National Development Plan 2007 - 2013

Environmental Protection Agency
An Ghníomhaireacht um Chaomhnú Comhshaoil

STRIVE

Report Series No.40

Implementation of an Urban Community Composting Programme

STRIVE

Environmental Protection Agency Programme

2007-2013

Comhshaol, Oidhreacht agus Rialtas Áitiúil
Environment, Heritage and Local Government

Environmental Protection Agency

The Environmental Protection Agency (EPA) is a statutory body responsible for protecting the environment in Ireland. We regulate and police activities that might otherwise cause pollution. We ensure there is solid information on environmental trends so that necessary actions are taken. Our priorities are protecting the Irish environment and ensuring that development is sustainable.

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EPA STRIVE Programme 2007–2013

Implementation of an Urban Community Composting Programme

(2005-WRM-MS-34-M1)

STRIVE Report

Prepared for the Environmental Protection Agency

by

The Rediscovery Centre, Ballymun

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DISCLAIMER

The EPA STRIVE Programme addresses the need for research in Ireland to inform policymakers and other stakeholders on a range of questions in relation to environmental protection. These reports are intended as contributions to the necessary debate on the protection of the environment.

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Executive Summary

Background

In 2007, the quantity of biodegradable municipal waste disposed of to landfill increased by 4% to 1,475,077 tonnes in Ireland. This was at variance with the 2010 target of 967,433 tonnes set by the Council Directive on the Landfill of Waste (1999/31/EC) (the 'Landfill Directive') (European Council, 1999) and demonstrates that despite concerted action over the last number of years, Ireland is moving further from meeting its obligations under the directive. Full implementation of the National Strategy for Biodegradable Waste is increasingly urgent, given that the first target year of 2010 requires a reduction in landfilling of biodegradable municipal waste of over 550,000 tonnes from current levels.

Table A summarises the components of biodegradable waste generated and recovered in 2007 and highlights that, with the exception of textiles, organic waste had the lowest recovery rate (8.6%) of any biodegradable waste fraction.

While the separate collection of household food and garden waste at kerbside increased by 20% to 18,705 tonnes in 2007, the reduced collection of household food and garden waste at civic amenity sites resulted in a decrease in the overall collection rates of 1,000 tonnes (Le Bolloch et al., 2009). This is despite the recognition in the 2006 *National Waste Report* (Le Bolloch et al., 2007) that the separate collection and diversion from landfill of organic waste must be accelerated.

In addition to establishing services for the separate collection of organic waste, Ireland must now prioritise the development of an adequate infrastructure to treat this waste. Failure to meet Irish landfill diversion targets will result in financial penalties in the region of €180 to €270 million per annum (CRÉ, 2007).

Community composting presents an opportunity to micro-manage some of Ireland's organic waste at source, supporting key environmental sustainability principles and encouraging public engagement.

Composting is a highly developed activity across Europe. In 2006 over 1,800 plants were in operation throughout Europe with an annual capacity of more than 17 million tonnes of biodegradable waste (Barth, 2008). However, current activity in Ireland is limited to less than 50 composting facilities, primarily dealing with biodegradable waste from gardens such as grass cuttings and plant leaves (otherwise know as garden waste) only.

Table A. Biodegradable municipal waste generation and management, 2007.

Material	Gross quantity available (tonnes)	Quantity landfilled (tonnes)	National landfill rate (%)	Quantity recovered (tonnes)	National recovery rate (%)
Wood	240,675	16,994	7.1	223,681	92.9
Paper	914,069	384,245	42	529,824	58
Organics	918,423	839,806	91.4	78,617	8.6
Textiles	244,924	234,033	95.6	10,891	4.4
Total	2,318,091	1,475,077	63.6	843,013	36.4

Source: Le Bolloch et al., 2009.

Research Methodology

This study reviews the potential contribution of community composting initiatives towards achieving landfill diversion targets and investigates barriers to project implementation. The study assesses all aspects of community composting projects from waste collection and processing to compost production, quality assurance, utilisation, marketing, education and awareness.

From 2006–2008, an organic waste composting project was established within a high-rise urban development in Ballymun, Dublin. This used in-vessel composting technology to process household organic waste to produce compost. The compost was analysed to measure chemical, physical and nutrient composition and then used in horticultural trials, at the National Botanic Gardens, Glasnevin, Dublin to quantify benefits and highlight potential applications. In addition, an education programme to encourage participation was developed, and marketing opportunities for local compost use were also assessed and defined.

Research Findings

- In-vessel composting technology is economically and technically viable for small-scale organic waste processing and can result in volume reduction of up to 87%.
- Urban composting projects can bring significant social, environmental and economic benefits to urban communities.
- Effective education is paramount to the success of community composting initiatives.
- Small-scale in-vessel composting can be employed to produce quality compost, which will meet compost quality standards, such as the proposed Industry-Led Quality Standard for Source-Separated Biodegradable Material Derived Compost.
- The use of waste-derived compost in horticultural applications can lead to increased growth rates and improved soil quality. Plant response is dependent on nutrient content and compost stability.
- There is a local market demand for waste-derived compost.
- Commmunity composting initiatives, if established in all apartment developments in Dublin alone, have the potential to divert 14,680 tonnes of organic waste from landfill each year.

1. Introduction

1.1 Project Details

Composting can be an opportunity for solid waste management while also acting as a valuable resource in soil improvement and land remediation. Internationally, community-scale composting projects are both popular and effective for processing organic waste in many urban environments. They involve the cooperation of communities in the management of their own waste, supporting key environmental principles, increasing environmental awareness and enhancing social cohesion.

In Ireland, only a very small number of initiatives have been undertaken and there exists a huge potential for further development. This project, which assesses the potential role of community-scale in-vessel composting in Ireland and identifies challenges associated with small-scale organic waste composting, was funded under the Environmental Research, Technical Development and Innovation (ERTDI) Programme 2000–2006.

1.2 Background to the Project

Ballymun Regeneration Limited (BRL) was established in 1997 by Dublin City Council to develop and implement a masterplan for the regeneration of the area, with the objective of transforming Ballymun from a failed local authority estate with high levels of social deprivation and little private sector investment into a vibrant and sustainable town with retail, neighbourhood and community facilities located alongside mixed tenure housing. The largest regeneration project in Europe, it deals not only with physical regeneration but also with social and economic development, and has a strong focus on environmental sustainability. More information on the regeneration can be found on the BRL website (www.brl.ie).

In 2001, BRL engaged the services of the environmental action group, Global Action Plan (GAP), to implement projects aimed at raising environmental awareness and encouraging positive behavioural change in relation to environmental responsibility. At the time, waste-management services in Ballymun were limited to a mixed waste collection service, whereby all waste types were collected in one bin. One of GAP's first environmental action projects was the development of a small community recycling centre. This was located in the basement of one of the Ballymun flat blocks and encouraged people to separate different materials for recycling. Due to an interest from people using the recycling centre in the potential application of community scale in-vessel composting, BRL purchased an in-vessel composter for processing household kitchen and garden waste. The compost was initially located in a tower block basement and the project ran successfully for approximately 18 months. However, following complaints from residents relating to odour, the composter was relocated to the civic centre where organic waste from the community-recycling centre, along with waste from the civic centre canteen, continued to be processed.

Building on this experience, BRL's Environmental Team was keen to identify and address the main barriers to implementing community composting projects within an urban environment and an application was made to the EPA's ERTDI programme to fund a research project involving the installation of a new in-vessel composter alongside an education and awareness support programme. The project also involved a literature review of community composting, a compost trial and a market-development aspect to identify the potential benefits of food-waste-derived compost.

1.3 Project Objectives

- Determine the technical and economic feasibility of small-scale in-vessel composting projects in urban areas.
- Establish a small-scale organic waste composting project in Ballymun.
- Develop a template for small-scale in-vessel community composting projects.
- Develop consumer confidence in waste-derived compost products.
- Determine the social and environmental benefits of community composting projects.

1.4 Key Project Tasks

1.4.1 Literature Review

A review of relevant legislation, literature and research was carried out to assess the drivers for, and obstacles to, developing the community-composting sector in Ireland. Lessons learned from established community projects worldwide were also collated.

1.4.2 Compost Processing

Building upon information gathered during the literature review, a survey of potential sites was carried out to select the most appropriate apartment complex for project implementation. A pilot compost collection and processing programme was established in two potential sites and the pilot ran for 8 weeks. The pilot identified the most appropriate site and optimum conditions and operational parameters for the full-scale programme roll-out. The final programme was established within the Santry Cross Development in Ballymun and monitored for 44 weeks. The results were reviewed and used to identify barriers to and opportunities for small-scale community composting.

1.4.3 Education and Awareness Programme

During the pilot and full programme, key awareness-raising activities were carried out. Specific actions were assessed to determine their effect on resident participation in the project. The education and awareness activities, information and tools used were reviewed and revised throughout the pilot and full-scale programme in order to achieve maximum participation. Key contributors to resident participation were identified.

1.4.4 Quality Assurance Programme

During the project, qualitative and quantitative data relating to the composting feedstock or input materials, the composting process and the compost product were gathered. Operating parameters and compost produced were compared to national and European standards. Variability between compost batches was determined and the correlation between the process parameters and the results were used to establish optimum operational procedures and to develop a quality assurance programme for small-scale in-vessel community composting.

1.4.5 Pot Trials

Pot and *in situ* trials were carried out at the National Botanic Gardens, Dublin to determine the benefit and potential use of waste-derived compost. The results of the trials and the compost analysis were compared to commercially available products and suggestions for end-use were presented.

1.4.6 Marketing Strategy

A survey of local compost users was carried out to establish the local requirement for compost and the perception of waste-derived compost within the market. Results were used to determine key messages for inclusion in a marketing strategy necessary for the product acceptance.

1.5 Research Approach

The project was action based and results focused and as such a degree of flexibility within the methodology was allowed for. In general, a translational approach was applied to the research. Lessons learned from the results of pilot programmes and during implementation were immediately incorporated within the project methodology.

2. Composting

2.1 What is Composting?

Composting is a natural biological process involving micro-organisms that break down the complex carbohydrates and proteins in dead organic material into simpler nutrients that can be taken up by plants. In its simplest form it can be viewed as the recycling of organic waste into a valuable soil replacement or conditioner which can be used to grow new crops.

CRÉ (The Composting Association of Ireland) describes compost as ‘the product resulting from the controlled biological decomposition of biodegradable wastes that have been sanitised and stabilised to a degree which is potentially beneficial to plant growth when used as a soil amendment’ (Benton and Foster, 2008, p.5). Similarly, the UK Community Composting Network (CCN) defines compost as ‘biologically processed, stabilised and sanitised (waste) organic matter resulting in a product (compost) with beneficial properties for plants and soil’ (Scott et al., 2003, p.2). The key points of both definitions refer to the biological process producing an end product that is stable or sanitised and which is potentially beneficial to plant growth. The CRÉ definition includes the word ‘controlled’ in reference to the biological process to highlight the view that composting is a managed process.

Composting is considered a variable process which occurs over a wide range of conditions and with many materials. The speed of composting and the qualities of the finished compost are largely dependent on the selection and mixing of feedstock and the management of the composting process.

In its physical form, finished compost has a soil/humus like appearance and has little or no resemblance to the original biodegradable material from which it was made. The chemical composition of waste-derived compost means that it is typically not used as a fertiliser unless altered through the addition of nutrients in the process. However, even unimproved compost generally contains some fertiliser properties as a result of chemical decomposition of the original biodegradable material from which it was made (i.e. nitrogen, phosphate and potash). The chemical and micro-nutrient composition of compost should be included in calculations for fertiliser application and nutrient management planning. The biodegradable materials that are used to make compost can include green waste such as leaf cuttings or grass, manures or digestates, and food waste or leftovers.

2.2 Benefits of Composting

Composting, as a waste management option, offers significant environmental benefits, some of which are detailed below. Composting of biodegradable waste reduces the need for landfill and incineration, saves valuable resources and reduces greenhouse gases.

Waste diversion from landfill is one of the key benefits of organic waste recycling. When municipal solid waste (MSW) is landfilled directly, the anaerobic biological breakdown processes produce landfill gas and leachate. Over 90% of all the converted organic carbon is released as CO_2 and CH_4 as landfill gas; the remainder is released as leachate (Binner, 2002). Composting presents the opportunity to reduce greenhouse gas emission from landfill, the third largest contributor of all anthropogenic methane emissions. Additional disadvantages of landfill include noise, dust and land and water pollution.

Other benefits of compost are its use in agricultural applications where it can (i) reduce the use of fuel-consuming land preparation processes because of improvements in soil health and (ii) help reduce greenhouse gas production and other environmental impacts associated with chemical fertilisers and pesticide production. Composting is also very beneficial to soil organic carbon and related sinks and helps improve the uptake of nutrients (Favoino & Hogg, 2008).

2.3 Options for Composting

For composting in rural or suburban areas the best option is that householders engage in home composting. However, this is generally not possible for urban multi-storey or terraced dwellings with no garden space, and in this instance a collective or community-composting scheme or alternatively a centralised composting programme can be employed.

A wide range of processes and technologies can be used for managing the decomposition of organic wastes. Indeed, more than one type of system is often used during the composting process. Simple systems such as ‘windrows’ – which can be indoor or outdoor – rely on mechanical aeration to optimise the process, with or without forced aeration. Aerated static piles usually operate by pulling or forcing air through the compost pile, with agitation occurring only when piles are moved or blended. In in-vessel composters (such as those used in this project), air is supplied by fans, and mechanical agitation by the rotation or movement of a drum through which the material moves during the composting process.

Most composting systems or processes need a significant amount of space for compost maturation: a key benefit of an in-vessel system is the accelerated initial phase of the composting process, which results in significant volume reduction, and early homogenisation of the feedstock. Coupled with the benefits of a closed system in terms of not attracting vermin and birds, this makes it a very attractive process for treating organic putrescible waste.

In-vessel composters are currently used in many locations throughout the world (e.g. Japan, South Africa, Sweden and Scotland) for both commercial and local authority applications. In Ireland, commercial composting companies use them to treat food waste, green waste and non-hazardous industrial sludge; hotels also employ them to treat food waste. Some local authorities have initiated in-vessel composting facilities – notably, Galway County Council’s in-vessel composting facility in Ballinasloe, which processes the domestic organic waste from 1,500 homes in the area. In Northern Ireland the Magherafelt District Council has installed state-of-the-art vertical composting units to deal with all the food waste in the Magherafelt area. The compost produced in both these instances is used predominantly as a soil ameliorant in the landscaping industry or for remediation of landfill cover.

2.4 What is Community Composting?

The community-composting sector is very diverse – projects range from individuals or small groups working on allotment sites or promoting home composting through to social enterprises with local authority contracts providing kerbside collection services. While there is no definitive categorisation, a common thread of community composting initiatives is that the community group or organisation is either involved in the management of a composting initiative or in the promotion of community composting. Some case studies are provided in Section 3.6.

2.5 Benefits of Community Composting

Community composting projects offer significant environmental and social benefits over centralised composting projects; these can be categorised into three key areas: (i) environmental; (ii) social and (iii) economic.

2.5.1 Environmental Benefits of Community Composting

One of the key environmental benefits of community composting is the opportunity to apply the proximity principle: converting locally arising waste into a locally available resource. The environmental impacts associated with the transport of waste are avoided and the compost can also be used locally to improve soil condition. Research shows that over 45% of European soils have low values for organic matter content and reduced fertility (Barth, 2009). Compost has the potential to improve both the nutrient content and organic matter of degraded soils.

2.5.2 Social Benefits of Community Composting

Community composting projects can provide employment and volunteering opportunities as well as local and targeted education and awareness raising. The project is also seen as an opportunity to build social cohesion, with neighbours working together on a common goal. The projects generally result in the development of further programmes such as gardening groups and social networks. The most important social benefit according to a recent review of composting initiatives is bringing together a local community and creating a sense of civic pride (Slater, 2007). Community composting also tends to return all decision-making processes relating to household waste management to the occupants, further encouraging social engagement, participation and environmental responsibility.

2.5.3 Economic Benefits of Community Composting

Community composting presents an opportunity to realise significant cost savings for a number of groups, including householders, in the form of reduced waste charges through to government in the form of reduced European Union financial penalties, thereby highlighting the merits of the polluter pays principle, which seeks to ensure that the polluter or producer of waste should pay the full costs of pollution and these costs should not be borne by any third party or society at large. In addition to savings in waste management fees due to waste reductions, cost benefits are also realised through reduction in transport costs and revenue generated from compost sales.

2.6 Community Composting Drivers

The realisation of cost savings is often identified as a key driver for the development of community projects (Slater, 2007). Collective environmental concern can also lead to projects being developed. In urban areas, the dense concentration of housing, businesses and industry resulting in concentrated waste generation also presents an opportunity for localised organic waste collection.

Key drivers in environmental policy have been identified, and in particular the waste management hierarchy, which classifies strategies according to their desirability in terms of waste minimisation, has established a clear preference for composting over incineration and landfill for example.

Legislation can also act as a driver towards community composting – for example, the Landfill Directive seeks to prevent waste disposal to landfill. Other legislative drivers are discussed in Section 3.

2.7 Barriers to Community Composting

Although community-composting schemes have been slow to develop in Ireland they are on the increase, with three small-scale projects currently operating in North Dublin. Composting is a living, dynamic process. As such, maintenance of a composting system requires more attention and training than standard recycling and disposal alternatives (Regenstein, 2000). While successful projects offer key benefits over landfill and incineration, the composting process can be messy, odorous and subject to complaint if managed badly.

Similarly, legislatory restrictions relating to waste processing and composting such as planning, licensing and Animal By-Products (ABP) regulations can be discouraging. The start-up costs associated with community composting projects, especially where in-vessel systems are employed, can also be a significant deterrent.

Figure 2.1 shows that the most frequently cited problems experienced by community composting groups in the UK were legislation and bureaucracy, followed by funding issues, lack of space and issues with staff resource or time commitments (Slater, 2007). In relation to legislation and bureaucracy, the costs and time involved in compliance with waste licensing, planning and ABP regulations were cited as specific problems by respondents.

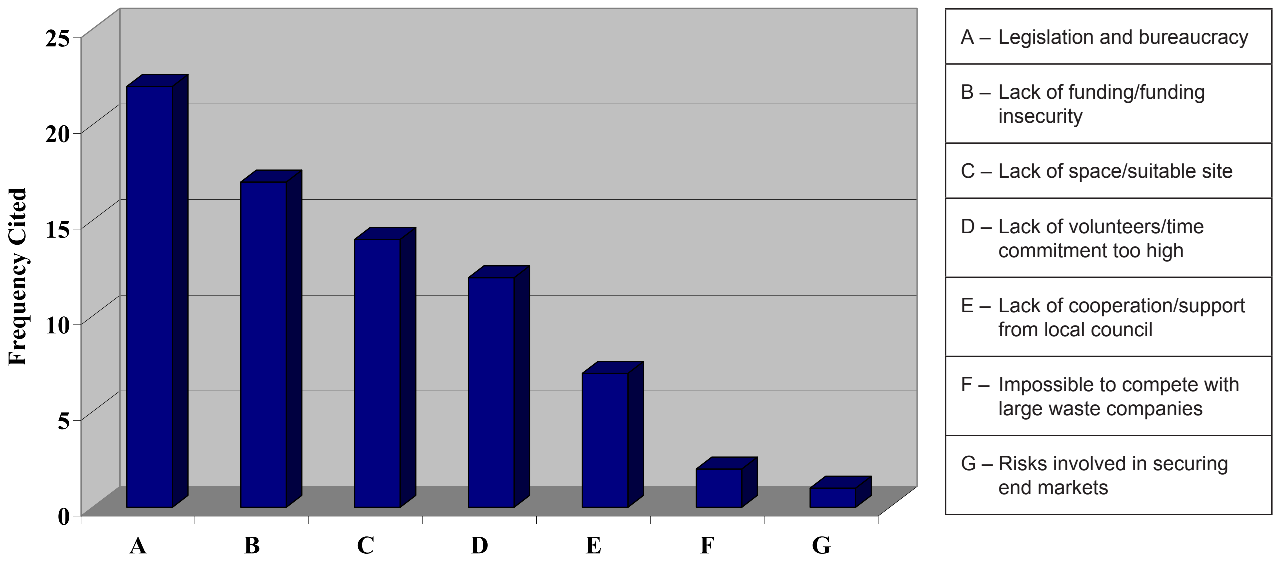


Figure 2.1. Barriers to community composting.

3. Literature Review

3.1 Introduction

The literature reviewed provides a context for the development of community composting initiatives. It is not a comprehensive review, but it provides a background to some of the key elements of this study and in particular summarises:

- relevant European Union (EU) and national environmental policy;
- current status of community composting;
- barriers to community composting.

3.2 Principles of European Union Policy

European Union environmental policy aims to provide a high level of protection of the environment and is based on a number of principles:

- The **precautionary principle** recognises that our knowledge of ecosystems is incomplete, and foresight, consistency and prudence should be applied in minimising the risk of damaging the environment.
- The **prevention principle** seeks to avoid waste generation where possible.
- The **proximity principle** seeks to manage waste as close to point of source as possible.
- The **polluter pays principle** seeks to ensure that the polluter or producer of waste should pay the full costs of pollution and these costs should not be borne by any third party or society at large.

3.3 European Union Directives

3.3.1 The Waste Framework Directive

The internationally recognised waste management hierarchy, which dates back to the 1975 EU *Framework Directive on Waste* was implemented nationally via the *Waste Management: Changing Our Ways* policy document of 1998 (DoEHLG, 1998) and subsequent *Delivering Change* (DoEHLG, 2002) and *Taking Stock, Moving Forward* (DoEHLG, 2004) policy documents. The documents, in line with the stipulations of the directive, set the primary objectives of reducing Ireland's current high dependence on landfill in favour of an integrated system which promotes waste management options in the following preferential order: prevention, reduction, reuse, recycling, recovery and disposal.

3.3.2 The Landfill Directive

Disposal of biodegradable waste to landfill impacts negatively on the environment through:

- release of landfill gas including high concentrations of CO_2 and CH_4, significant greenhouse effect contributors;
- generation of leachate which must be collected and treated to prevent groundwater pollution;
- slow degradation requiring landfill gas and leachate management for many years after site closure.

The European Council Directive on the Landfill of Waste (the 'Landfill Directive') (1999/31/EC) sets new standards for all landfills to improve environmental protection and also requires all Member States to phase out disposal of biodegradable waste to landfill. Ireland has availed of a 4-year derogation

Table 3.1. Irish landfill waste reduction targets.

