which will have to content themselves with poorer quality and dwindling supplies. Since phosphorus is an element (like metals such as mercury or cadmium), it is not degradable and will not disappear. Phosphorus contained in agri-foodstuffs will, unless recycled in agriculture, gradually spread to watercourses and groundwater. There is therefore a risk that phosphorus that is not returned to arable land will leak into the environment in a way which has hitherto not become apparent and will cause environmental damage.

When we separate sludge from the water, we also get on average nearly up to 90% phosphorus in the sludge. But little advantage is taken of important nutrients in waste water such as nitrogen and potassium. But for the plants we should need to build a circle where we can get back clean nutrients, if we want to build what we talk such a lot of, the sustainable society and sustainable agriculture.

### **Heavy metals**

Well, what is then the problem? Let us focus on metal content of soil and waste. Technology-linked environments contain three times more cadmium, fifteen times more lead and twenty times more copper than arable land. When these metals erode, they must not be allowed to disperse into farmland, even if copper sometimes needs to be added to soil with a low copper content.

For the past twenty years, six to seven metals have been regularly analysed on the instructions of the authorities, as provided for in the Sewage Sludge Directive 86/278/EEC. There are historical reasons, such as widespread industrial use, for controls on these metals. In recent decades a large number of new metals and other raw materials have come into use. They too should be checked in organic waste. Certain tests on the silver content of sludge and soil, show that levels in the soil have doubled within a period of between five and ten years in normal sludge spreads. The content of certain other metals (wolfram, gold, platinum, uranium) has doubled in the space of decades.

The Sludge Directive indicates metal concentration in mg metal/kg dry matter. This measurement criterion has certain limitations:

1. Metal concentration can be diluted by mixing sludge from treated sewage with lime, sand, peat, animal manure etc, thereby obtaining concentrations below the mg metal/kg dry matter limit value;
2. The degree of decomposition/digestion plays a role; a more digested or composted material will have a higher metal concentration per kg dry matter;
3. This measurement gives no indication of the element's origin. For instance, sludge and animal manure can have roughly the same metal concentration. In the former case, 95% of these metals will stem from technology-related environments and, in the latter, most metals will derive from foodstuff and the farmer's own land.

A supplementary method of measurement is to indicate the content of certain metals in relation to the phosphorus level, e.g. in mg cadmium/kg phosphorus. This method offsets the shortcomings of the mg/kg measurement.

Two basic principles are used by scientists to determine the acceptable level of metal concentration in arable land:

1. Metals can be added to the soil up to a certain limit considered harmless to land, crops or human health (Often this is interpreted as implying that anything up to that limit is permissible. Once the arable land has reached this ceiling, spreading must move elsewhere.);
2. Fertilisation must be reduced so that a balance is established between the introduction and loss of metals in the particular area concerned. (Here the precautionary principle is interpreted more strictly, but a given increase in metal concentration in the soil - possibly 2 times (+100%) over 10,000 years can be accepted, i.e. an increase of 1.0% every year over the first 10 years, 0.3% over the next 90 years and 0.001% over the next 9,900 years.).

### Organic pollutants

We have also other problems related to sewage sludge, let me state our comments on hazardous organic substances, which occur more often in waste water and sludge from waste water treatment plants than in other types of organic waste. The reason is quite simply that they are often contained in effluents or, as a result of wear, are evacuated with the water collected in the sewage system.

Although thousands of substances can be analysed, they are merely a fraction of the 100,000 or so substances contained in waste. Many of them decompose during processing in the waste water treatment plant, while new substances are probably being created at the same time. Only for a few of these substances is the environmental impact known.

Methods of analysis for organic and inorganic pollutants need to be developed.

In order to reduce the quantity of undesirable substances, water from certain sources of waste must be closed off or purified before release into the sewage network. Such sources include industrial activities, run-off water and leachates from landfills and car maintenance plants.

Another step is to curb the use of hazardous substances for domestic or industrial purposes. Progress on the EU's policy and rules on chemical products need to be speeded up so that manufacturers document all ingredients and replace unsuitable or undocumented products by a set deadline.