Year	Quantity landfilled (tonnes)	Landfill Directive Target	Max. quantity allowed to be landfilled	Difference from 2006 levels
1995	1,289,911			
2004	1,304,426			
2005	1,307,570			
2006	1,412,581			
2010		75% of 1995 quantity	967,433	445,148
2013		50% of 1995 quantity	644,956	767,625
2016		35% of 1995 quantity	451,469	961,112

Source: Le Bollochet al., 2007, p.19.

for the first two phases of the Landfill Directive, and Table 3.1 shows the current targets in relation to the 1995 baseline year.

3.3.3 The EU Biowaste Directive

The European Environmental Bureau (EEB) considers that 'a European stand-alone legal instrument for the management of biowaste would have cross-cutting benefits' (EEB, 2009, p.1). These include addressing the issue of soil organic matter decline, encouraging recovery of organic matter, helping Member States meet the Landfill Directive diversion targets and addressing climate change issues (EEB, 2009). A directive on compost and other biowaste was proposed in the 2002 European Commission *Towards a Thematic Strategy for Soil Protection* (European Commission, 2002). This communication highlighted the importance of boosting recovery of organic matter in order to fulfil the various goals stressed in the Soil Strategy itself, including combating erosion, halting the decline in organic matter content, carbon sequestration and protection of biological diversity.

This proposed directive if passed in its current form would be a key legislative driver in ensuring that Member States meet the requirements of the Landfill Directive. The proposed measures within the directive – to source separate biowaste, harmonise standards and encourage community composting – would ensure a definite shift from landfill disposal of biowaste to composting.

Furthermore, a biowaste directive has the potential to fulfil multiple objectives of the strategic framework for the European Commission's environmental policy up until 2012, the 6th EAP, particularly in relation to meeting the targets of the Landfill Directive, to be consistent with the Commission's Communications on *Towards a Thematic Strategy for Soil Protection*, and to help achieve the goals of the European Climate Change Programme in considering the role of soil organic matter in carbon sequestration (EEB, 2009).

A Green Paper on the management of biowaste in the European Union was published by the European Commission in 2008. The EEB considers that 'the Green Paper and its associated questionnaire fall short of providing a strategic vision to prioritise biological treatment over other options for biowaste (specifically incineration or any non-conventional thermal treatment, e.g. gasification, pyrolisis) and promote separate collection of biowaste for a high quality compost as clearly requested in the new Waste Framework Directive. Instead, it seems to seek a "balance" amongst different treatment options' (EEB, 2009, p.2).

3.3.4 Animal By-Products Regulation

To limit the spread of bovine spongiform encephalopathy (BSE) and similar animal-borne or carried diseases the European Parliament and the Council of the European Union published the Animal By-Products Regulation (ABP) laying down health rules concerning animal by-products not intended for human consumption in October 2002 (European Parliament, 2002). This regulation was transposed into Irish law via SI 248 of 2003. Under the legislation, the treatment of animal products is categorised according to assumed risks and split into high (Category 1), medium (Category 2) and low risk (Category 3) material categories. Parameter values relating to composting processes of time, temperature and particle size are outlined for each category.

Domestically produced catering waste is considered to be low risk (Category 3). Catering waste arises from kitchens where it would have been deemed fit for human consumption, and is defined in the EU regulation as 'all waste food including used cooking oil originating in restaurants, catering facilities and kitchens, including central kitchens and household kitchens' (European Parliament, 2002, p.27).

In relation to composting process parameters, catering waste (with/without manure and/or digestive tract content) may be treated to either the EU processing standard of 70 °C for 1 hour with a maximum particle size of 12 mm or the national standard of 60 °C for 48 hours (twice), with a maximum particle size of 400 mm.

3.4 European Union Environmental Action Programme

In addition to European Union directives the EU also influences environmental management through the Environmental Action Programme.

Under the The Sixth Environment Action Programme ('6th EAP) of the European Community 2002-2012 (European Parliament and Council, 2002), the thematic strategy for soils lays down principles for soil protection and proposes legislative measures in relation to soils.

Considering that soil is the basis for 90% of all human food, livestock, fibre and fuel and given the interdependent relationship between soil quality and other environmental media such as water quality, legislation setting soil quality standards is urgently needed in this area. A Commission legislative proposal on soil is still in development as proposed under the 6th EAP thematic strategy on soil.

3.5 National Legislation and Position Papers

3.5.1 *The National Strategy for Biodegradable Waste*

Biodegradable municipal waste (BMW) is waste that can undergo biological decomposition. It is typically composed of food and garden waste, wood, paper, cardboard and textiles (Curtis, 2008). The National Strategy for Biodegradable Waste was published in 2006 by the Department of the Environment, Heritage and Local Government (DoEHLG, 2006b). This outlines government policy for the diversion of biodegradable municipal waste from landfill. The strategy proposes to promote separate collections of biodegradable waste on a widespread level and ensure development of markets to create demand for the materials recovered while restricting alternative outlets through bans and taxes and restriction of illegal activities. The strategy proposes setting up an implementation group to co-ordinate the implementation of the strategy.

According to the strategy, approximately 75% of municipal (household and commercial) waste is biodegradable (DoEHLG, 2006b). Despite a commitment to reduce BMW disposal to landfill by 75% of 1995 levels, the quantity of BMW disposed of to landfill increased by 4% to 1,475,077 tonnes in 2007. This is at variance with the 2010 target set by the Landfill Directive of 967,433 tonnes. Full implementation of the National Strategy for Biodegradable Waste is increasingly urgent, given that the first target year of 2010 requires a reduction in landfilling of biodegradable municipal waste of over 550,000 tonnes from current levels.

National legislation for source separation of commercial organic waste is currently being prepared by the DoEHLG to accelerate implementation of the strategy. In addition, CRÉ and the Environmental Protection Agency (Curtis, 2008) have both proposed a number of measures to ensure the landfill directive targets are met, including:

- collection of green waste (garden/landscape materials) at all recycling centres;

- the banning of organic waste disposal to landfill;
- the banning of untreated municipal waste disposal to landfill;
- financial incentives in favour of recycling and not disposal, including increasing the landfill levy;
- increase composting capacity and home composting;
- stimulation of markets for high-quality compost (CRÉ, 2008);
- promotion of at-source composting;
- expansion of research and development for at-source composting;
- increase of the landfill levy;
- market research for treated organic municipal waste products;
- subsidy for the treatment of organic municipal waste;
- development and assignment of responsibility for a national waste management plan;
- development of guidance on waste infrastructure and contaminated sites;
- development of stabilised biowaste standards;
- promotion of green procurement and marketing of organic municipal waste products.

3.5.2 National Animal By-Products Regulation

The Department of Agriculture, Fisheries, and Food (DAFF) is currently finalising the conditions for approval and operation of composting plants treating animal by-products in Ireland. CRÉ (McGovern, n.d.) has called for flexibility in implementation of the regulation, including a separate publication detailing the specific guidelines on catering waste to clarify the position and help facilitate growth of the sector.

Prior to 2008, the spreading of waste-derived compost was prohibited on pastureland (90% of land cover in Ireland). This prohibition was questioned by the Irish composting industry and CRÉ in relation to the approaches taken in other Member States and DAFF published additional ABP regulations (SI 252 and S1 253). Under DAFF's 2008 review, compost made from allowed feedstock materials can now be landspread, providing farmed animals do not have access for 21 days after landspreading, pigs for 60 days after landspreading and that there is a 21-day waiting period following landspreading of compost before production of an ensiled crop or hay.

Under current regulations the processing of household kitchen waste falls under the remit of the ABP regulations. Requirements to meet the processing parameters outlined in the regulations could impact negatively on community composting projects as essentially expensive technological treatment and regular monitoring would be required, rendering small-scale composting initiatives unfeasible.

3.5.3 Comptroller and Auditor General

The Comptroller and Auditor General noted in his annual report for 2005 that 'there is a significant risk that Ireland will fail to meet the targets set down in the Landfill Directive.' He also highlighted the 'possibility of EU financial penalties arising from any such failure' (Purcell, 2005, p.75). These financial penalties are estimated to be in the region of €180–€270 million per annum (CRÉ, 2007).

3.6 Status of Community Composting

Despite community composting schemes being quite slow to develop, many of the social, economic and environmental benefits discussed in Section 2.4. can be demonstrated by existing projects. The following section reviews the experiences of five small-scale composting projects around the world, identifying different options for collecting feedstock, engaging with participants and developing a successful composting initiative.

3.6.1 Flanders, Belgium

VLACO, the Flemish composting organisation, co-ordinated a programme to promote home composting (DoEHLG, 2006(a)). Three tools were used to encourage participation: (i) awareness, (ii) the polluter pays principle and (iii) the availability of cheap home composters.

This project highlighted the importance of awareness raising or 'sensitisation' where information and campaigning on waste reduction helped to achieve changes in attitudes and behaviour. Direct financial subsidies, the pricing of residual waste and biowaste collection graded against the organic waste prevention via home composting were also found to encourage participation.

The number of people active in home composting in Flanders grew from 19% in 1997 to 35% in 2002. 17% of the city populations and 39% of the rural population participate in home composting (DoEHLG, 2006(a)).

3.6.2 East London Community Recycling Partnership

East London Community Recycling Partnership (ELCRP) is a community recycling organisation based in Hackney, where high-density housing estates account for 56% of residences primarily in high-rise blocks. In 2004 ELCRP began to trial a food-composting scheme with 275 households (Binns, 2005).

Householders are provided with kitchen waste caddies and a Bokashi preparation to prevent odour. Bokashi is a mix of sawdust and bran that has been inoculated with 'effective micro-organisms'. Widely used in Japan and Korea, Bokashi speeds up the composting process while inhibiting organic kitchen waste from putrefying and collections are carried out on foot by ELCRP staff. The bins are collected from individual doorsteps on a weekly basis. On average, 2.7 kg of meat-included food waste and cardboard is collected per household per week. This is composted in Webb's Rockets (in-vessel containers) in a shed on the estate, and then fed to outdoor wormeries to mature.

The project has been in operation since initiation in 2004 and was the first community organisation in the UK to gain ABP regulation approval for its system. Participation rates on the project are approximately 90%. ELCRP claim this success is due to the direct involvement of residents either as employees or in a voluntary capacity, which encourages ownership. To encourage engagement ELCRP also facilitates meetings, workshops and partnerships with tenants associations, playgroups and community organisations.

ELCRP claims that the benefits of this project have resulted in a significant increased interest in composting. Formerly, all food waste was disposed of through disposal chutes, which frequently became blocked, attracting flies and vermin. Since the separation of food waste from the residual waste, these problems have stopped. The local authority has, as a result, saved on costs of unblocking chutes as well as vermin control and waste disposal costs (Binns, 2005).

3.6.3 Crampton Buildings, Dublin

The Crampton buildings project is a worm-composting project (vermicomposting) started by residents of flats in Temple Bar, Dublin in 1998. A large wheelie bin was converted into a vermicomposter containing 25 kg of earthworms to process kitchen scraps and other suitable waste. After some time, a prototype composting unit was introduced, replacing the wheelie bin with some 10–15 households using the scheme regularly. The finished compost was used by residents in window boxes, etc.

No formal collection methods were used for this project and participation rates of 25–30% were considered successful by scheme participants. Some education and awareness work was carried out (e.g. the distribution of flyers) to remind people to keep supplying waste. Feedback from residents indicated that participation rates might have increased if households had been provided with small kitchen caddies. Also, difficulties arose in monitoring and keeping the worm population alive.

Recent research suggests that participation rates have dwindled. 'Insights from the Crampton Buildings experience highlight the difficulties in raising and maintaining residents' interest in communal composting in the face of free mixed-waste collection, and when key composting "leaders" leave the community. These are key considerations to potential communal composting strategy devisers at a time when urban residential densities are increasing, and communal bins in flat complexes offer little economic incentive to source-separate waste' (Binns, 2005, p.90).

3.6.4 Dhaka, Bangladesh

Research-based non-governmental organisation (NGO) 'Waste Concern' began composting activities in Dhaka in 1995 with the aim of developing a low-cost technique for composting the city's MSW and creating job opportunities for the urban poor. The composting facility uses a labour-intensive Indonesian windrow technique and is operated at full capacity of 3 tonnes/day of waste serving 1,430 households. The composting process is carried out over a period of 53 days (7–8 weeks). The compost piles are turned manually and as the compost becomes mature it is manually screened and packed.

The marketing of compost is facilitated by the NGO through direct marketing to end users and through a bulk supplier or retailer working in the fertiliser industry. Financial analysis of the plant revealed that revenue from compost sales covers over 75% of the total annual costs of the plant, which makes an annual profit of over US$3,745. Waste Concern was given the land for the plant by the government who have estimated a saving of US$18,518 in transportation and landfill services. Based on the success in Dhaka, the NGO also run composting initiatives in Khulna city and Chittagong city (Korner and Visvanathan, 2007).

3.6.5 Christchurch, New Zealand

Although not a community composting initiative, the experience of kitchen waste recycling in New Zealand is also of interest to this project. Organic waste is the largest component of the Christchurch waste stream – totalling around 76,000 tonnes per year, i.e., 32% of the total waste going to landfill in Christchurch. Garden organics make up around 51,000 tonnes of this, with kitchen organics making up around 25,000 tonnes.

In order to increase the diversion of organic waste from landfill in Christchurch a kitchen organics collection trial was conducted. Its aim was to investigate the feasibility of a kerbside domestic kitchen organics collection to meet the targets of the New Zealand Solid and Hazardous Waste Management Plan 1998 (Christchurch City Council, 2003).

Domestic kitchen organics were collected at the kerbside over an 8-week period (May to July 2002) from two socioeconomically different areas in Christchurch (Fendalton and Burnside). Participation was voluntary and the overall participation rate was 23%. Each household received information and all materials required for the trial. Some households set out buckets every second week (8%) while most placed them out every week (87%).

The council considered the project a resounding success. Those involved were overwhelmingly supportive of the service and were not only willing to continue to use it in its current form but were also willing to pay for the service through their rates. Nearly all the households participating used the service on a regular basis. Alongside the positive public support, the benefits of diverting this material chiefly relate to the avoided landfill costs (NZ$84 per tonne), the reduction in costs associated with treating leachate and landfill gas, and the beneficial use of the material as a compost product.

Among the recommendations included in the trial report were that an enclosed processing facility for putrescible material should be established in Christchurch to process domestic kitchen organics and that a similar system should be established for businesses (Christchurch City Council, 2003).

3.7 Factors Affecting Recycling and Environmental Behaviour

The case studies above provide an introduction to factors that affect recycling and environmental behaviour. Research has shown that 'the inclusion of societal and cultural realities, household involvement and analysis of individual needs are indispensable to the success of recycling and waste-reduction interventions in which change of individual behaviour is the key factor and main focus' (Mosler et al., 2008, p.524).

However, an interesting factor established from this research is that, in general, 'personal factors only effect the variance of recycling behaviour slightly, although a tentative list of personal predictors shows a consistent influence on recycling behaviour from specific attitudes, knowledge, income, and locus of control' (Mosler et al., 2008, p.524).

Situational factors have been shown to have a much stronger predictive power on recycling behaviour than personal factors. Lebersorger (2008) notes that the dwelling character is an important determinant for waste quantity and waste composition. Compared to single-family dwellings (SFD), waste diversion rates in multi-family dwellings (MFD) are usually lower. For example, studies have reported waste diversion rates of 12–55% for areas with predominately MFDs in Dresden, Germany, and 62–96% for SFDs (Lebersorger, 2008).

Lebersorger's research also notes that in SFDs the household and building can be considered a functional unit, whereas in MFDs many factors are involved. In SFDs the consequences from waste minimisation by recycling or waste prevention can be more directly perceived than in MFDs. In contrast, in MFDs decision processes are much more complex. Typically, a property developer manages the construction of the building or complex. Important decisions are often taken by property owners or managers who in most instances do not live in the MFD and are therefore not directly affected by the consequences of their decisions.

As such, MFDs have to be considered as a special field and require the development of adapted solutions that allow for specific conditions. Past attempts to improve multi-family recycling have often focused upon only one condition such as the fee system for residual waste. However, alongside the collection scheme, there are several other factors that differ between SFDs and MFDs and have a significant influence on residents' attitudes and behaviour.

As well as available floor space for recycling facilities, a second aspect is the distance to the storage containers and waste collection points. Residents of MFD usually have to go downstairs and thus often have to pass several floors to reach the waste collection points.

Providing compostable bags from cardboard or bioplastics for the residents can help facilitate the separation of bio-waste. Residents can collect biowaste in their kitchen in such a bag and dispose of the waste and bag together. Thus, they are spared washing their small collection bin (kitchen caddy) for biowaste. These bags also mean that no bin has to be carried down to the composting area and taken back to the dwelling, allowing residents to deposit biowaste on the way to work, shopping, etc.

Research also highlighted key social aspects to be considered, such as high population density, anonymity, high tenant turnover and a lack of a sense of personal responsibility.

4. Project Implementation

4.1 Work Package Objectives

- Evaluate organic waste collection and compost processing systems.
- Determine key elements and optimum conditions necessary for food waste composting projects.
- Design and establish a successful composting programme in an apartment block in Ballymun.
- Produce compost from household organic waste.
- Identify barriers to the implementation of waste composting initiatives.

4.2 Introduction

A review of relevant literature, case studies and experience of previous environmental initiatives in Ballymun highlighted a number of key elements to be considered in the implementation of a best-practice composting programme. These included:

- site selection: availability and convenience of facility;
- collection system: bins, bags etc.;
- type of composter/processing equipment;
- frequency of collection.

An additional project objective was to apply the core EU principles of proximity and polluter pays to community composting implementation and management. In order to incorporate these within this project, criteria for finding a suitable site had to include:

- the potential to be able to reward people who participate in the initiative thereby reducing waste disposal costs for the apartment complex (polluter pays principle);
- a site for processing waste – the composting process should be as close to source as possible and also be easily accessible. The location of the composter and its proximity to the potential resident participant was important (proximity principle).

A study was designed to determine best practice in relation to community composting. The study was broken down into pilot and full-scale implementation phases. The results from the pilot study, which ran for 8 weeks in Santry Cross, Ballymun and 6 weeks in Gateway, Ballymun, established optimum conditions for the full-scale programme. The full-scale programme ran for 44 weeks and resulted in key recommendations for a community-composting project development.

4.3 Pilot Study Objectives

- Analyse participation and quality levels throughout the programme.
- Assess which parameters resulted in the greatest participation within the pilot.
- Compare potential project sites.
- Develop operational and management procedures for the full-scale programme.

The methodology and collection procedures were reviewed and the results analysed to inform Phase 2.

4.4 Pilot Programme Methodology

Prior to and during the implementation of the pilot project a number of project parameters were evaluated and assessed, including site selection, waste-collection methods and processing options.

4.4.1 Site Section

Following a survey of suitable study areas within Ballymun, a comparative analysis was carried out between three potential apartment complexes in Ballymun: Gateway, Santry Cross and College View. A summary of the key selection criteria and analysis is given in Table 4.1. The table highlights criteria such as resident and management buy-in and the availability of an area for composting as essential.

Having reviewed this information, the team decided to run a pilot programme at two of the preferred sites: Santry Cross and Gateway student accommodation. College View was eliminated due to the time requirement to carry out an architectural and engineering assessment of the load-bearing capacity of the roof garden, absence of consensus from all residents and management, potential elevated costs of installation and longer-term liability concerns. Both Santry Cross and the Gateway site met the minimum requirements in relation to availability of a site for the composter and interest from management and residents. However, demographics between both residential developments varied greatly given that the Gateway accommodation was primarily targeted at students. A pilot at both sites presented an opportunity to further test the selection criteria and identify results due to demographics. Additionally, because the success of the project would be dependent on a number of influences that could be determined only by assessment of a project roll-out, the implementation at two sites allowed future flexibility within the project.

Pilot participants were a 50/50 mix of those residents who expressed an interest in participating in the project, and those who had very little prior knowledge and/or interest. Residents were given the opportunity to find out about this pilot through door-to-door introductions and at an open day in a nearby hotel.

4.4.2 Collection Service and Duration

To facilitate an easy to use system, it was decided to operate a weekly door-to-door collection service over 8 weeks. The project was carried out with 21 apartments in each study area. Participants left compost bags or kitchen caddies outside their front door at a prescribed date and time to be collected by the project team. The service was

Table 4.1. Selection criteria for community composting pilot.

Site Selection Criteria	Site A Gateway	Site B College View	Site C Santry Cross
Percentage owner occupiers	None	Low	High
Location in Ballymun	Suitable	Suitable	Suitable
New build apartment	Yes	Yes	Yes
Available area on site to locate in-vessel composter	Yes, underground car park but access is limited.	Yes, 2nd floor roof garden only. No space at ground level	Yes, two potential sites
Structural works required for composter installation	Pipe work, ventilation etc.	Architectural/engineering assessment may be required	Alteration of existing bike shed area
Support of facility management company	Yes	Yes, however, keen to pass on benefits to landlords rather than residents	Yes, happy to pass on cost benefits to occupiers
Dwelling characteristics	Multidwelling (student flats)	Multidwelling	Multidwelling
Representative of other developments nationally	Not really as student only residence. Replicability limited	Yes	Yes
Other considerations	Positive response from tenants. Potential for incentives limited	Limited response from residents. Majority non-national. Multi lingual survey required	Enthusiastic response from Residents committee. Newly occupied with management issues on going

Table 4.2. Caddies assessed during community composting pilot.

Caddy	Supplier	Price per unit (€)	Max. cost (135 units) (€)	Max. budgeted amount
5 litre standard	Dublin City Council	10	1350	1500
5 litre standard	Eco Ireland	25	3375	1500
Different sizes	Wicklow County Council	6.50 upwards	877.50	1500
Meco 7 litre	www.wastess.com	5.50 inc. VAT	742.5	1500
Meco 10 litre	www.wastess.com	6.50 inc. VAT	877.5	1500
Minimax 7 litre	www.epson-ewell.gov.uk	(£5.00) 7.22	(£675) 973.93	1500

Table 4.3. Liners assessed during community composting pilot.

Bag / Liner	Supplier	Price per unit (€)	Max. cost (7000 units) (€)	Max. budgeted amount
Clear liner	www.epson-ewell.gov.uk	6 roll of 52 0.12 cent per bag/unit	807.70	1200
Biobags, cornstarch (compostable)	www.ecoshop.ie	30 bags (8 litres) per roll at 5 0.16 cent per bag/unit	1166	1200
Brown paper bags	www.mashers.co.uk	500 bags (7 x 26.5cm x 21.5cm) for 18 0.4 cent per bag/unit	280	1200

supported by an education and awareness campaign, which is discussed in detail in Section 5.

4.4.3 Collection System

Because a door-to-door service was operated it was decided that kitchen caddies could be used by the householder to both store and collect the waste. A number of waste caddies were assessed by the project team during the pilot phase and people participating were offered their preferred size. Options included 5, 7 or 10 L bins. Organic waste production was estimated at 4 kg per household per week based upon the findings of the national study *Organics Waste Management in Apartments* (Carey et al., 2005) which quotes average household rates of 3.64 kg per week. Details of the caddies used within the trial, their cost and capacity are given in Table 4.2.

In addition to the provision of caddies, all participants within the study areas were offered liner bags. (The team trialled three options during the pilot.) Details in relation to the bag types and costs are given in Table 4.3.

4.4.4 Compost Processing System

From the review of relevant literature and case studies, key considerations in relation to composting systems (e.g. in-vessel, open windrows, vermiculture, etc.) were established. Features of each system in relation to operating capacity, technical/processing restrictions, type and size of collection system, ease of use, odour mitigation, volume reduction, and cleanliness of the system were considered.

Based on the findings and the previous application of in-vessel composting in the Ballymun area, in-vessel technology was selected as the preferred composting system. During the pilot phase, waste was processed in the existing in-vessel ‘Jora’ composter located at the civic centre in Ballymun. This allowed the process equipment requirements to be assessed for consideration and inclusion within the decision-making process for full-programme roll-out.

4.4.5 Data Collection

The project team continued to collect the following data throughout the project:

- names and addresses of project participants;
- input weights of food waste per dwelling;
- comments and feedback from project participants;
- temperatures within the composter;
- composting process observations.

4.5 Results

Figure 4.1 shows the amount of waste collected weekly from Santry Cross participants during the 8-week period. The average amount of waste collected per week was 11.7 kg. The average amount of waste per household (hhd) per week was 1.55 kg.

Figure 4.2 shows the number of Santry Cross apartments participating in the project during the 8-week period. The maximum number of apartments participating in any one week was 11. The average number participating per week was 7.75.

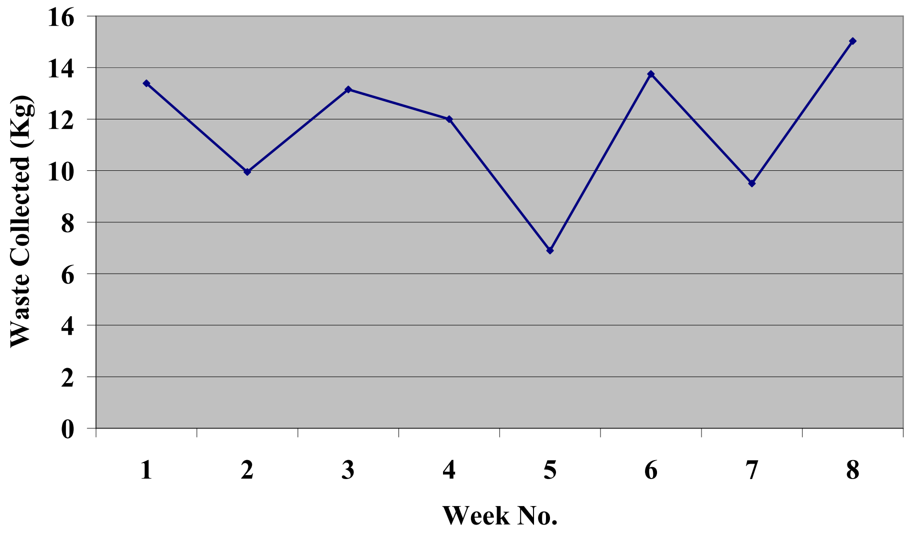


Figure 4.1. Amount of waste collected weekly (Santry Cross).

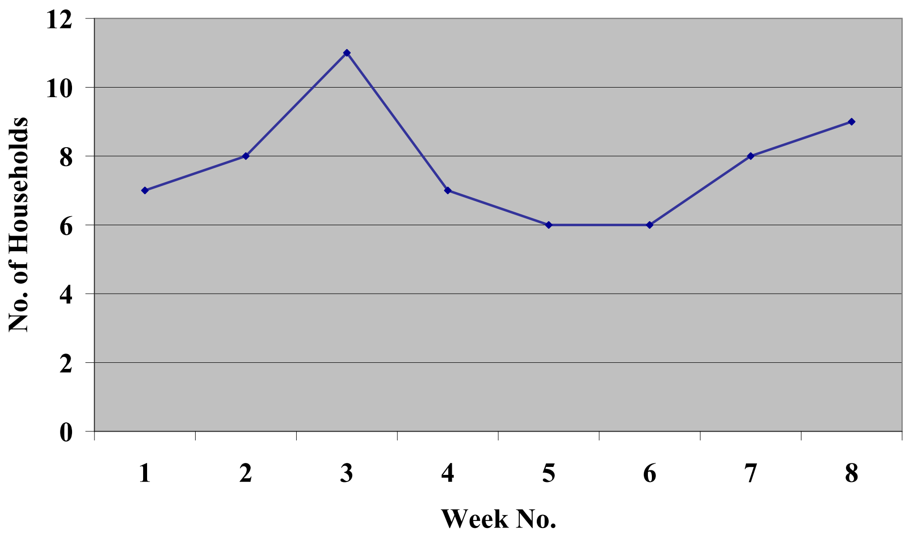


Figure 4.2. Number of apartments participating (Santry Cross).

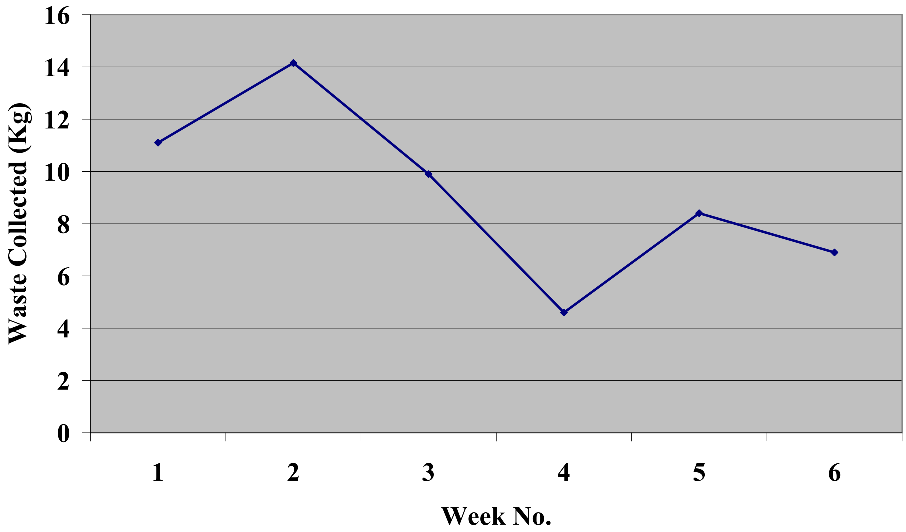


Figure 4.3. Amount of waste collected weekly (Gateway pilot study).

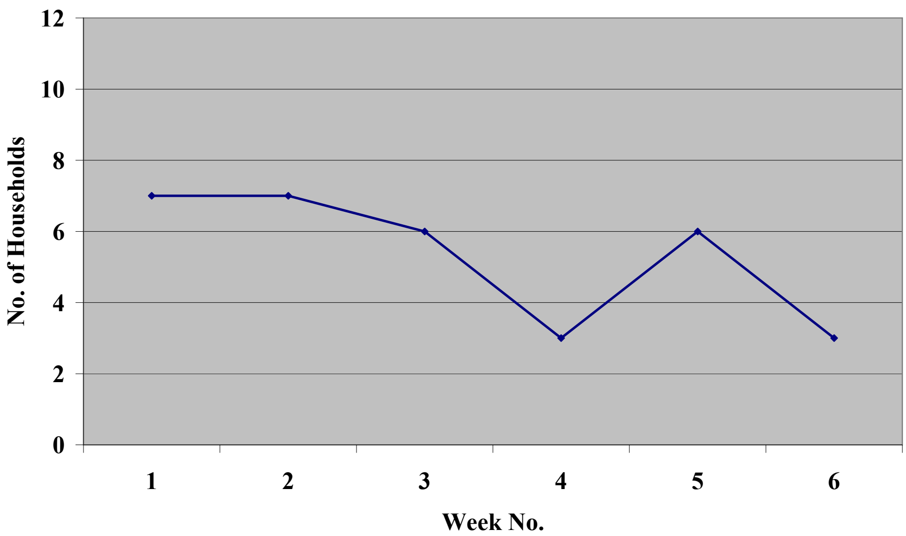


Figure 4.4. Number of apartments participating (Gateway pilot study).

Figure 4.3 shows the amount of waste collected at Gateway during the 8-week study period. The average amount of waste collected per household per week was 1.31 kg. The average amount collected per week in total was 9.17 kg.

Figure 4.4 shows the number of apartments participating in the project per week. The average number of apartments participating per week was 5.3 and the maximum number in any week was 7.

Overall, participation rates were lower than expected. The numbers within the Gateway complex were particularly disappointing. At the highest point of participation, there were still only 7 out of 20 apartments using the composting service being provided to them. Detail of feedback from both areas is given below.

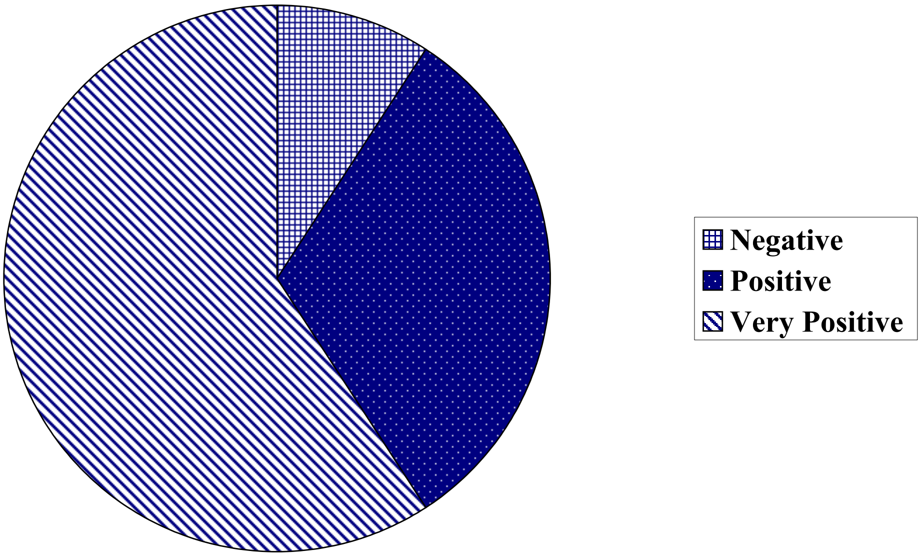
4.5.1 Feedback from Participants

Feedback from participants was crucial to the successful development of this work package and site selection. It was a key function of the pilot study to identify project weaknesses and to use this information to develop and improve the main composting initiative.

Door-to-door surveys of participants in Santry Cross and Gateway were carried out during the course of the project to gather feedback and to assess the attitudes of residents. The outcomes of the surveys are summarised in Figures 4.5 and 4.6 and an example of comments received are contained in the accompanying tables.

4.5.1.1 Santry Cross

Figure 4.5 illustrates the feedback overall among participants in Santry Cross – the results show a generally positive feedback from participants, although some issues were identified in relation to bin sizes and the ability to visualise project implementation.



Examples of comments made	Category
'Would be interested if it leads to management savings. Felt the service was very good.'	P
'Was happy with service, although did not remember to use it every week.'	P
'Think the project is great. Tues and Thurs evening 1700–1900 would suit best. Would prefer 25 L caddy.'	P
'Interested in theory, but feel we're not ready for it yet.'	N
'Think it will be more of a success when people can actually see the machine being installed, as this will raise awareness.'	N
'Very happy – small green bin was perfect, 8 L bin is good. Tues 1700–1900. Text is best communication.'	VP
'Good. Would like to be able to follow up information and progress on the pot trials.'	P

Figure 4.5. Analysis of feedback (Santry Cross pilot study).

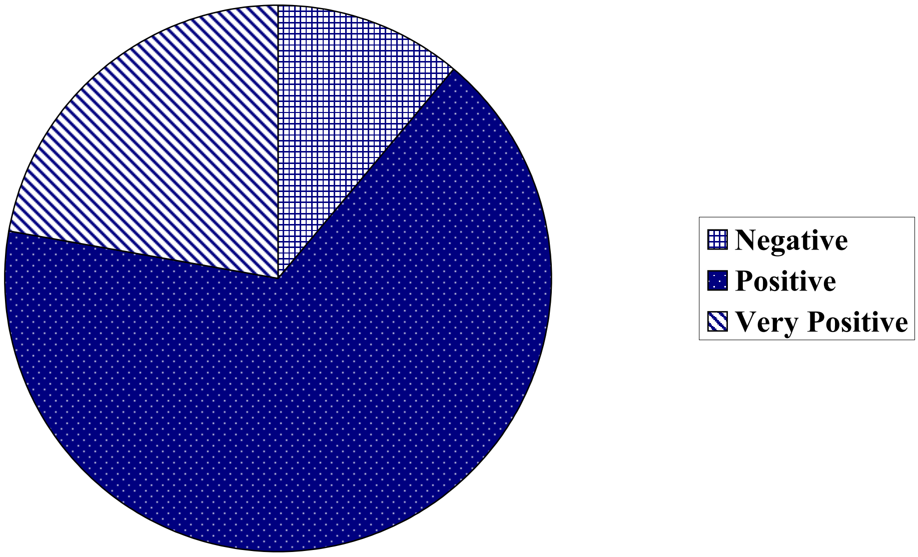
4.5.1.2 Gateway

Figure 4.6 gives an analysis of feedback and a table of comments from the Gateway residents. Overall, feedback here was more negative than in the Santry Cross development.

4.5.2 Site Selection

Based on the feedback and results, it was decided to develop the full programme at Santry Cross. Participation levels and average volumes of waste collected per household at Santry Cross were significantly higher than the Gateway development.

Feedback was further reviewed and changes made to the full-scale programme in response. This is discussed in detail in Section 4.6.



Examples of comments made	Category
'More regular collection or better reminder techniques may have worked better.'.'	N
'Once a week wasn't enough, got smelly.'	N
'Thought it was good. Liked the fact that they didn't have to bring the bin anywhere.'	P
'Caddy was too small if a 3 person flat was going to use it properly everyday, especially if they were cooking items from scratch as opposed to packet, ready made dinners, etc. [Had larger green caddy]'	N
'Good idea, hard to get everyone in the apartment to take part.'	P
'I didn't know when the pick-ups were being done. Not enough info was given.'	N
'Good and necessary. Pity there was no other recycling in the building. Once a week for 3 people in the flat was not enough.'	N
'Only used for one collection. Problem with once a week collection was if you forgot one week, then you always had a problem.'	N
'Good to have, but smelly. Biodegradable liners broke down too soon.'	N

Figure 4.6. Analysis of feedback (Gateway pilot study).

4.5.3 Composter Observations and Selection

The following observations were made during the pilot phase:

- Compost temperatures were highest in the 12/24-hour period following input of feedstock, indicating increased biological activity with new feedstock.
- Odour issues were experienced following use of shredded paper as a substitute for wood chips and this was abandoned.
- Odours were also experienced when there was a delay in woodchip delivery.
- Material not processed within two days of collection began to putrefy resulting in odours and the material having to be disposed to landfill.
- Regular and even input of materials into the in-vessel compost machine prevented stress on the compost process/system and resulted in less variance in compost temperatures.
- A temperature probe, purchased for recording daily temperature, was considered inadequate.

Details of in-vessel systems considered for the composting process are given in Table 4.4.

Following the observations and site visits, the project team concluded that a Big Hanna T-120 in-vessel composter was the most suitable for the project. This was because the T-120 allowed sufficient capacity for the apartment complex and – importantly from a quality assurance perspective – allowed effective daily logging of compost pile temperatures on site and via remote log-in. The T-120 also included a user-friendly control panel allowing ease of access to change machine parameters. In-vessel composting is not necessarily an odour-free process and the T-120 supplier was able to offer an integrated odour management solution in addition to a comprehensive maintenance support programme, which was also considered essential.

4.5.4 Collection

4.5.4.1 Caddies

The pilot study had recorded complaints in relation to odours associated with the collection and storage of organic waste in the home and communal areas. Levels of participation were quick to fall following issues with odour, particularly when associated with missed collections. A number of personal and logistical factors were contributory factors in this regard, but links between odour and hygiene were hard to overcome once they had occurred. People's perceptions of 'clean' and 'dirty' were strong deciding factors in their future participation.

If householders missed a collection date and placed their bin or bag at their apartment doors, issues with odour and hygiene were inevitable. Leakage from biobags onto carpets was also problematic. In order to address odour issues within the home a number of actions were implemented. The project provided compostable liners for people participating to help keep their caddies clean and encouraged people to use them. Where participants did not want to use the liners, it was suggested that they use torn-up newspaper to line the bottom of the bin and that they washed the caddy regularly with a non-bacterial detergent. Bokashi, a Japanese bran and compost activator, was also offered to householders to absorb

Table 4.4. Comparison of options for in-vessel composting.

Composter	Capacity	Supplier	Total price (excl. VAT) (€)	Budgeted amount
Big Hanna T-120 plus logging system. Inc. delivery, commissioning, training and 12 month warranty	90–135 houses = 26 tonnes per annum (tpa)	NEC Distributors	27,294	27,675
Joraform 5100 Industrial Food Waste Digester. Inc. delivery and installation	45–90 houses = 17.5 tpa	Grow Green Solutions	24,000	27,675
Green Rocket A500 inc. delivery	26 tpa	Green Rocket Ireland	22,050	27,675

moisture and expedite the composting process. The increased frequency for waste drop-off was also seen as a positive action to combat in-house odours.

4.5.4.2 Bags

Paper bags were found not to work for door-to-door collections as they became too weak when damp. They were however considered suitable for lining bins. A comparison between the other two bags trialled (see Table 4.3) recorded no particular preference among users. However, neither of the bags used was suitable for direct disposal to the composter receptacle/waste chute as they got caught up in the waste shredder and caused the machine to break down. This was easily overcome by emptying the bag's contents into the waste chute and then placing the empty used biobag directly into the main chamber of the in-vessel composter. One cost consideration however is that approximately 5,000–7,000 bags are required per annum for a weekly collection for 135 apartments. However, this amount of bags was not used during the project as full participation (135 apartments) was never reached, and instead the project team ordered bags on an as-needed basis.

4.6 Full Programme Objectives

- Implement the findings from the pilot study.
- Develop a successful programme in Santry Cross.
- Identify barriers to project implementation.

4.6.1 Methodology

Taking into consideration the findings of the pilot project and feedback from participants, a number of programme improvements were implemented. A Big Hanna in-vessel composter was installed within a modified bicycle shed in Santry Cross. The door-to-door weekly collections were replaced with an advertised organic waste drop-off service.

The changes to the collection processes resulted in service improvements, which allowed for:

- supervised periods when the compost machine could be visited throughout the week;
- increased frequency of service, providing participants with the capacity to compost up to 3 or 4 times weekly if they wanted;
- face-to-face contact with the project team to discuss waste-management and environmental issues;
- reduced demand in terms of staff hours compared to door-to-door collection service;
- elimination of odour issues relating to material spills in apartment hallways;
- swift identification and management of contamination and other issues by project team staff;
- effective monitoring of landfill diversion rates;
- accurate collection of data for calculating reduction in waste-management fees.

The changes could also potentially provide for:

- additional reductions in kitchen odours due to more regular opportunities to compost;
- improved participation as residents see the composting process in action and become more interested and engaged;
- increased 'ownership' of the programme by residents;
- possibility of residents, following training, getting more involved in the operation of the compost programme;
- provision of a communal focal point for residents;
- ability to focus door-to-door education and awareness sessions on those residents not participating in the programme.

4.6.2 Data Collection

The project team continued to collect the following data throughout the project:

- names and addresses of people participating in the project;
- input weights of food waste per dwelling;
- comments and feedback from people participating.

4.7 Results and Discussion

4.7.1 Waste Collection and Participation Numbers

Figure 4.7 shows that the average amount of food waste composted per apartment per week was 4.35 kg. This is higher than the figure of 3.64 kg per week outlined in the national study *Organic Waste Management in Apartments* (Carey et al., 2005) but less than the figure of 7.09 kg for houses outlined in the same study. Of particular note is the major increase in waste in comparison to pilot study results, indicating the improved diversion rates due to increases in the frequency of service, revised procedures and awareness-raising activities.

Seasonal variations also had an impact on the amount of composting activity. Although not recorded here, bad weather and poor light were causal factors noted on several occasions throughout the programme. Even though the Big Hanna was fully enclosed in a modified bike shed in the car park of the development, all residents had to go outdoors to bring kitchen waste to the compost machine and reduced participation rates were observed during periods of bad weather.

Figure 4.8 shows the number of apartments using the composter. The results give maximum participation levels. It is notable that levels of use drop dramatically during the December 2007 period (Weeks 15–18) even though the availability of the service was maintained over the holiday period.

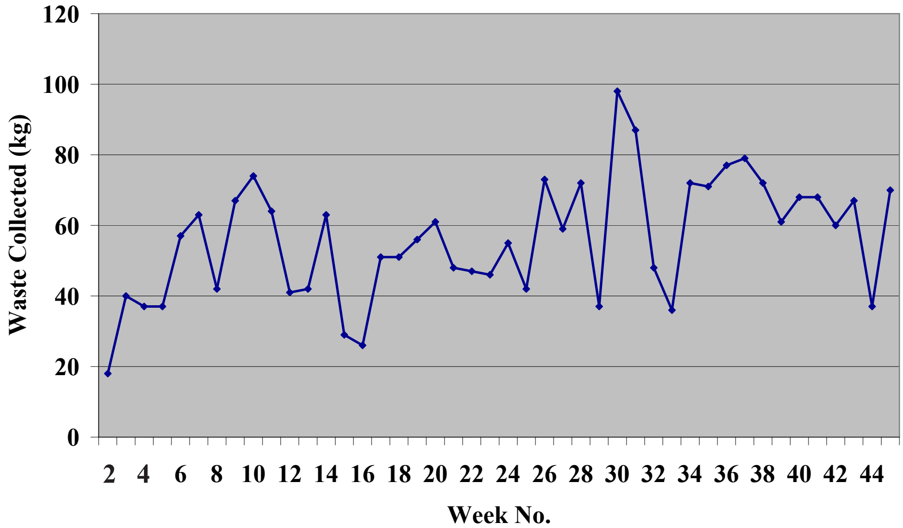


Figure 4.7. Amount of waste (kg) collected weekly.