A third way to reduce pollutants in organic liquid waste is to introduce separated systems, and so avoid mixing organic waste with other forms of waste and consequently deal with each component individually. As a third aspect we can focus on contamination risk.

## Pathogens

Waste containing faecal matter and other organic waste includes pathogenic organisms such as bacteria, viruses and parasites. All organic waste must be carefully inspected and treated appropriately so as to avoid contamination. The need for preventive measures and control has increased.

The use or elimination of waste from urban areas must not involve any risk of epidemics in people, livestock or wild animals. Farmers suffer considerable financial loss when disease strikes their herds. If organic waste from urban areas is to be used in agriculture, the product must be safe, particularly with reference to salmonella and E. Coli O157. For certain diseases, that also presupposes that waste may not be used on arable land or as fertiliser, and that it must not be landfilled until the risk of contamination has been eliminated.

But the use of sludge is not only a question for agriculture and society, we need also consumers' confidence in agriculture. Consumers are entitled to demand, and receive guarantees, that the foodstuffs on sale comply with established food safety regulations. The producer and the salesperson of the food should provide such guarantees. The consumer's evaluation of food quality plays a decisive role in the value of such products and determines which products he/she chooses. The food market is sensitive to alarms regarding various risks and high standards of food safety must be guaranteed so as to foster confidence. This also influences farming methods, and the use of sewage sludge.

Whether or not the use of sludge is acceptable will be influenced by the food products' measurable quality but will above all depend on the general public's confidence in the use of sludge in agriculture and in the waste water system's capacity to supply non-pollutant nutrients. In most Member States there is an ongoing debate on whether it is appropriate to use sludge and other organic forms of waste on arable food-producing land. There are a number of reasons for the low acceptance. The sludge contains a number of pollutants. Knowledge about the function of sewage systems, the influence of individual human activities and the need to return nutrients to agriculture is generally low.

## Commission Report on the implementation of Community waste legislation

In its Report on the situation regarding implementation of Community waste legislation, COM(1999) 752, the Commission states that the use of sludge on arable land is considered to be the most environment-friendly option, and that no reports have been received of damage to people, animals or crops caused by the use of sludge on farmland.

The ESC does not agree with the Commission's intention and is critical of this over-simplified approach. As this own-initiative opinion shows, there is every reason to have doubts about the use of sludge on farmland in view of its present quality. Few of the metals, which pollute sludge, have been analysed. The metal concentration allowed in sludge is far too high for sustainable use. Certain sludge spreads, which are accepted in the Sludge Directive, involve a doubling in the metal concentration in soil after one or two single spreadings. Too little is known about all the organic pollutants mixed into sewage sludge, or about the health risks.

A number of research surveys also challenge current limit values (e.g. cadmium in foodstuffs) and indicate that the risks to human health could be greater than researchers have thought to date. The same holds for dioxins. The Report shows no recognition of the problems and does not spell out the need for healthy soil to be able to produce healthy food for thousands of years to come. The Report indicates that the use of sludge is regarded with increasing suspicion, though it states that this distrust is not scientifically justified. According to the "precautionary principle", action should be taken even if sound scientific proof of the danger is not available.

In the ESC's view, the decisive factor for agriculture and the food industry is consumers' confidence in their raw materials and products. So the potential use of sewage sludge in agriculture is to be decided by farmers and consumers

### **Regulatory aspects**

In our opinion we also have a chapter with some important comments related to the legislation and with some important regulatory aspects.

We underline the need that the revised Directive take into account the guidelines of the Communication on the precautionary principle. The Committee wishes to see evidence of an integrated approach, as the Commission has recently tabled several documents referring to a series of principles and guidelines governing the future of its legislation, also applicable to the subject under analysis.

Water is protected under the forthcoming Water Framework Directive. In addition, the ESC highlights the absence of any Community minimum requirements regarding soil protection and urges the Commission to trigger procedures to this end.