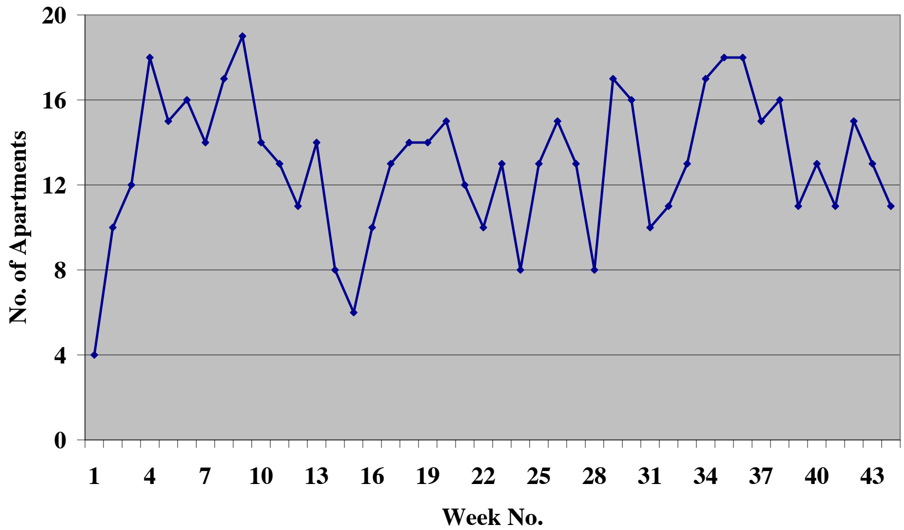


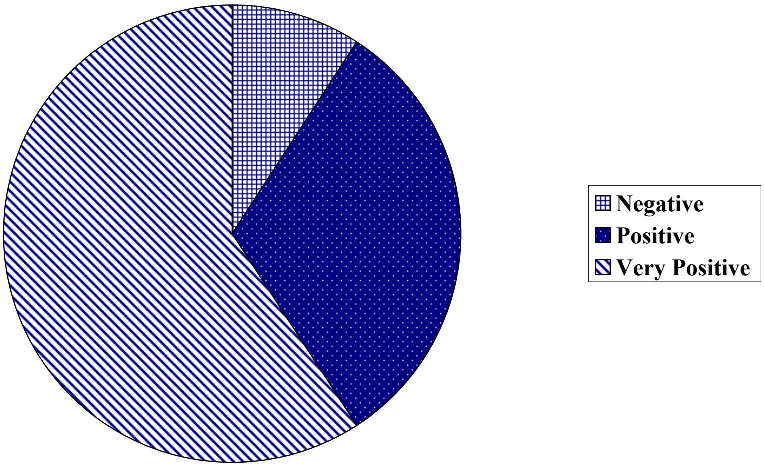
Figure 4.8. Numbers of apartments involved in the composting project.

4.7.2 Comments and Feedback from Participants

Results and interpretation of feedback on the composting project were gathered during door-to-door sessions and when people composting were visiting the compost shed in June 2008 (see Figure 4.9).

4.7.3 Amount of Total Waste Diverted

Not surprisingly, the amount of waste collected correlated with the numbers of people participating. As noted above, seasonal variations had an impact on the amount of composting activity, but unfortunately the project did not



Examples of comments made	Category
'Some of the compost bags leaked, but they were good and made it easier.'	N and P
'The caddies get quite smelly sometimes.'	N
'The opening hours were very good also.'	P
'I'm very happy with the service.'	P
'The idea works great, very happy. Think service is excellent.'	VP
'Times suit, very happy with service. Sometimes the shed wasn't opened when it was supposed to be though. Would like it to be open more often. Flowers and gardening workshops were great.'	P
'Thinks it is great. Sometimes it's hard to get down there on time though due to work. Hope it can continue. If it comes down to volunteers I might be interested in volunteering.'	VP
'Very happy with service.'	P
'Think it's great. Only problem is my shift work, but not a complaint against the programme.'	P
'It's great, no problem with it.'	VP
'Good but maybe open more on weekends.'	P
'The service is fine.'	P
'Very good service.'	P
'It's great. Think it's good.'	VP
'Good. May need to be open more.'	P
'Very good service.'	VP
'Fine, no problems. Don't come much as I live alone.'	P
'Opening times great.'	P

Figure 4.9. Feedback and analysis from project main study.

have access to data on the total amount of waste collected (kg) at the development throughout the project and therefore it was not possible to calculate diversion rates as a percentage of the total waste produced. It was observed that at least 1 out of 9 euro bins (1100 litre coloured bins normally found in apartment car parks and commercial premises) was diverted, and details of the waste contract, which were on a pay per lift and not pay by weight basis, were provided, which can enable estimations of cost savings to be calculated (see Section 4.7.5).

4.7.4 Contamination

Contamination levels of waste received were recorded as zero to low and verified by the compost sample analysis (see Section 6). These results are not surprising given that the composter was always staffed by a project team member, who would quickly check the content of the feedstock, remove any contaminants and highlight to the resident why any of the material had to be removed and could not be composted.

Since the handover of the project to facility management, the project team has noticed, via regular visual checks, a slight increase in amount of plastics in the Big Hanna, indicating that physical inspection of the feedstock and removal of contaminant materials by staff should be maintained.

4.7.5 Other Factors Influencing Participation

Lebersorger's research (2008) highlighted a number of situational factors which can play an important part in determining recycling behaviour in MFDs, including the decision-making processes relating to facility management, high tenant turnover, anonymity, lack of personal responsibility and lifestyle differences.

The transient nature of apartment living impacted on project participation rates; a high proportion of apartments within our study area were not occupied for various periods of time due to tenant turnover, and as such households were unavailable to partake in the composting programme. This resulted in a smaller than expected number of tenants using the service.

Due to the nature of the decision-making structure of the apartment complex, owner–occupiers and in particular people or families renting apartments were not empowered to be involved in decisions affecting the apartment development. The property developer had established a holding company for the apartment development, of which it retained majority shareholding control during the entire project period. In addition, an external property management company had been contracted by the developer to manage the collection of fees and service charges, cleaning, maintenance, car parking and security.

Moreover, due to the low levels of occupancy and a lower percentage rates of owner–occupiers, residents within the apartment were not as involved in collective decision making with either the facility management company or the property developer as had been anticipated. When the project commenced, an ad-hoc residents' association consisting of a number of owner-occupiers was active and the project team was in regular contact with this group. Issues relating to financial management of the apartment complex were the group's key concern and it was envisaged that with their support the details of the financial incentive scheme could be realised. While continually supportive of the composting initiative, the group's focus tended to be on other management issues relating to the new development. During the project the ad-hoc residents' association was dissolved. This was particularly disappointing for the project team as it had been planned to try and increase contact and train interested volunteers through the resident's association. Carey et al. (2005) note that the one indication of an apartment complex's lack of suitability for implementing an organic waste collection scheme is when there is a non-existent or inactive residents' committee.

Proposals to implement a financial incentive scheme for people using the Big Hanna were made to both facility management companies during the project period. This proposal was based on a 10–15% discount on total waste management fees (based on actual compost feedstock data) to be recouped from the savings made

Table 4.5. Projected cost saving scenarios.

Scenario	Food waste composted monthly (kg)	Monthly cost savings (€) *1	Recovery subsidy (€) * 2	Monthly cost savings including recovery subsidy (€)	Annual cost savings including recovery s ubsidy (€)
Actual	224	162.30 (1 eurobin diversion)	16.81	179.11	2,149.32
Potential (50% capacity)	616	324.60 (2 eurobin diversion)	46.37	370.97	4,451.64
Max. (100%) Capacity (T120)	1200	649.20 (4 eurobin diversion)	90.33	739.53	8,874.36

*1 Based on Annual Refuse Charge (Year Sept 2005 to Aug 2006 = €17,528.58). Charge per 1000 L eurobin (9 bins) = €1, 947.62. Charge per 1000 L eurobin bin per month including rental and lifts = €162.30. Data received from Keenan Property Management, 2005–2006. Average weight per 1000 L eurobin = max. load 440 kg × landfill waste density @ 0.7 = 308 kg.
*2 Based on average of domestic recycling subsidies paid per tonne in 2008 (www.repak.ie).

Table 4.6. Projected composter payback period.

% Usage	Without recovery subsidy (years)	With recovery subsidy (years)
25	14	12.7
50	7	6.1
100	3.5	3

by the removal of 1–2 mixed waste eurobins due to the use of the Big Hanna. Despite a detailed calculation of the cost savings and the support of the ad-hoc residents' committee for this proposal neither facility management company committed to passing on the savings.

An associated issue was that fees for waste management were based on the size of apartment and not the amount of waste produced. For these reasons it was not possible to ascertain exactly how effective the polluter pays principle would be if it were fully implemented, and a number of recommendations are made in light of this in Section 5.6. In the absence of any other financial incentive, the project introduced a '*Rotter*' competition, whereby a Supervalu voucher was given to the household composting the most. A number of residents, particularly children, expressed support for this initiative – however, the inability to pass on realised cost savings to those people participating was a considerable disincentive to participation in the project.

Details in relation to realised (actual) cost savings and projected cost savings if an organic waste-recycling rate or recovery subsidy was to be introduced have been calculated and are given in Table 4.5. Table 4.6 gives payback periods, with and without the recycling subsidy, for the composter purchased based on usage rates of 25, 50 and 100%.

The payback periods are based on a cost of the in-vessel composter, including installation and commissioning, of €27,294, excluding VAT.

In contrast to the pilot study, no complaints were received throughout the main programme relating to odour. It is assumed that this was because of a number of factors: increased frequency of the drop-off service; provision of bin liners and Bokashi (successful in dealing with odour management within the dwellings); and the installation of an effective biofilter to treat exhaust gases from the Big Hanna.

4.8 Summary

- A successful small-scale composting project for processing household kitchen waste was established within the Santry Cross development in Ballymun.

- In-vessel composting of organic waste has been proven to be a technical and economically viable technology for waste management in urban environments.

- The principles of the proximity principle have been demonstrated to be achievable through community composting initiatives. However, the polluter pays principle was more difficult to apply due to complex waste management fee structures.

- Furthermore, the study highlights issues relating to waste management fees within the study area, which are dependent on floor area and result in single-person households paying disproportionately higher fees compared to larger families within the same development. This agrees with the Dublin City Council report *Successful Apartment Living*, which further highlights the needs of owners to be central to the legal and financial structures of apartment management companies and to be aware of their entitlements. The study notes that 'In theory, since the apartment owners own the company, they have the power to establish the level of service charge, the way services are provided and which agent they employ', however, 'since most of the costs arise from services provided by agents, in reality, the agent sets the service charge' (Hanlon, 2007, p.3).

- Essential elements for the successful implementation of community scale composting initiatives within apartment dwellings, based upon the findings of this study include cooperation and commitment from the residents' association and the management company, provision of flexible and frequent access to the service and access to an effective processing system and odour mitigation processes or technology.

- The introduction of a recovery subsidy for organic waste would increase management company motivation to introduce a composting service and would reduce the payback period for composting equipment.

5. Education and Awareness

5.1 Work Package Objectives

- Develop and implement an education and awareness programme to promote the benefits of organics waste recycling and encourage participation in the community composting initiative.
- Investigate the effect of the education and awareness campaign on project participation rates.
- Identify key elements of an effective education and awareness campaign.
- Assess ways of encouraging ownership of the project among residents and participation in the day-to-day project within an apartment complex.

5.2 Introduction

Building upon the findings of the literature and case study experience, an education and awareness programme was developed to highlight the key environmental, economic and social benefits of community composting. The key messages for the communications strategy included details of the benefits of composting over landfill, environmental sustainability principles, potential cost savings, application of compost for soil improvement and details of the research study priorities.

Promoting composting and achieving biodegradable waste reduction is heavily reliant on developing public participation and engagement. Achieving changes in attitudes and behaviour through an education and awareness programme are considered generic indicators for the overall success of the project. The project team used a variety of communication methods throughout the project to engage with people within the study areas, increase participation and ensure continued composting activity.

Along with raising the general awareness of residents through education, there was also a targeted goal of empowering residents to a point where their knowledge and understanding are developed enough to want to get more involved. This builds upon the GAP model of empowerment described in the Ballymun *Eco Book* (Cocking, 2004).

5.3 Methodology

During the operational pilot studies in Santry Cross and Gateway, a complementary education and awareness programme was implemented targeting all households in each study area.

As noted above, the project provided door-to-door waste collections on pre-arranged days throughout the study period. The educational team provided intensive support and assistance to residents for the first 3 weeks of the trial in Santry Cross and for 1 week in the Gateway development. This support consisted of door-to-door sessions, telephone calls and the provision of a help-line, online support, mobile texts and information leaflets. Information was also posted in the communal areas of apartments, and resident feedback was continually assessed.

A key main element of all the education and awareness activities was the continual reinforcement of project benefits, primarily:

- reduction in organic waste going to landfill;
- use of compost to improve the local environment;
- cost savings based on reduced waste management costs.

Following the period of concentrated educational support and assistance, the project team withdrew active contact, such as door-to-door information sessions, and only provided responsive support and assistance to residents' queries or requests.

The aim of this strategy was to establish from participation levels what level of support was actually necessary and what had the greatest impact on resident participation in the project. The results were analysed and findings incorporated into the education and awareness campaign for the full programme. Following 44 weeks of implementation and monitoring, the results were collated and assessed.

5.3.1 Data Collection

The project team collected the following data:

- numbers of dwellings participating in the composting initiative;
- comments and feedback from participants;
- comments from non-participants.

5.3.2 Education and Awareness Programme Schedule

Table 5.1 illustrates the various education and awareness methods undertaken during the pilot and full-scale programme. Figure 5.1 details the frequency of education and awareness methods undertaken throughout all stages of the project.

Table 5.1. Summary of education and awareness methods.

Method	Description
Meetings	Regular meetings were held with both facility management companies (FM) and the ad-hoc resident's committee.
Open days	Two open days were held in Days Hotel, one prior to the installation of the Big Hanna and one shortly after the machine was up and running. All apartments were invited to these events where there was a presentation with questions and answers and refreshments.
Door to door	Door-to-door contact was used to meet residents, explain the project and distribute any relevant leaflets.
Leaflet mail drop	The preferable distribution method for leaflets was with face-to-face contact during the door-to-door sessions as this enabled the project team to answer any questions etc. Leaflets were distributed in both English and Polish.
Newsletter	The compost team produced a newsletter called the *Rotter* to distribute regular information on project progress.
Mobile texts	Regular reminders were texted to participants reminding them of the opening hours of the compost shed, or other relevant information such as upcoming meetings, gardening workshops, etc.
Help line	All leaflets, posters, etc. contained contact details including mobile number and email for the project team who could be contacted if there were any questions, issues, etc.
Compost shed open	The opening hours of the compost shed evolved and changed throughout the project. Generally, the compost shed was open on a supervised basis between 3 and 4 times a week.
Gardening workshop	To encourage use of composter, balcony gardening workshops were organised in Santry Cross for residents. Compost from the compost machine was used in planting-up pots for balconies with guidelines and tips on how to use the compost in gardening applications from a community gardener.
Letters	Letters were sent to all residents at key points of the project explaining the project; compost shed opening hours, handover, etc. The project team also maintained written correspondence with both FM companies.
Posters	Information posters were placed in communal areas of apartments for all residents to see. These were regularly updated.
CD fridge magnet	Old CDs were reused by placing a compost shed opening hours timetable and contact details sticker over one side with a magnet on the other.
Website	A separate page was created on the project team's website (www.rediscoverycentre.ie) and this was regularly updated with project information such as the information leaflets which were downloadable in pdf format
Signage	Two large 'What you can compost' signs were hung inside the compost shed and a further sign outside the shed.
General support	Occasionally, the project team had to contact people individually to provide specific support or answer questions by phone or email. An open door policy was encouraged.
Training	The project team provided training for facility management staff on how to operate the composter, what to do in case of breakdown, etc.

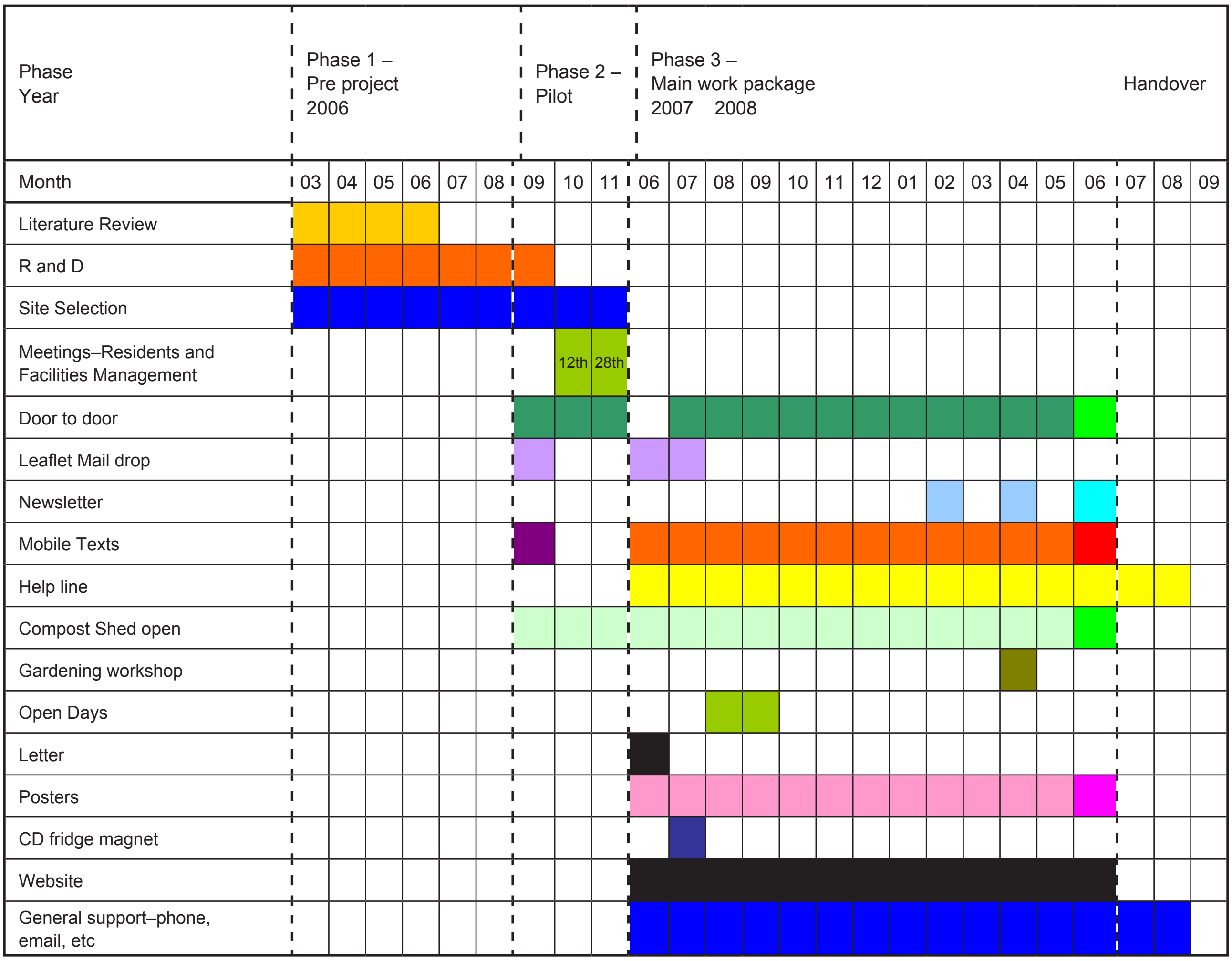


Figure 5.1. Education and awareness methodology, 2006–2008 phases.

5.4 Results and Discussion

5.4.3 Pilot Results

The aim of the pilot programme was to establish from participation levels what elements of the education and awareness programme worked, which elements were most accessible and which resulted in the greatest participation rates within the study areas. Figure 5.2 shows the participation rates between targeted Santry Cross residents.

Results show that individual participation levels peaked on the final educational session in the third week (Figure 5.2). Levels slumped and evened out following withdrawal of the educational and active support. A letter was sent to all apartments on 16 November inviting residents to an information open day, which appears to have had a positive effect on participation levels.

It is worth noting that even at the highest point of participation, there were only 11 out of 21 apartments using the composting service provided. Various factors may have influenced this – the project team noted in particular high apartment tenant turnover and communication issues, namely, the project team on occasion had difficulty explaining the idea of the composting service in English. As a result, it was noted that project information would need to be developed in more than one language (including, if possible, Polish and Lithuanian). On average, less than 2 kg per week of food waste was presented by each apartment participating. Levels of contamination in the caddies presented were low to zero.

Figure 5.3 shows participation levels observed in the Gateway development. This pilot programme in the student

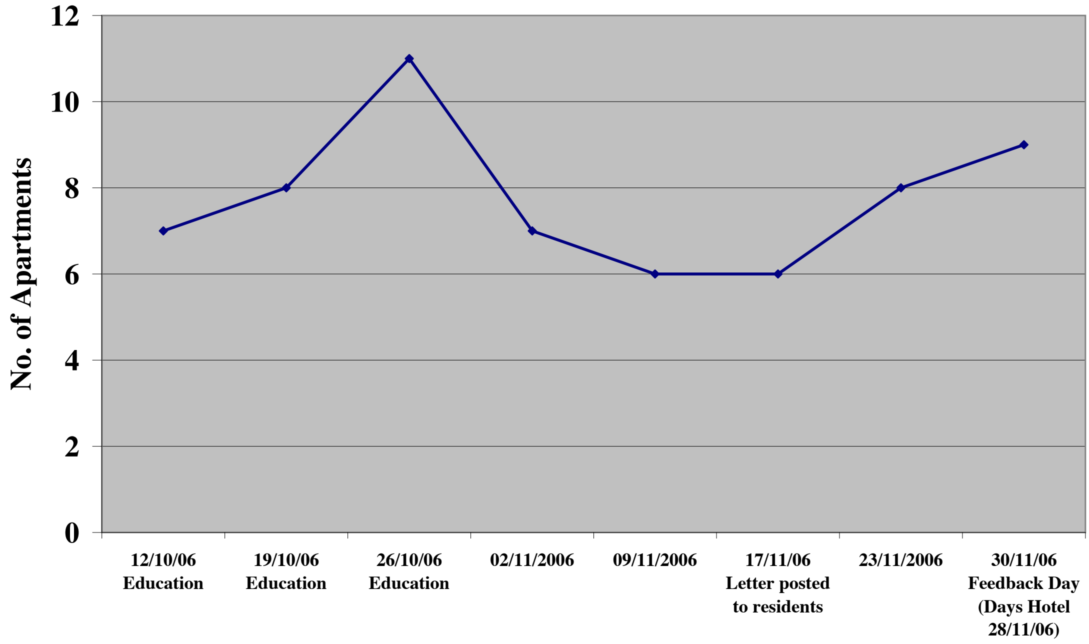


Figure 5.2. Number of apartments participating, Santry Cross pilot study.

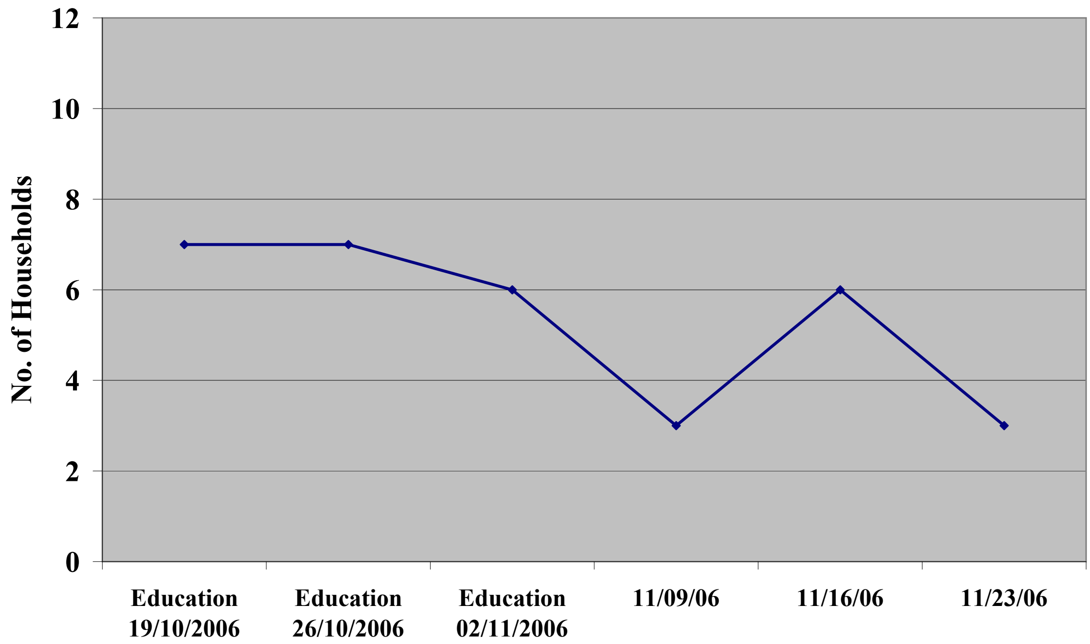


Figure 5.3. Number of households participating, Gateway pilot study.

residence in Ballymun followed a similar format to that in Santry Cross – however, door-to-door educational support was provided only for the first week. In relation to numbers participating, the results show that following the first week of educational support numbers remained steady and then fell until Week 4 when there was a slight increase for 1 week and then a final decline again. At the highest point of participation, there were still only 7 out of 20 apartments using the composting service being provided to them. Factors such as student lifestyles and shifting study and holiday patterns may have been an issue in this apartment block. On average less than 2 kg per week of food waste was presented by each apartment participating. Levels of contamination in the caddies presented were low.

5.4.2 Main Programme Results

The main composting programme in Santry Cross, where all (89) apartments had access to the Big Hanna T120 ran for 44 weeks from September 2007 through to June 2008.

Here, the education and awareness campaigns concentrated on face-to-face sessions such as open days, visits to the Botanic Gardens pot trials, balcony gardening workshops and door-to-door calls. Figure 5.4 below shows the effect of education activities and seasonal variations on the numbers of participant numbers. Open days occurring during Weeks 2, 3 and 5 resulted in initial project uptake. This early increase may have been assisted by the inclusion of the residents who had already been involved in the pilot project and were familiar with the process.

Door-to-door sessions produced increases in participation, but this was not sustained throughout the entire period of door-to-door contact. This indicates how some people used the compost machine shortly after a door-to-door visit and discussion with a team member, but over the period their regular behaviour did not alter.

The two gardening workshops both occurred at downturns in participation (Weeks 27 and 33) and appeared to initiate an increase in participation following each workshop.

The results show a significant decrease in participation during winter months and over holiday periods (Weeks 13–19) and an interesting follow-on study would be to track this pattern over a number of years to assess the actual impact of seasonal variation.

Although participation levels were sustained throughout the project, primarily as a result of the education and awareness campaigns, as a percentage of the total number of people in the complex, less than 20% participated in the initiative, as shown in Figure 5.5. These figures are comparable to food waste collection studies in New Zealand but were considered low by the project team and compared to the pilot study results within the same study area, which resulted in average participation rates of approximately 40%. It is important to note that the percentage participation rates within the main trial were calculated based upon estimated occupancy levels, which could not be confirmed and appeared inaccurate based on observations.

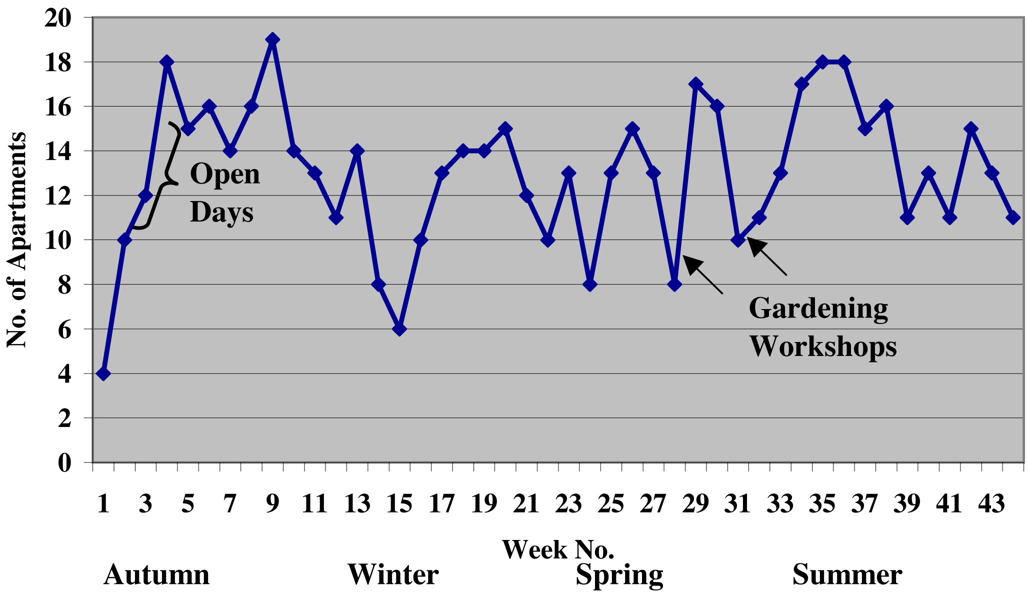


Figure 5.4. Effect of education activities and seasonal variation on participant numbers.

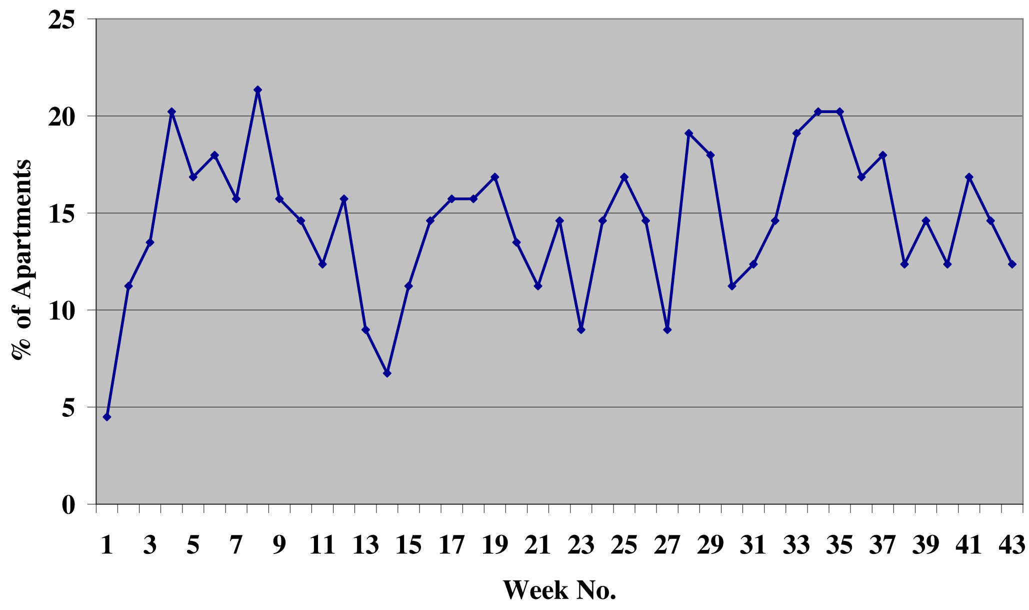


Figure 5.5. Number of apartments participating as a percentage of total apartments.

5.4.3 Effectiveness of Education Programme

Throughout the 44 weeks, there was a concerted effort in all education and awareness activities to try and encourage participation from all of the 89 units within the project area of Santry Cross. Generally, a pattern emerged where the same group of people regularly used the machine with very low levels of contamination. The project team considered that these people had become used to and were comfortable with using the service. Door-to-door sessions in the later stages of the project specifically targeted people who were not participating.

In all education and awareness materials, such as flyers, signs, newsletters, a visual representation of the communication was included. This proved to be an effective way of encouraging people to source separate waste materials, and also easily crossed language barriers. The various communications material developed also proved effective at communicating the biological processes involved, and what materials were acceptable for composting, as evidenced by the low levels of contamination in materials presented and the range of non-English-speakers who used the service regularly.

In assessing the effectiveness of the education and awareness element of the project, it is difficult to separate the personal factors from the situation factors as discussed in Section 4. Low levels of tenancy had a significant affect on project roll-out and it was difficult to ascertain how many of the 89 apartments were actually occupied.

Following discussions with facility management and the residents' committee it was agreed to issue the project team with a fob (electronic key) allowing access to the apartment development, in order that they would be able to talk to people face to face about the composting project. While door-to-door calls were the most effective way to make face-to-face contact about the initiative, in practice these calls were often difficult to make due to the design of the Santry Cross apartment block. For example, the doorbell of apartments on the fourth floor would be located at the ground floor entrance. As not everyone would choose to answer their door buzzer, some people were then surprised to receive a knock on their apartment door a few minutes later. Concerns over privacy and security were as a result raised as an issue and some residents were not supportive of people other than themselves having fob-key access to the development. As such, while the apartment development was designed with privacy and security as key elements, these same considerations also allow in practice increased anonymity and social exclusion and immobilise residents from making collective action initiatives.

Although the results primarily show increased participation rates coinciding with educational campaign activities, anomalies do exist where the volume of waste being diverted drops and people participating drops within a period of education and awareness. Other factors regardless of engagement come into play here such as darker evenings, colder months and rain.

A newsletter (the *Rotter*) was produced and distributed to all the households within the complex. This was also an effective way of advertising the project, best composter competitions and gardening workshops. The success of these as a communication tool was evidenced by an increase in numbers attending advertised events.

5.5 Summary

- The most effective methods of increasing participation were the door-to-door communications and pictorial material. The results also show that an ongoing campaign is necessary to sustain high levels of participation.
- The open days, planting workshops and events resulted in higher numbers of participation and presented an opportunity for the project team to get to know the residents better, discuss project details and to facilitate social networking/community development. Some people cited these benefits as being personally more important than the more commonly recognised benefits of the composting initiative.
- Low participation rates within the project were primarily attributed to the inability of the project to pass on cost savings to the participants and the low occupancy numbers in comparison to management company records.

6. Compost Quality and Assurance

6.1 Work Package Objectives

- Produce a quality compost from household organic waste.
- Collate compost analysis data and investigate variance in compost quality over time.
- Compare compost to available European and national standards.
- Identify key factors affecting quality assurance.
- Develop a quality assurance system, based upon results, for small-scale in-vessel composting.

6.2 Introduction

Although small scale, collectively, the community sector has the potential to contribute significantly to landfill diversion rates. During the project literature review, compost quality was identified as one area that was particularly important in relation to community buy-in, sector growth and market development. As the project progressed, it became increasingly apparent that compost quality was dependent on a number of factors, which are discussed below.

6.2.1 Conditions for Optimal Composting

Rynk's (Benton and Foster, 2008, p.5) definition of composting provides an explanation of how the biological process works:

> Composting is the aerobic decomposition of organic materials under controlled conditions. During composting, the micro-organisms consume oxygen and organic matter and generate considerable heat, large quantities of carbon dioxide and water vapour. Carbon dioxide and water losses can amount to half the weight of the initial materials. Composting of waste thus reduces both the volume and mass of the biodegradable materials while transforming them into a valuable soil conditioner.

Although many aspects of composting are inexact, the quality of the finished compost is largely dependent on the selection and mixing of raw materials (feedstock) and the management of the composting process. The composting process itself therefore largely focuses on these two main areas. The compost operator, by monitoring and altering the conditions of the composting process, must provide the micro-organisms with the necessary ingredients they need to survive and thrive throughout the composting process.

Benton and Foster (2008) outline the key conditions for optimal composting, which include:

1 Appropriate carbon to nitrogen (C:N) ratio. A balanced diet of carbon and nitrogen is required for microbial activity and growth.

2 Sufficient oxygen to support aerobic organisms.

3 Sufficient moisture to permit biological activity without hindering aeration.

4 Temperatures that encourage vigorous microbial activity from thermophilic (heat loving) microorganisms.

6.2.2 Composting Process Parameters

The key conditions discussed above can be expressed as a range of parameter values known as 'process parameters'. Rynk defines the ideal conditions for optimal composting for these parameters in Table 6.1.:

Table 6.1. Ideal conditions for optimal composting.

Parameter	Preferred range
Carbon to nitrogen ratio	25-35:1
Moisture content	50–60% moisture
Oxygen concentration	10–15%
Porosity (or air space in pile)	45–60% air space
pH (acid to alkaline)	6.0–8.0
Temperature	45–65°C

Source: Benton and Foster, 2008, p.12.

6.2.3 In-Vessel Composting

The type of composting technology or system employed can also affect the composting process. For example, closed systems tend to be more aggressive than open windrows and as a result the time required to reach maturation is generally shorter. In-vessel composting is a term adopted to cover a wide range of closed compost systems in which the material being composted is enclosed in a bin, drum, silo, reactor or other container.

Moreover, processing within the vessel can be batch or continuous. Batch processing is where input materials are processed at the same time without adding new feedstock. Continuous processing is where input materials are loaded periodically and are composted as they move through the system to the opposite end to be discharged. Both the Jora composter and the Big Hanna T120 used in this research are continuous process systems.

6.3 Quality Standards

Compost standards generally categorise the end product according to feedstock material, product characteristics and procedures used. In this way the end user can be confident that the product supplied will be of consistent quality and can be used with confidence. By producing compost to a standard and achieving accreditation, the producer is proving his/her commitment to quality assurance. Independent verification of the standard further confirms the quality of the product and the confidence of the end user or buyer. Quality standards can be voluntary (e.g. industry or consumer association led) or mandatory where they are enforced with legislative and judicial backing.

6.3.1 European Standards

On the basis of existing experiences in countries with established quality assurance schemes, the European Compost Network (ECN)/ORBIT is developing a European Quality Assurance Scheme (ECN-QAS) for compost. The target of the ECN-QAS is to define an accepted basic product standard, to harmonise essential requirements for the production process and to monitor all by an independent and regular control (Barth, 2008).

6.3.2 National Quality Compost Standard

CRÉ, the Composting Association of Ireland, is currently leading an EPA-funded research project to develop a national compost standard for Ireland. The research to date has developed a proposed industry-led compost standard, which is detailed in Table 6.2 and gives upper limit values for heavy metals, pathogens, impurities and stability. The standard has the same pathogen standards as the APB regulations. It is proposed that this compost standard will be introduced alongside a voluntary Quality Assurance Scheme (QAS) and audited by an independent third party. Recommendations for the compost end user on suitability of the compost product for use in agriculture, landscaping, horticulture and growing media will also be included as part of, or alongside the QAS.

6.3.3 Publicly Available Specification PAS 100

The main compost standard in use in the UK is PAS 100. PAS 100 was prepared and published by the British Standards Institution jointly with the UK Composting Association and WRAP. Minimum requirements for compost and the composting process are specified within the standard including: source separation of biodegradable materials; monitoring and recording using a HACCP (hazard analysis and critical control point) system; batch documentation to ensure traceability; evidence of training and competent personnel; testing for pathogens, heavy metals, physical contaminants, phytotoxins (plant poisons) and weed propagules; storage classification and labelling of finished product. Table 6.2 gives a comparison of the proposed Irish Standard.

Table 6.2. Comparison of UK PAS 100 and proposed Irish compost quality standard limits.

Heavy metals (mg/kg dry matter)	**Proposed compost quality standard for Ireland**	**PAS 100**
Mercury	0.4	1
Cadmium	1.3	1.5
Nickel	56	50
Chromium	92	100
Copper	149	200
Zinc	397	400
Lead	149	200
Pathogens *Salmonella* (in 25 g) *E. coli* (cfu/g fresh mass)	 0 1000	 0 1000
Impurities Total glass, metal & plastics >2 mm diameter by weight	0.5%	0.5%
Stability	13 Oxygen Uptake Rate mmol O_2/kg organic solids/h	16 Respiration rate mg CO_2/g organic matter/day
Organic Matter Organic matter (% by weight)	20% Minimum	Not Specified

6.4 Methodology

In order to investigate variance in compost quality over time and compare compost produced with the proposed standard, the following data were recorded for each batch of compost produced during the project.

6.4.1 Input/Feedstock Materials

Input materials were checked and any contaminated materials removed. The material was then weighed and fed to the composter. As food waste composition contains a high percentage of nitrogen, wood pellets were added by the compost operator to maintain a carbon:nitrogen ratio of 25-30:1. This also had the effect of improving porosity within the compost mix. The weight of wood pellets added to each batch was recorded.

6.4.2 Temperature

The temperatures within compost piles were checked and recorded daily. The interior of the Big Hanna T120 is fitted with three temperature sensors. Data from these sensors was sent via a SIM card to a laptop modem and the data recorded on the laptop. Temperatures in the Jora composter were recorded manually.

6.4.3 Moisture

Moisture checks were carried out on a weekly basis. Where necessary, water was added to the compost pile. A record was kept of the volumes added.

6.4.4 Compost Analysis

Analysis of finished compost batches was carried out at Irish National Accreditation Board accredited laboratory Bord Na Móna Environmental Ltd. The project collated data relating to heavy metals, pathogens, impurities, nutrients, pH, electrical conductivity and stability.

6.5 Results

In total, four batches of compost were produced during the project timeframe. As both in-vessel composters used during the research are continuous process machines, batches are defined by date (i.e. all food waste composted between date A and date B was sent for analysis on date B). Results from process monitoring and compost analysis for each batch are included below in the following format:

- batch detail, dates, volume reduction and cycle time;
- time and temperature profile;
- stability;
- potentially toxic elements;
- pathogens;
- physical contaminants.

Discussion of findings and comparison with the proposed industry-led compost quality standard for Ireland are included in Section 6.6. The results also highlighted key factors for consideration in small-scale composting, which have been used to produce a guide to quality assurance for small-scale in-vessel composting (see Appendix). Discussion of plant response and compost nutrient analysis is discussed in Section 7 in conjunction with the data from the project pot trials.

6.5.1 Batch 1

Batch 1 was produced in the Jora composter at the Ballymun Civic Centre during the pilot trials. This batch was matured for an additional 4 weeks in an outdoor non-aerated bay prior to sampling. Tables 6.3 to 6.5 and Figures 6.1 and 6.2 below give results for process parameters and compost analysis for Batch 1.

Physical Contaminants

No marked quantities of contaminated materials were reported.

Table 6.3. Batch dates, cycle time and volume reduction, Batch 1.

Dates	Input food waste (kg)	Input wood pellets (kg)	Time in vessel (weeks)	Output compost (kg)	Volume reduction %
30/01/2007 to 10/04/2007	432.5	105	9–10	146.15	73

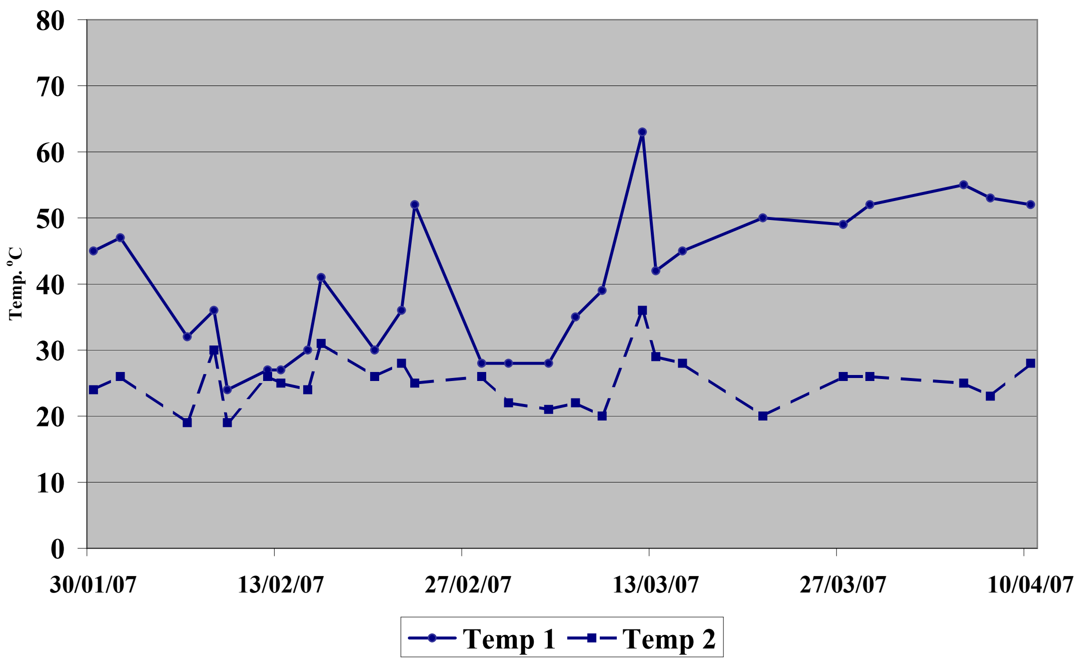


Figure 6.1. Time and temperature profile, Batch 1.

Table 6.4. Stability, Batch 1.

Stability test / unit	Requirement*	Batch sample value
Oxygen Uptake (mg O_2/g dm/h)	< 1fresh <0.65 stable	0.95

*As recommended by Bord na Mona Environmental Ltd.