### **Conclusions**

Nutrients for plants are transported to urban areas through agri-foodstuffs. Nutrients remain in food waste and toilet water and can be channelled back into agriculture without added pollutants so that agriculture and society can be sustainable.

Over the next 10,000 years a doubled content of most metals in soils might be acceptable. That means that sludge can be used when the amount of metals added in the next 10-20 years does not exceed 10-15% and that it is to be reduced to almost zero within a generation. Hazardous organic substances are in the long run to be avoided all together. A model for risk assessment and methods for analysing the effects of key chemicals in biological systems is needed now. Use of sludge in agriculture must not generate increased risks of contamination in agriculture or among the general public.

Little advantage is taken of important nutrients in waste water such as nitrogen and potassium. However, 90% of the phosphorus content is captured in the sludge. People are sceptical not only about sludge quality but also about the capacity of the sewage system in its present state to purify sewage, and hence to contribute to a sustainable society.

As a result, doubts regarding the use of sludge in agriculture exist in most countries. Often there is little understanding from sludge producers and authorities regarding this problem. The questions need to be identified and proper targets and actions should be defined in order to change the situation.

EU consumers are entitled to demand safe food and to influence the production methods and resources used in agriculture. Many groups, including the chemical industry, consumers, sludge producers, building firms, planners and decision-makers, are responsible for ensuring that society develops in a way that allows nutrients to be recycled. Agriculture has the task of maintaining soil quality and bears ultimate responsibility for what is spread over arable land. The environmental impact cost from any use or disposal of sludge should be internalised in the costs for water use and pollutant products. In the ESC's view, agriculture should in the long run only use nutrients from organic waste kept separate from other pollutant waste which increases the metal content or introduces hazardous organic substances. Hence the use of sludge as agricultural fertiliser is highly dubious, and in most cases manifestly unsuitable unless the sludge and the system delivering it are greatly improved.

## Recommendations

The revised Directive should indicate clearly that the overall long-term aim is to channel back non-pollutant nutrients from the Community's sewage into agriculture. It must specify that the precautionary principle and PPP are applicable in evaluating sources connected with the sewage system and the production and use of sewage sludge.

The revised Sludge Directive must adopt a holistic approach to all effluent waste from waste water treatment plants and other urban waste sources. It should preferably encompass all waste and discharges which are not covered by the forthcoming Water Framework Directive. Though water protection legislation exists, there is currently no Community minimum requirements regarding soil protection. The ESC urges the Commission to draw up such legislation.

The origin of waste, the substances introduced into it and the processes it has undergone must be reported to the authorities and to the user. As a back up to the mg/kg measurement, the quantity of certain metals could be indicated in relation to the volume of phosphorus (e.g. mg cadmium/kg phosphorus). This measurement offsets shortcomings of the mg/kg criterion.

Responsibility for environmental damage caused by sludge use should be specified in the Directive. The national authorities should report regularly on the use made of sludge, its quality and the quality of other types of waste so as to help authorities and users to make both national and international comparisons. The EEA has a natural role to play in collating such information to be notified by the Member States.

Systems for tracing sludge use, reliable testing methods and permanent monitoring systems need to be developed. Ways in which the Member States manage risks connected with the use of organic waste should be reported and published on a regular basis.

The ESC stresses the need for the waste committee to liaise closely with the Commission's scientific services in order to ensure objective risk evaluation.

Since one of the EU's aims is to create a sustainable society, greater priority must be given to environmental sustainability and steps must be taken to facilitate investment in new technologies that reduce the environmental impact of organic waste management in general, and the re-use of non-pollutant nutrients in particular.

The amended Sludge Directive should state that metal content in sludge can only be used when the amount of metals added in the next 10-20 years does not exceed 10-15%, to be reduced to almost zero within a generation. Hazardous organic substances are in the long run to be avoided all together. A model for risk assessment and methods for analysing the effects of key chemicals in biological systems is needed now. Use of sludge in agriculture must not generate increased risks of contamination in agriculture or among the general public. The Commission is requested to consult the ESC in its future work on the Sludge Directive and other regulations governing the production and management of organic waste.