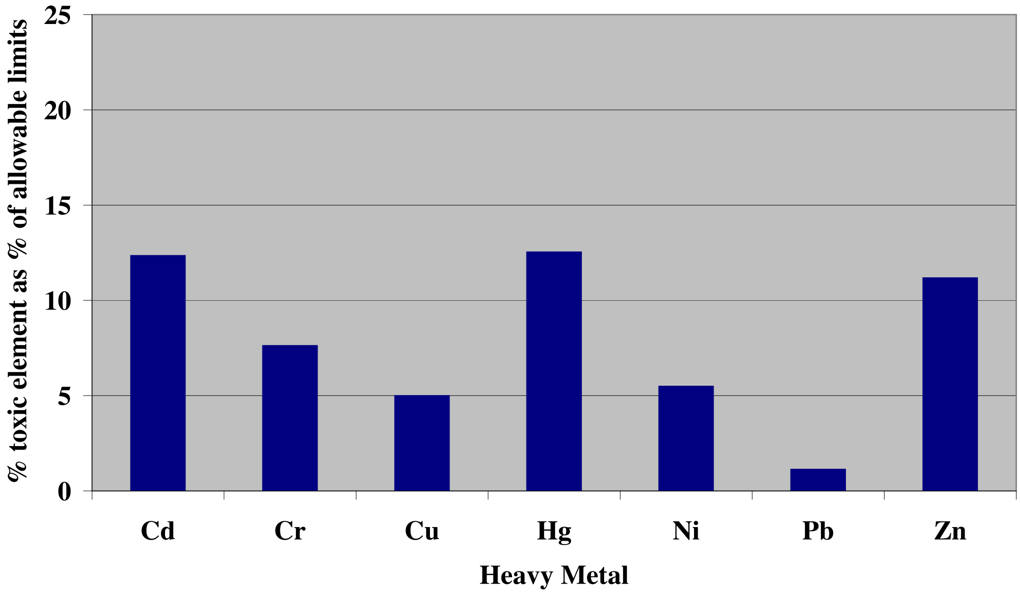


Figure 6.2. Potentially toxic elements as % of maximum allowable limit (proposed Irish Standard) Batch 1.

Table 6.5. Pathogens, Batch 1.

Pathogens / unit	Proposed Irish Standard limits	Batch sample value
Salmonella / (sp/25 g)*	0	Not detected
E. coli (cfu/g)**	1000	<10

* *salmonella* sp.

** cfu/g – colony forming units per gram.

6.5.2 Batch 2

Batch 2 was produced in the Big Hanna T120 at Santry Cross, Ballymun. This batch was sent for sampling immediately following processing. No additional time for maturation or curing was given.

Physical Contaminants

A marked quantity (1.44% on a dry weight basis) of plastic contaminant > 2 mm was reported in the sample, which exceeds the proposed Irish Standard limit of 0.5%.

Table 6.6. Batch dates, cycle time and volume reduction, Batch 2.

Dates	Input food waste (kg)	Input wood pellets (kg)	Time in vessel (weeks)	Output compost (kg)	Mass reduction %
04/12/2007 to 08/02/2008	483	132.8	8–9	61.2	90.07

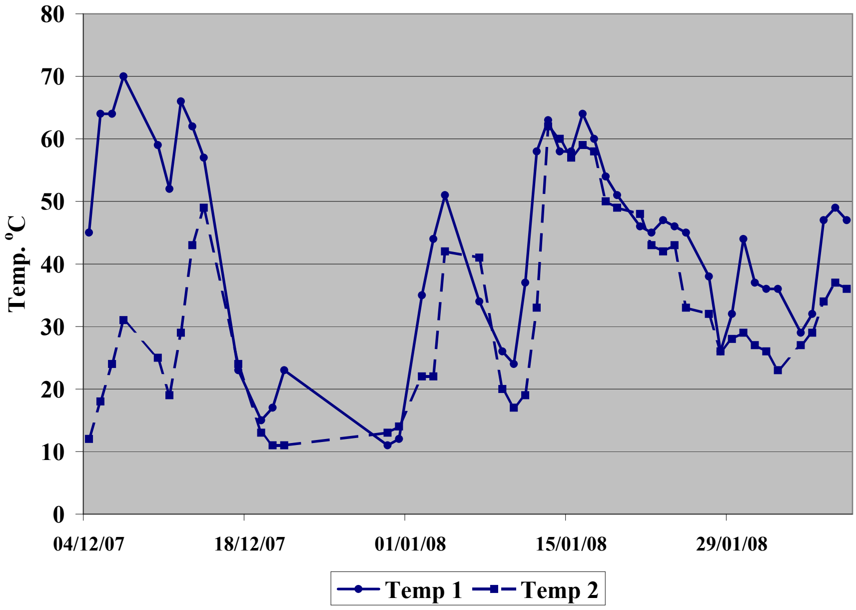


Figure 6.3. Time and temperature profile, Batch 2.

Table 6.7. Stability, Batch 2.

Stability Test / unit	Proposed Irish Standard Limit	Batch sample value
Oxygen Uptake / mmol O_2/kg OS/h	13	18.2

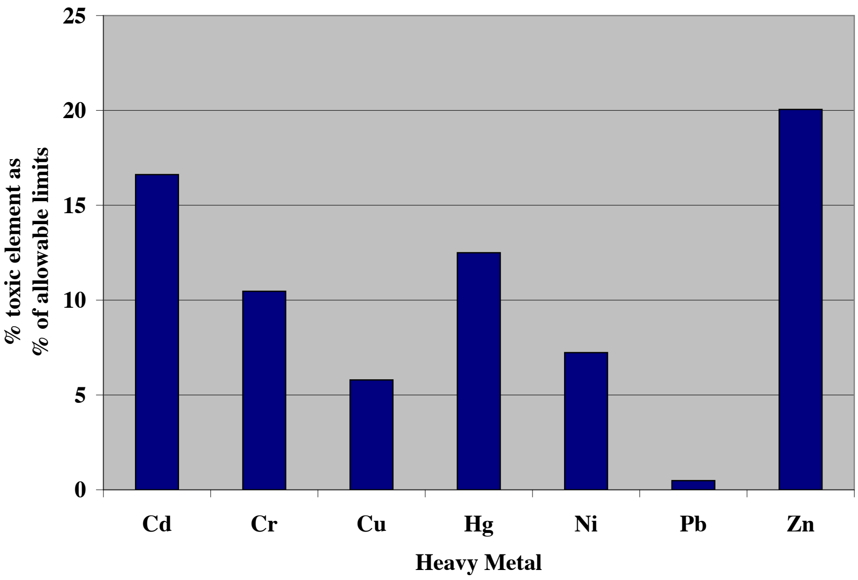


Figure 6.4. Potentially toxic elements as % of maximum allowable limit (proposed Irish Standard) Batch 2.

Table 6.8. Pathogens, Batch 2.

Pathogens / unit	Proposed Irish Standard limits	Batch sample value
Salmonella / (sp/25 g)	0	Not detected
E. coli (cfu/g)	1000	<10

6.5.3 Batch 3

This batch was sampled immediately following processing in the Big Hanna to allow for direct comparison with Batch 2.

Physical Contaminants

No marked quantities of contaminated materials were reported.

Table 6.9. Batch dates, cycle time and volume reduction, Batch 3.

Dates	Input food waste (kg)	Input wood pellets (kg)	Time in vessel (weeks)	Output compost (kg)	Mass Reduction %
09/02/2008 to 20/03/2008	426	62	6–7	53	89.14%

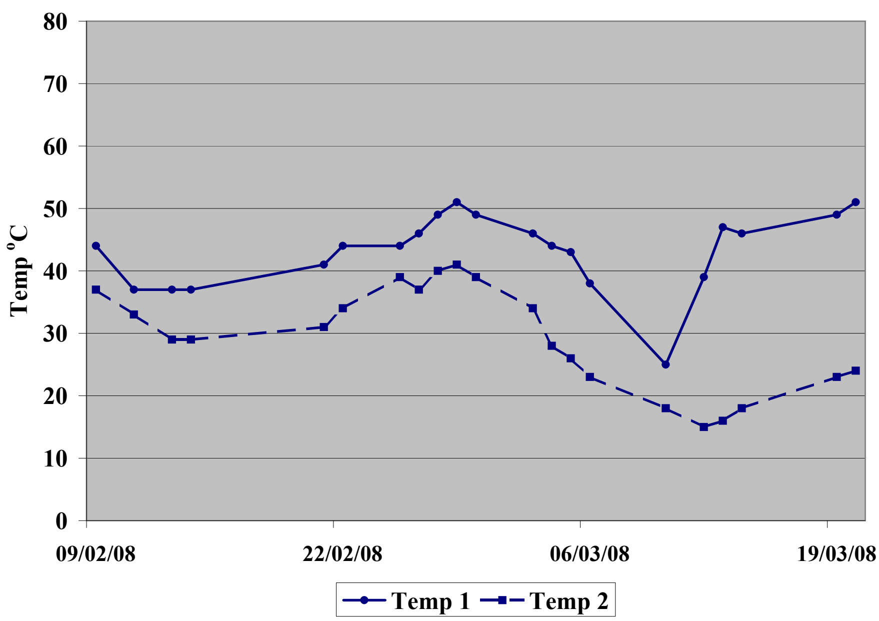


Figure 6.5. Time and temperature profile, Batch 3.

Table 6.10. Stability, Batch 3.

Stability Test / unit	Proposed Irish Standard Limit	Batch sample value
Oxygen Uptake mmol O_2/kg OS/h	13	21.54

Table 6.11. Pathogens, Batch 3.

Pathogens / unit	Proposed Irish Standard limits	Batch sample value
Salmonella / (sp/25 g)	0	Not detected
E. coli (cfu/g)	1000	100

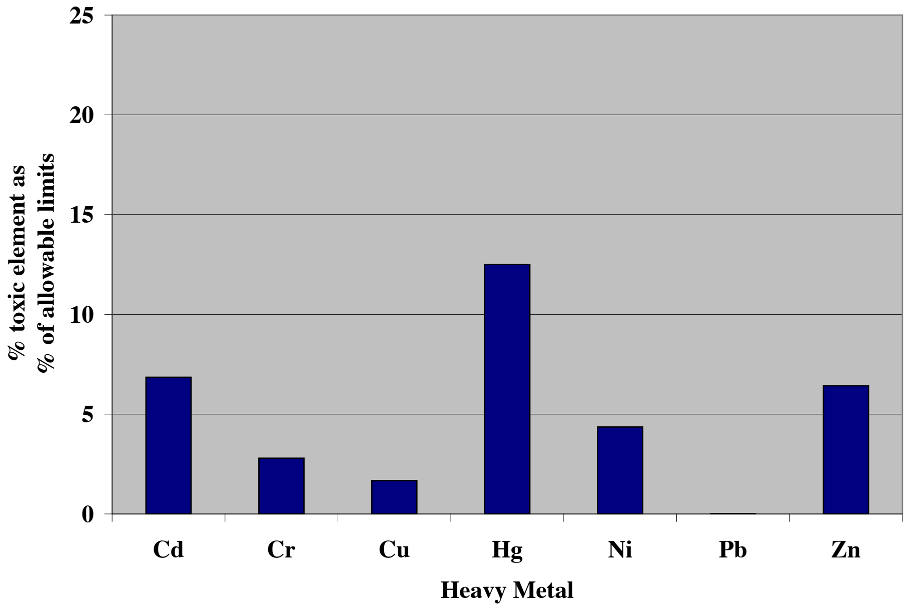


Figure 6.6. Potentially toxic elements as % of maximum allowable limit (proposed Irish Standard) Batch 3.

6.5.4 Batch 4

For Batch 4, a sample was taken after a 4-week maturation period in an outdoor non-aerated tarpaulin covered bay. The total compost cycle time was approximately 16 weeks.

Physical Contaminants

No marked quantities of contaminated materials were reported.

Table 6.12. Batch dates, cycle time and volume reduction, Batch 4.

Dates	Input food waste (kg)	Input wood pellets (kg)	Time in vessel (weeks)	Output compost (kg)	Mass Reduction %
26/03/2008 to 19/06/2008	816	237	11–12	115.2	89.06

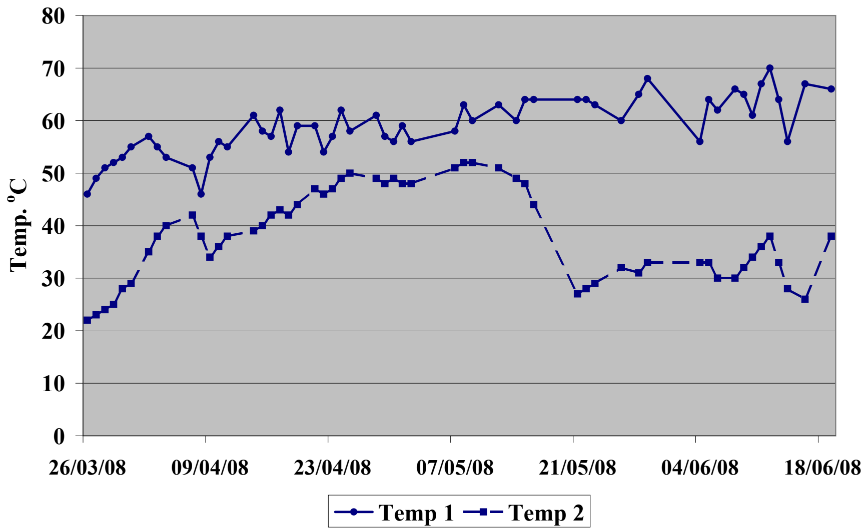


Figure 6.7. Time and temperature profile, Batch 4.

Table 6.13. Stability, Batch 4.

Stability Test / unit	Proposed Irish Standard Limit	Batch sample value
Oxygen Uptake / (mmol O_2/kg OS/h)	13	4.75

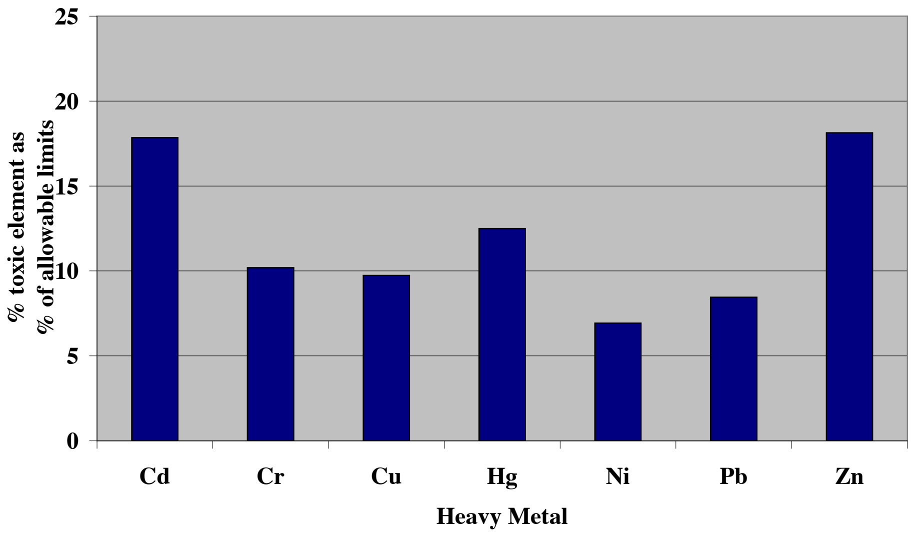


Figure 6.8. Potentially toxic elements, Batch 4.

Table 6.14. Pathogens, Batch 4.

Pathogens / unit	Proposed Irish Standard limits	Batch sample value
Salmonella / (sp/25 g)	0	Not detected
E. coli (cfu/g)	1000	20

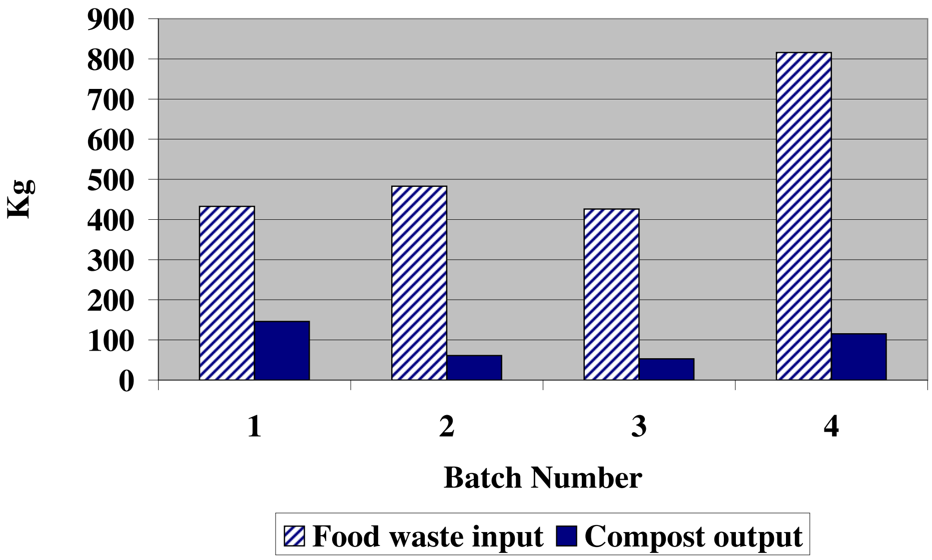


Figure 6.9. Mass Reduction (Batches 1–4).

6.6 Discussion

6.6.1 Volume Reduction

The mass reduction achieved during the composting process is important from a waste and landfill reduction perspective. In all four batches a significant mass reduction was achieved up to 89% for the Big Hanna and 72% for the Jora. A total average mass reduction of 85.27% was achieved over the four batches (see Figure 6.9).

6.6.2 Temperature

The study of temperature profiles within a compost pile provides an indication of compost activity and maturity. In the natural composting process, micro-organisms break down organic matter to produce CO_2, water vapour, heat and a relatively stable organic end product. The general process proceeds through three stages: (i) a mesophilic 'moderate temperature' phase, (ii) a thermophilic 'high temperature' phase and (iii) a maturation 'cooling' phase. Specific bacteria predominate the three phases. The mesophilic microbes break down readily available and soluble compounds, increasing the temperature in the compost from approx. 20 °C to 40 °C. As the temperature rises, thermophilic bacteria begin to dominate and thrive. High temperatures generated aid the decomposition of more complex carbohydrates, fats and proteins. Temperatures greater than 55 °C also destroy most human and plant pathogens. As the availability of complex compounds is depleted, the temperature decreases and the thermophilic bacteria are replaced by mesophilic microbes, which feed on the remaining organic material. This final phase of maturation is the longest phase and is also referred to as 'curing'.

The time and temperature profile for Batch 1 shows that the temperatures remained low for the first 5–6 weeks after which a period of sustained active composting followed. The results also confirm that the temperatures required under ABP regulations were reached only once in the latter half of the in-vessel cycle. For Batch 2, temperatures of over 60 °C were reached during the first 3 weeks of the cycle; however, during Week 4, the temperature of the pile fell to 15 °C and it took approximately 3 to 4 weeks for temperatures to return to the 45–65 °C zone required for active composting. The fall in temperatures coincided with the Christmas and New Year period, while activity levels and participation were low with input material weight of *c*. 20 kg per week being recorded, well below the machine capacity of 490 kg per week. The resulting temperature drop highlights the importance of maintaining a steady input of feedstock and, following this, the project team

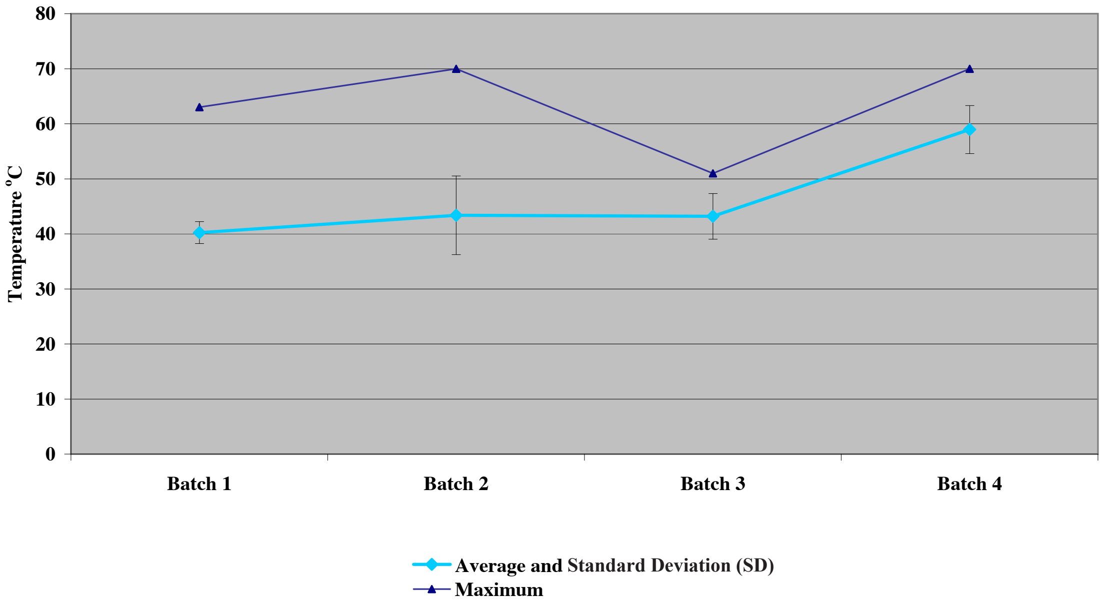


Figure 6.10. Average temperatures and SD (Batches 1–4).

focused on trying to increase participation rates to maintain composting activity within the required temperature zone. For Batch 3, the temperatures were predominately low. Highest temperatures of 50 °C were recorded only twice throughout the entire process. Temperature requirements of the ABP regulations were not achieved. For Batch 4, the time and temperature profile shows a sustained period of activity in the 45–65 °C zone for the entire in-vessel process period. The initial period saw temperatures of 55 °C, following which pile temperature was continuously above 60 °C. Batch 4 was also matured externally for an additional 4 weeks giving a total compost cycle time of 16 weeks, significantly longer than other batches.

Comparison of Temperatures Between Batches

Figure 6.10 compares the average and maximum temperatures of all batches. A maximum temperature of 70 °C was reached during the in-vessel process in Batches 2 and 4. As discussed above, the maximum temperature reached during Batch 3 was just over 50 °C. During production of this batch of compost, Batch 3, a new staff member was being trained in to operate the Big Hanna and this may have affected operational consistency. The use of wood pellets during this phase was comparatively low, which can affect the C:N ratio of feedstock materials. It was also noted that this batch, unlike previous batches, required the regular addition of water to keep moisture content at the required level, and it is possible that low moisture levels prevented sustained active composting. The SD of the temperature is greatest in Batch 2. This was the first batch ever produced in the Big Hanna composter. SD then decreases for Batches 3 and 4, indicating a certain level of consistency in regard to machine operating procedures and composting conditions. The SD of temperatures is lowest in Batch 1, which is to be expected as the project team had worked with the Jora system for over 12 months.

6.6.3 Stability

Maturity and stability are important parameters for compost quality assessment. Maturity is a general term describing the fitness of compost for a particular end use (Brewer and Sullivan, 2001). Mature composts are considered ready to use, when they contain negligible or acceptable levels or pathogens, potentially toxic elements or phytotoxic compounds. Stability can be defined as the extent to which readily available biodegradable material has decomposed (Gomez et al., 2005).

There are several methods for determining stability/ maturity and a wide range of respirometric protocols have been reported, based either on CO_2 production, O_2 uptake

Table 6.15. Comparison of batch self-heating tests.

Batch	Requirement	°C Reached
Batch 1	< 45	37
Batch 2	< 45	23
Batch 3	< 45	36
Batch 4	< 45	23

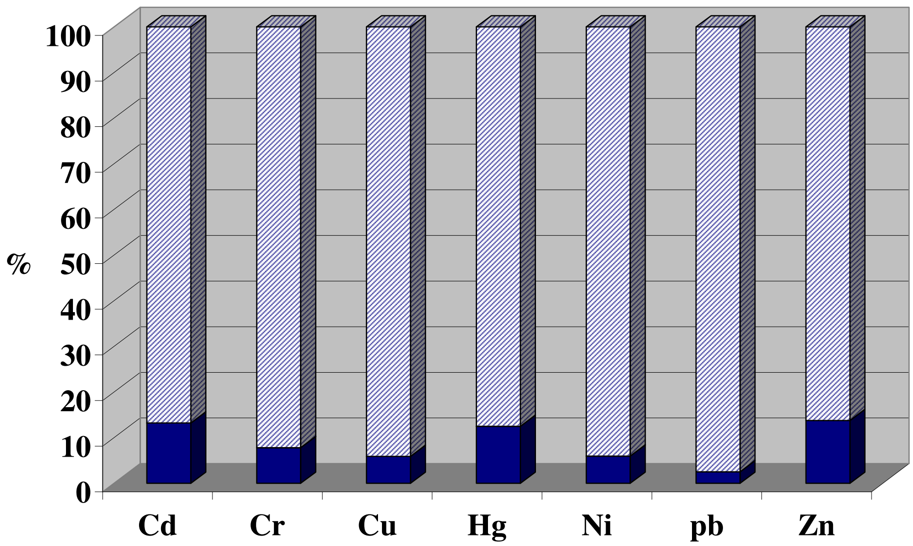


Figure 6.11. Average heavy metal concentration across 4 batches as a percentage of the proposed standard limits.

or the release of heat. The Ballymun Compost was tested for stability using both O_2 uptake and the release of heat by Bord Na Móna Environmental Ltd. The project team also applied the Solvita Respiration test as a stability indicator, which measures CO_2 production and NH_3 release. The test was applied for operative purposes mainly to give an indication of how stable the compost batches were immediately on discharge from the T120 and prior to use in the pot trials.

Batch results for oxygen uptake rates (OUR) are given in the previous section and are compared to the requirements of the proposed Irish Standard. Based upon these results, Batch 4, with an entire process cycle of 16 weeks, is the only batch to reach the OUR limit of 13 mmol O_2/kg OS/h, with results for other batches as high as 22 mmol O_2/kg OS/h. Analysis of the stability measurements for Batches 2 and 3 indicate that the compost processing time in the Big Hanna was not sufficient and should be extended where possible and/or subject to an additional outdoor maturation period. Table 6.15 compares results attained during the self-heating test for each batch. The results contradict the OUR showing all batches meeting within the required limit of less than 45°C, necessary to confirm stability. Although not a requirement of the proposed Irish Standard, this method of assessing stability is used in several countries internationally. The result between the two tests highlights the need for additional research on stability analysis methods.

6.6.4 Potentially Toxic Elements

Levels of heavy metals (cadmium, chromium, copper, lead, mercury, nickel and zinc) for all 4 batches easily met limits proposed in the Irish Standard. Figure 6.11 shows the average concentration across all 4 batches as a percentage of the proposed limits and further highlights the low levels of potentially toxic elements in the compost produced from household organic waste.

6.6.5 Pathogens

The presence of indicator species such as *E. coli* or *Salmonella* in compost is measured to evaluate health and safety risks. Levels of *E. coli* and *Salmonella* measured across all four batches were either absent or significantly below the proposed Irish Standard limits. These results confirm that – as expected – the compost produced does not pose a risk to soil, human, animal or plant health.

6.6.6 Physical Impurities

All compost samples were analysed for the presence of plastic, glass and metal impurities. With the exception of Batch 2 where quantities of plastics were detected, no marked quantities of physical contaminants were reported in any other batch. The detection of plastic in Batch 2 was not anticipated by the project team and could not be satisfactorily explained as all feedstock was checked manually and no contaminants had ever been observed in finished compost.

6.7 Summary of Results

- Management of an in-vessel composter is a learning process with a trial and error element.
- An average volume reduction of 85.27% can be achieved during the in-vessel composting process.
- Levels of physical contamination were low, indicating that the educational programme and operational procedures were successful in removing contaminated materials from the process.
- Three out of four batches of compost produced showed above upper limit values for oxygen uptake, indicating that these batches had not reached stability.
- A total cycle time of 14 to 20 weeks is recommended to produce stable compost. An in-vessel cycle time of 12 weeks plus a 4 to 8-week maturation period is suggested.
- A sustained temperature of above 50 °C is required for the in-vessel process period to produce stable compost.
- Further analysis of compost stability measurements is recommended due to inconsistencies between results.
- Provided Rynk's optimal conditions for composting are met (Section 6.2.2), a safe and stable compost product can be produced from household food waste.
- The end use of the compost should be considered when determining how stable the compost needs to be i.e. the composting period can be shortened or lengthened depending on the level of stability required.
- All requirements of the proposed Irish Compost Standard were reached in Batch 4 of Ballymun Compost, indicating that a safe and stable compost product can be made with a small-scale process.

7. Compost Trials

7.1 Introduction

In order to confirm the benefits of organic waste-derived compost, its use and value as a resource in horticultural applications had to be determined experimentally. For that reason a series of basic pot trials were undertaken during 2007 and 2008 to study the performance of a number of vegetable and ornamental plant species and varieties grown in the compost. Compost was used at varying rates as a substitute for potting mix and growth rates were monitored for a variety of species. The trials took place in the National Botanic Gardens in Glasnevin, Dublin, which also offered study tours of the project.

7.2 Work Package Objectives

- Establish basic pot trials to determine the potential benefits of biowaste-produced compost in horticultural applications.
- Assess the potential of waste-derived compost as a substitute for potting mix.
- Increase public confidence in waste-derived composts.

7.3 Background

A wide range of horticultural trials of composts made by home gardeners and community projects have been undertaken worldwide. Results of these trials have been very mixed. Some have demonstrated that there is considerable value in using composts derived from biowaste, whereas others have suggested that proprietary composts offer much better results. This disparity is attributable to a range of factors, including the usage of a wide range of different types of biowaste for compost production, the ways in which the composts were produced and the design of the trials (plants used, environmental conditions and differing soil mixes). However, the varying quality of home compost is not surprising. The quality of composts varies greatly even in commercially produced proprietary potting compost mixes – for example, *Gardening Which?* magazine published a critical report in January 2008 on peat-free composts, which performed much worse in some instances than peat-based composts.

The use and value of Ballymun Compost as a resource for horticulture had to be determined experimentally. For that reason a series of basic pot trials was undertaken during 2007 and 2008 to study the performance of a number of vegetable and ornamental plant species and varieties grown in the compost. The plants chosen for the trials were ones that would be commonly used for local gardening, such as strawberries, lettuces and decorative annual plants, *Bellis* and *Aster*.

Following initial compost analysis, compost batch pot trials were carried out to determine the potential benefits of biowaste-produced compost in horticulture. The results were used to identify the possible use of the compost as (i) a potting mix replacement; as (ii) a peat replacement materials and (iii) for reducing the necessary fertiliser application rates.

7.4 Methodology

The objective of the trials described in this report was to investigate the potential use of Ballymun Compost as a component of a potting compost mix and compare the performance of a range of mixes with and without the addition of the Ballymun product. A range of preliminary trials and two separate final trials were undertaken from early 2007 to August 2008 as described below.

The trials took place in the National Botanic Gardens in Glasnevin, which allocated a section of its nursery to accommodate the trials. The trials were also used for educational purposes and incorporated into educational and outreach activities of the gardens. Residents from Ballymun who had provided organic waste for the production of the compost were offered an opportunity to visit the trials and follow progress. Signage was erected at the area allocated to the trials to explain the Ballymun Composting project to visitors.

The trials evaluated the compost's potential as a nutrient source and its potential as a peat dilutant. It also examined other factors that affect a compost's potential for use in a growing media, such as its bulk density (bulk density is the mass of the material, divided by the total volume it occupies). The bulk density of the compost was determined as a measurement of the mass of 1 L of material weighed under controlled laboratory conditions. In order that a compost be suitable for use in a potting substrate, its addition should not substantially increase the bulk density beyond that of a standard commercially available compost.

Other factors examined were electrical conductivity (EC). This is a measurement of the nutrients available to plants in a substrate. If there is too little nutrient available, plant growth will be depressed; this will also be the case if there is too much nutrient available.

The pH of a compost affects the ability of plants grown in it to absorb nutrients, pH is a measurement of the acidity or alkalinity of a compost. It is expressed on a scale of 1 to 14, 1 to 6 being acidic and 7 to 14 being alkaline. The optimum pH range for the growth of the majority of plants is between 5.5 and pH 6.5. The pH of composted food waste is variable and often outside the optimum range. The trial examines the affect this has on plants grown in a substrate containing composted food waste.

7.4.1 Preliminary Trials

The preliminary trials were conducted over the growing season in 2007 using varying levels of Ballymun Compost in different compost types with a range of plants. The plants included in the trial were: tomato, lettuce, peppers, sage and marigold. The composts used were 'multi-purpose compost, exploded bark, and the Botanic Gardens' topsoil + perlite. Substitution rates of 5% to 50% of Ballymun Compost were trialed with a number of control trials with 100% compost. The impact of varying levels of Ballymun Compost was evaluated by monitoring growth rates of plants over the period of the preliminary trial. Over 15 preliminary trials were carried out using various levels of Ballymun Compost. The compost used in this trial was produced in the Jora JK 5100 in-vessel composter during the pilot phase of the project.

The principal objective of the preliminary trials was to provide for early learning and to inform the design of the main trials. The initial trials assessed potential trial parameters such as:

- preferred location (pot vs field; greenhouse/polytunnel vs outdoor);
- relevant ranges of percentage compost substitution rates to be measured (0–50%);
- criteria for measuring benefits (plant height vs fruit yield vs plant weight).

The two sets of pot trials were run to evaluate the performance of the composted food waste under controlled conditions, across a range of plant species.

7.4.2 Main Trial 1

The batch of compost used in Main Trial 1 was produced using a Jora JK 5100 in-vessel composter. This batch had been composted within the vessel for approximately 10 weeks before use. The plant subject to be trialled was Bachelor's Buttons, a variety of the common daisy (*Bellis perennis*). The aim of the trial was to examine and monitor the effect of the addition of varying rates of compost on plant growth rates.

Formulations of each substrate were prepared containing 10%, 20%, 30%, 40% and 50% Ballymun Compost. The plants were grown in 1 L pots. Thirty plants were grown in each formulation, giving a total of 450 plants. The plants were grown over an 11-week period, and the fresh weights of all plants were measured at the end of the trial and the data recorded for analysis.

7.4.3 Main Trial 2

The batch of compost used in Main Trial 2 was produced using a Big Hanna T120 in-vessel composter. This batch had been composted within the vessel for approximately 10 weeks and received a further maturation period of 6 weeks under cover – 16 weeks composting in total.

In this trial three different plant subjects were chosen: lettuce (*Lactuca sativa*), strawberry (*Fragaria x ananassa*) and aster Roundabout (*Callistephus chinensis*). Formulations of each substrate were prepared containing 10%, 25% and 40% Ballymun Compost. There were 30 plants each of lettuce, strawberry and aster grown in each formulation. Controls were put in place for each subject in the multi-purpose compost so that a comparison could be made with the different formulations of Ballymun Compost. The plants were grown over a 10-week period and the fresh weights measured at the end of the growing period and recorded for analysis.

7.4.4 Substrates Used

All trials used the Ballymun Compost as dilutants in the three substrates which were:

- multi-purpose compost;
- peat-free compost;
- loam from the National Botanic Gardens.

7.5 Results

7.5.1 Preliminary Trials

Figures 7.1 to 7.3 give the results of a selection of the preliminary trials.

In the trials of sage in multi-purpose compost mixes, mixtures of up to 20% Ballymun Compost improved growth consistently over the period of the trials.

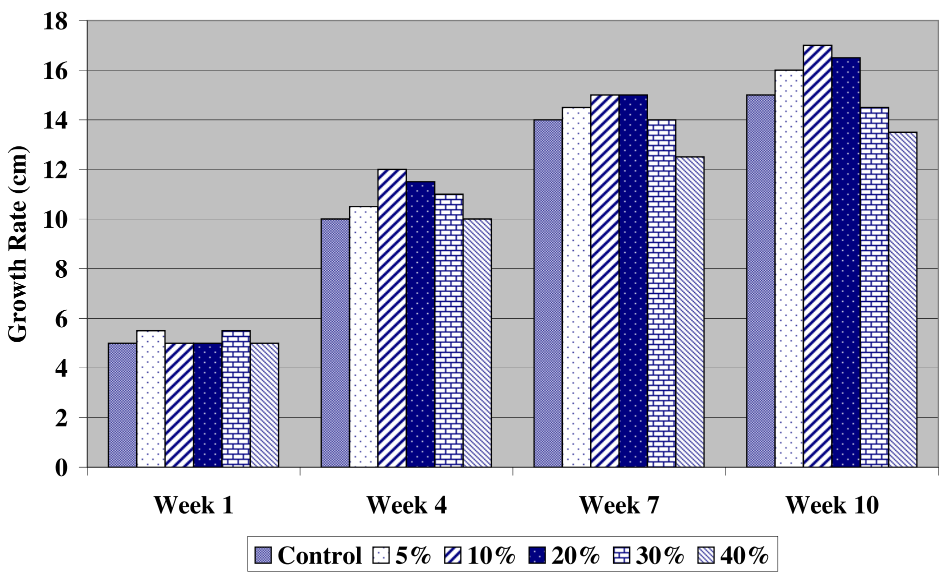


Figure 7.1. Results of trials of sage in mixtures of multi-purpose compost and Ballymun Compost.

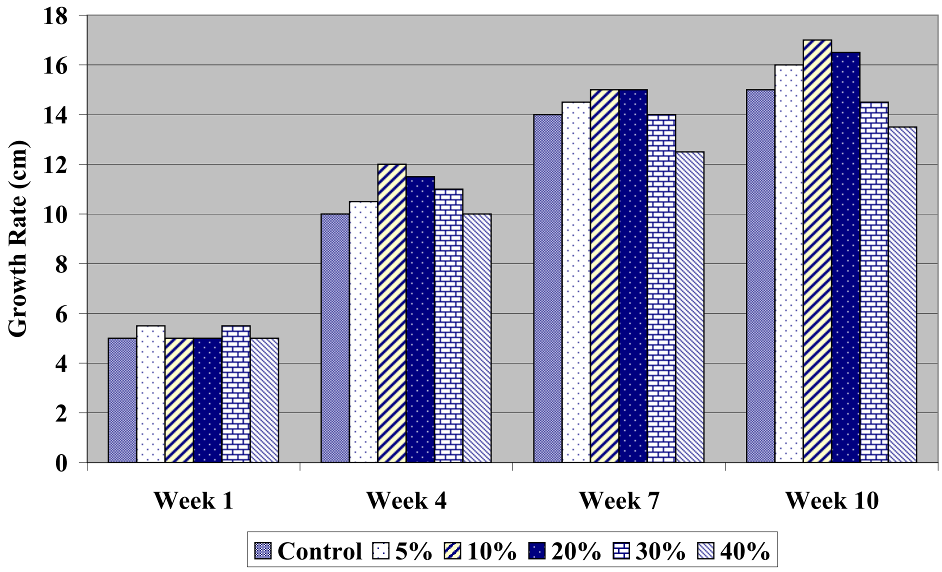


Figure 7.2. Results of trials of marigold in mixtures of topsoil and Ballymun Compost.

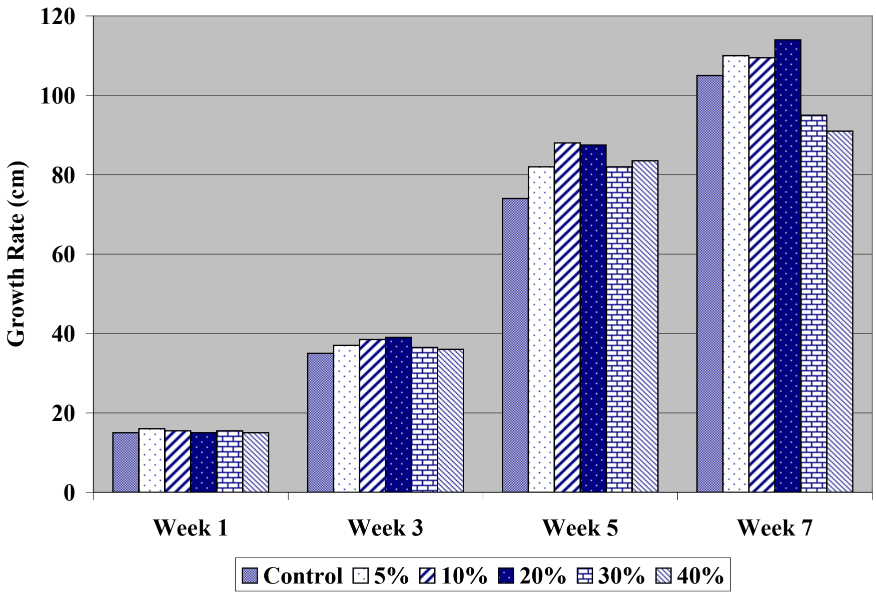


Figure 7.3. Results of trials of tomatoes in mixtures of multi-purpose compost and Ballymun Compost.

In the trials of Marigold in topsoil mixes, mixtures of up to 10% Ballymun Compost improved growth consistently over the period of the trials and mixtures of up to 20% increased growth rates up to 7 weeks into the trial.

In the trials of tomatoes in multi-purpose compost, mixtures of up to 20% showed a significant improvement in growth rates, while higher percentage mixtures resulted in a sharp decline in long-term growth rates.

The results of the preliminary trials were encouraging and demonstrated the benefits of Ballymun Compost in promoting growth rates. The three trials summarised are generally representative of the 15 trials carried out, demonstrating that the benefits of Ballymun Compost are dependent on the substrate, the plant species and most critically on the percentage substitution of Ballymun Compost. The optimum substitution rate ranged from 10% to 30% in the preliminary trials.

Based on the outcomes of the preliminary trials, it was decided to proceed with further trials during 2008.

A key decision was made to monitor results according to average fresh weights at the conclusion of the trial rather than growth rates during the trial. While this method fails to monitor temporal variations, it provides more robust and quantifiable results at the end of the trial. Other decisions included using a smaller number of species and using only 10-40% substitutions in Main Trial 2.

7.5.2 Main Trial 1 Commenced March 2007, finished July 2007

As can be seen from average fresh weights at the end of the trial, the 30% rate of Ballymun Compost gave the best result in this part of the trial (see Figure 7.4).

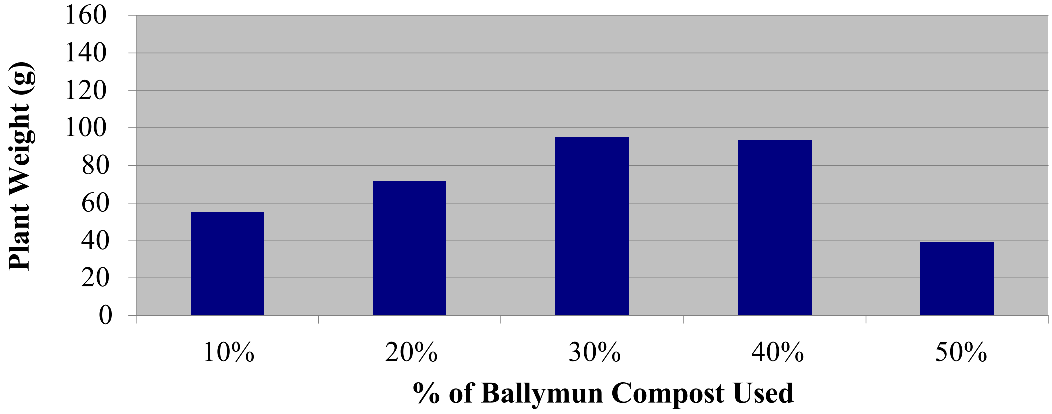


Figure 7.4. Results of trials of Bachelor’s Buttons in mixtures of multi-purpose (substrate A) compost and Ballymun Compost.

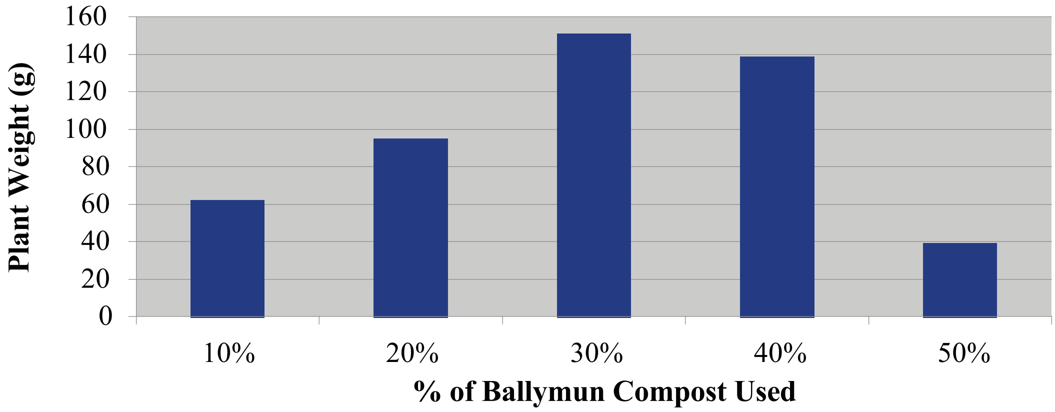


Figure 7.5. Results of trials of Bachelor’s Buttons in mixtures of peat free compost (substrate B) and Ballymun Compost.

As can be seen from Figure 7.6 showing the average fresh weights at the end of the trial, the 30% rate of Ballymun Compost gave the best result.

7.5.3 Main Trial 2 Commenced May 2008, finished July 2008

In this trial there was a control grown in the Multipurpose Compost for each of the three subjects, which allowed a direct comparison in the performance of the substrates containing Ballymun Compost to be made. This gave a clear indication of the benefit of adding the Ballymun Compost.

Aster

As can be seen from the average fresh weights at the end of the trial, the 10% rate of Ballymun Compost gave the best result in this part of the trial. Growth rates at 10% substitution out-performed the control by 15.2% (see Figure 7.7).

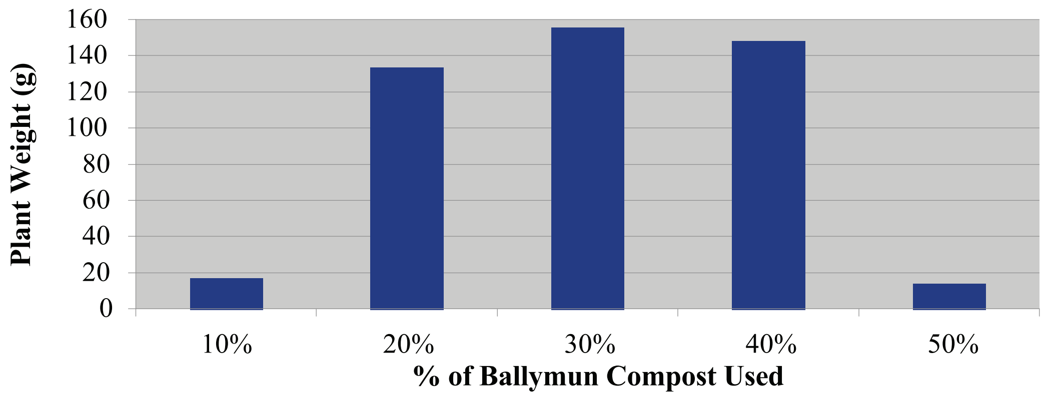


Figure 7.6. Results of trials of Bachelor's Buttons in mixtures of loam (substrate C) and Ballymun Compost.

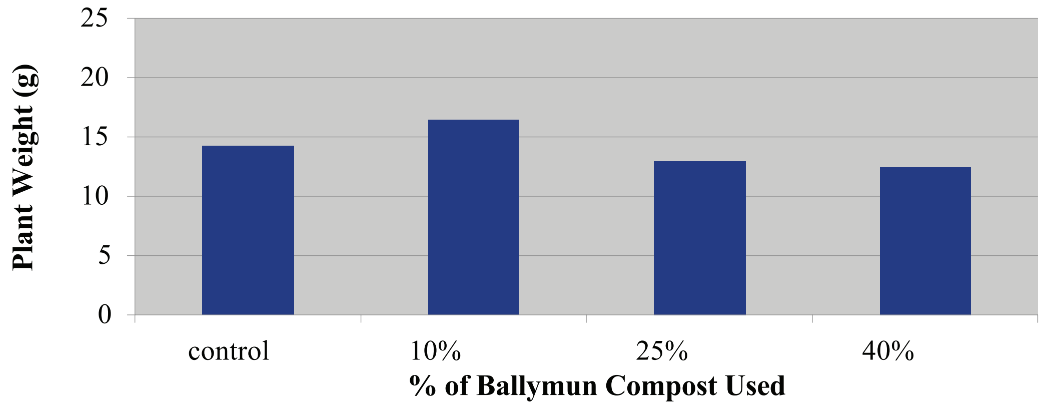


Figure 7.7. Results of trials of aster in mixtures of multi-purpose (substrate A) compost and Ballymun Compost.

As can be seen from the average fresh weights at the end of the trial, the 25% rate of Ballymun Compost gave the best result in this part of the trial (see Figure 7.8).

As can be seen from the average fresh weights at the end of the trial, the 10% rate of Ballymun Compost gave the best result in this part of the trial (see Figure 7.9).

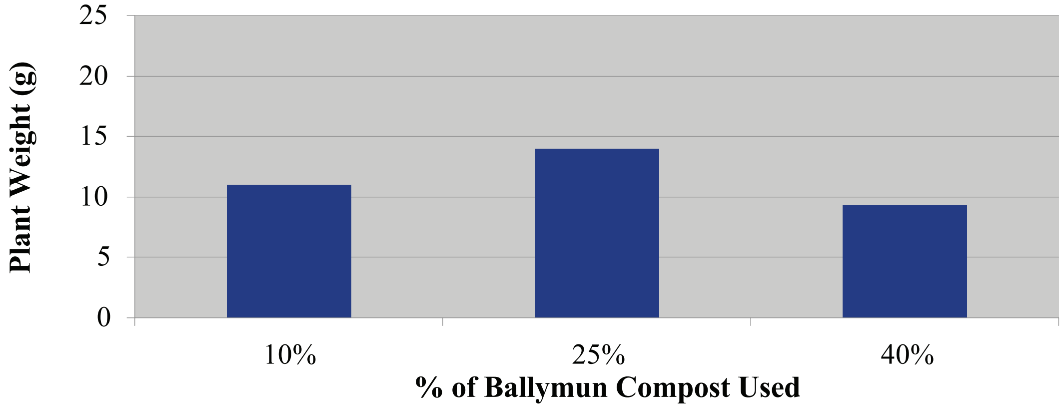


Figure 7.8. Results of trials of aster in mixtures of peat free compost (substrate B) and Ballymun Compost.

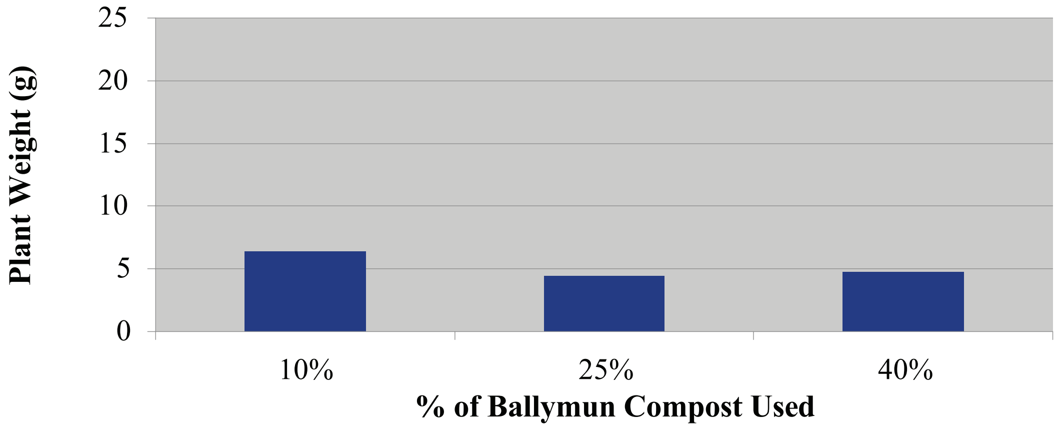


Figure 7.9. Results of trials of aster in mixtures of loam (substrate C) and Ballymun Compost.

Lettuce

As can be seen from the average fresh weights at the end of the trial, the control gave the best result in this part of the trial, out-performing the 10% Ballymun Compost rate by 2.69% (see Figure 7.10).

As can be seen from the average fresh weights at the end of the trial, the 10% rate of Ballymun Compost gave the best result in this part of the trial (see Figure 7.11).

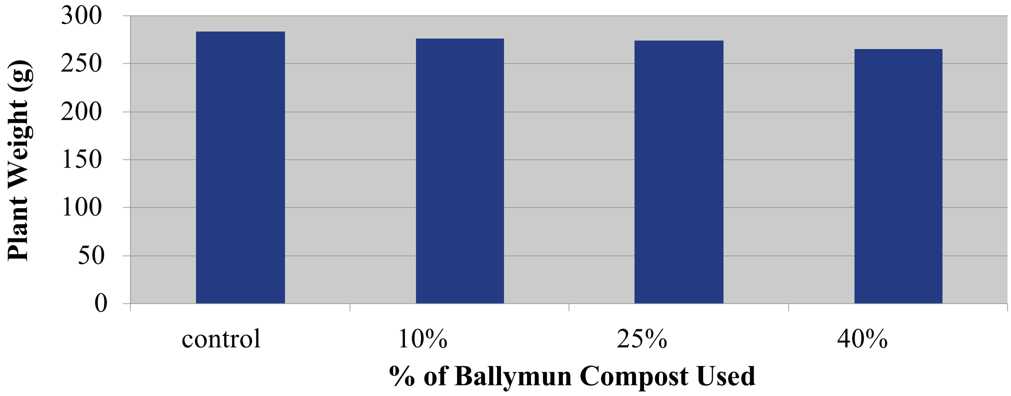


Figure 7.10. Results of trials of lettuce in mixtures of multi-purpose (substrate A) compost and Ballymun Compost (substrate A).

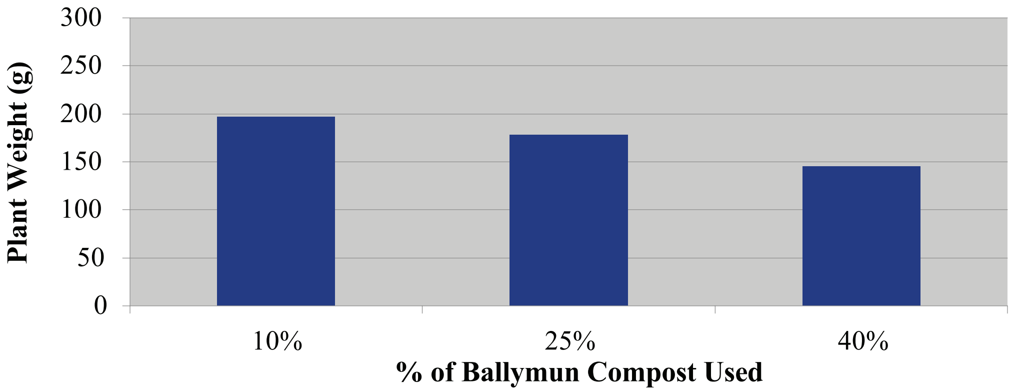


Figure 7.11. Results of trials of lettuce in mixtures of peat free compost (substrate B) and Ballymun Compost.

As can be seen from the average fresh weights at the end of the trial, the 10% rate of Ballymun Compost gave the best result in this part of the trial (see Figure 7.12).

Strawberry

As can be seen from the average fresh weights at the end of the trial, the 10% rate of Ballymun Compost gave the best result in this part of the trial, out-performing the control by 16% (see Figure 7.13).

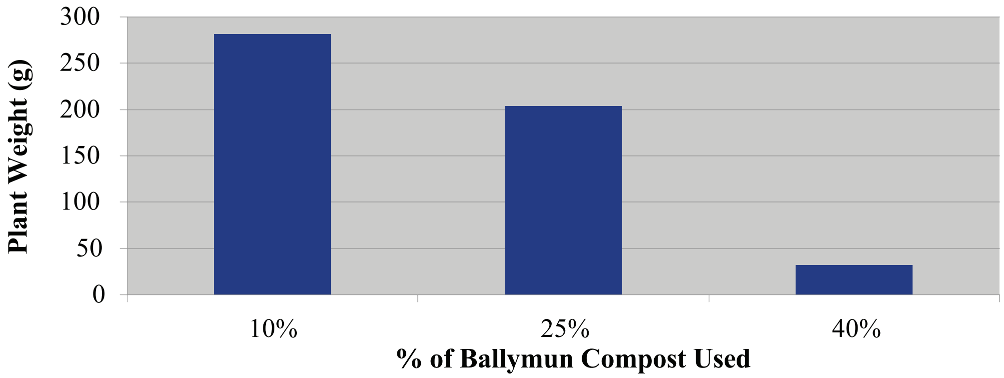


Figure 7.12. Results of trials of lettuce in mixtures of loam (substrate C) and Ballymun Compost.

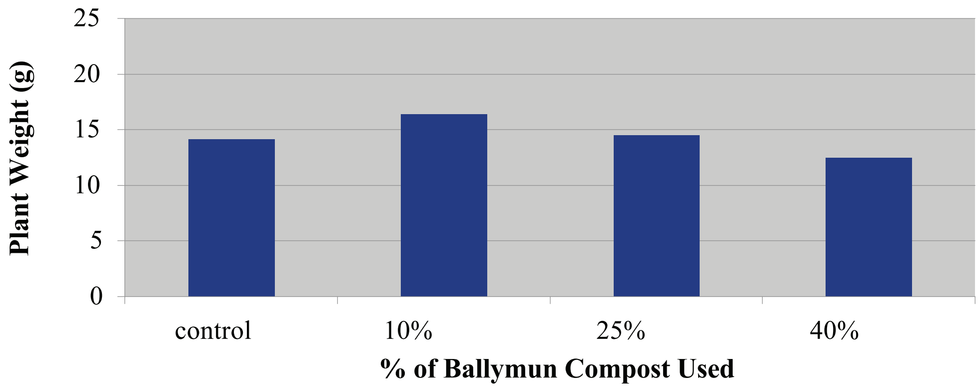


Figure 7.13. Results of trials of strawberry in mixtures of multi-purpose (substrate A) compost and Ballymun Compost.

As can be seen from the average fresh weights at the end of the trial, the 25% rate of Ballymun Compost gave the best result in this part of the trial (see Figure 7.14).

As can be seen from the average fresh weights at the end of the trial, the 10% rate of Ballymun Compost gave the best result in this part of the trial (see Figure 7.15).

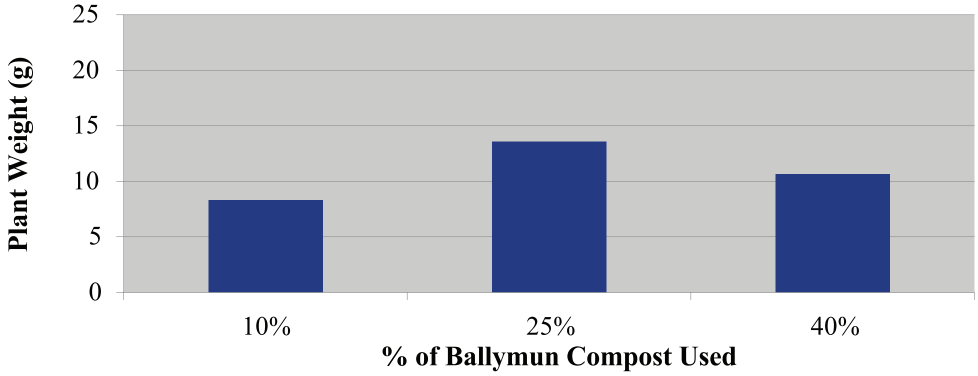


Figure 7.14. Results of trials of strawberry in mixtures of peat free compost (substrate B) and Ballymun Compost.

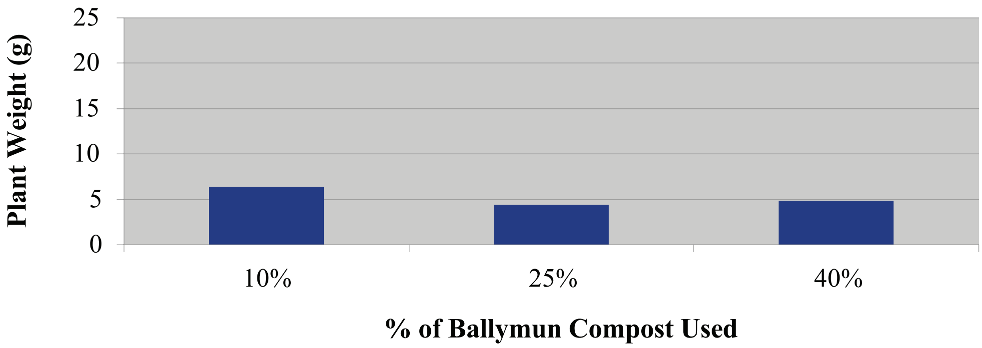


Figure 7.15. Results of trials of strawberry in mixtures of loam (substrate C) and Ballymun Compost.

7.6 Discussion

The growth of plants in a soil medium is influenced by both the chemical and physical composition of the growth medium used, and in particular its water-holding capacity. It was clear from the results of these trials that Ballymun Compost is indeed a valuable and useful compost additive, which can be used to act as both an organic source for compost mixes as well as a source of nutrient. The addition of Ballymun Compost in moderate concentrations improved plant growth significantly during the trials. It is clear that the compost is best used as an additive, and soil conditioner, rather than as a stand-alone growing medium.

Qualitative evaluation of the Ballymun Compost also indicated that it had excellent water-retaining properties (even when added in varying dilutions) and helped to ensure that potting mixes to which it was added retained moisture well.

Trials were not undertaken to determine whether the addition of Ballymun Compost to potting compost mixes used for seed sowing and germination would have a positive or negative outcome. However, such a trial might be valuable to undertake in the future. The relatively low level of plant nutrients in the Ballymun Compost (see Table 7.1) could be of positive value for such usage.

No impacts or constraints on plant growth from the use of any Ballymun Compost dilutions in other growing media were detected in relation to other factors affecting plant growth, such as susceptibility to insect or fungal attack.

7.6.1 Main Trial 1

The best response across the three substrates used was achieved at the 30% Ballymun Compost rate. At the lower rate of 10% dilution there was less nutrient available to the plants and consequently a lower plant growth response was achieved. At the higher rates of 40% and 50% Ballymun Compost the rate of plant growth response decreased as the rates of Ballymun Compost increased. This was due to excessively high EC.

7.6.2 Main Trial 2

Table 7.2 summarises the optimum percentage substitution of Ballymun Compost in the different species and different substrates in Trial 2.

It is interesting to note that while the general trend in all the trials is for an improvement in growth with the use of Ballymun Compost, the use of Ballymun Compost results in reduced growth in lettuce with all substrates. The best

Table 7.1. Nutrient and EC analyses

Substrate	N	P	K	EC
Westland Multipurpose Compost	210 mg/l	240 mg/l	270 mg/l	180 µS/cm
Westland Peat-free Compost	340 mg/l	160 mg/l	270 mg/l	180 µS/cm
Botanic Gardens' Topsoil	0	61.8 mg/l	132.5 mgl	-
Trial 1 Ballymun Compost	7.95 mg/l	6.3 mg/l	635 mg/l	6390 µS/cm
Trial 2 Ballymun Compost	25 mg/l	95 mg/l	1634 mg/l	1539 µS/cm

Table 7.2. Optimum levels of Ballymun Compost in Trial 2.

Plant species	Substrate		
	A – Multipurpose compost (%)	B – Peatfree compost (%)	C – Loam (%)
Aster	10	25	10
Lettuce	10	10	10
Strawberry	10	25	10

result was achieved in the control, which performed 1.2% better then the 10% Ballymun Compost and 6.6% better than the 40% BMC rate. The depressed performance with the use of Ballymun Compost was probably due to lettuce's susceptibility to excessively high EC levels.

While Ballymun Compost improved growth rate for all other species in all substrates it is notable that the greatest improvement, and the highest optimum substitution rate, occurred with the peat free compost substrate for all species. This is as expected as peat free compost has comparably higher rates of N than other substrates and significantly higher levels of N than the Ballymun Compost.

7.6.3 Dilution/Substitution Rates

The optimum dilution rate with Ballymun Compost appears to be between 10% and 30% in these trials, depending on the EC measurement of the substrates in the particular batch of Ballymun Compost being used. Therefore, it would appear that composted food waste has a value as a peat replacement material.

7.6.4 Electrical Conductivity Measurements

It would appear that where the Ballymun Compost applied had high EC measurements at the start of a trial these (the EC measurements) were reduced sufficiently by normal irrigation to enable plants to grow successfully. The EC of fully composted food waste was substantially lower then that of partially composted food waste, often being more than 50% lower. Generally, fully composted food waste gave the best results at the higher rates.

7.6.5 Bulk Density

The bulk density of a compost or substrate is a measurement of the weight of 1 L of either taken under controlled laboratory conditions. The average Bulk Density of all the batches of Ballymun Compost produced during the trial was 377 g/l which compared favourably to the multi-purpose compost at 300 g/l, The inclusion of Ballymun Compost in a substrate at the maximum rate of 30% would only increase the bulk density by 7.6%, which would not adversely affect its handling qualities.

7.6.6 pH

The average pH of all batches was approximately pH 8, well above the optimum range of pH 5.5 to pH 6.5 suitable for most plants. In commercially available composts the pH will be within this range. At the maximum rate of 30% Ballymun Compost mixed with 70% commercially available substrate there was no discernable negative affect on plant growth.

7.6.7 Fertiliser Values

There is considerable potential to make savings on fertiliser use in substrates containing Ballymun Compost. In comparison to a multi-purpose compost, stable composted food waste provides approximately up to 30% of the necessary P, 10% of the necessary N and up to 6 times the required K. Therefore at whatever rate the Ballymun Compost is used it will make a contribution to the nutrient content of the substrate. As composted food waste is so variable, nutrient analysis is necessary before use of each batch to ascertain its nutrient status.

7.7 Summary of Results

- The trial has established a suitable methodology for assessing the effect of waste-derived compost on plant growth.
- Waste-derived compost, when used as a soil additive, improves soil structure, and increases organic matter and nutrient content.
- Waste-derived compost presents an opportunity to reduce multi-purpose compost use and can provide 30% of P, 10% of N and all K present within a multi-purpose.
- The best growth response rates are achieved when waste-derived compost is used at rates of between 10 and 30%.
- Nutrient levels can vary significantly between batches results. Further analysis and pot trials would be required to determine a method for ensuring compost nutrient consistency.

- Composted food waste presents an opportunity as peat replacement.
- The use of mature waste-derived compost is preferable to partially composted materials and results in a better plant growth. Immature compost application results in high soil EC levels and suppresses growth.
- Waste-derived compost has the potential to contribute significantly to improving reduced fertility and organic matter content of soils in Europe.

8. Development of Compost Markets

8.1 Work Package Objectives

- Develop a programme to promote compost use in horticultural applications.
- Investigate the application of Ballymun Compost in local green areas, gardens and pot plants.
- Produce a marketing strategy for community compost to assist in the development of other community projects and enhance the replicability of the programme.
- Carry out market research in relation to perceptions of waste-derived compost with a view to reducing barriers to waste-derived compost.

8.2 Introduction

Development of markets for recovered biodegradable municipal waste is considered a key element in ensuring the success of the National Biodegradable Waste Strategy, with the end goal 'a situation where demand is strong and revenues are achieved that offset the costs of collection and treatment of waste' (DoEHLG, 2006a, p.107).

Working sub-committees have been established as part of the DoEHLG-led Market Development Group (MDG) investigating issues relating to plastic, organics and paper/cardboard.

MDG has recently published its *Market Development Programme for Waste Resources 2007–2011* (MDG, 2007). This proposes a number of initiatives to promote and to address the barriers to market development. Broadly, the initiatives can be grouped into three clusters:

1. Technical – for example, the development of materials standards and systems of quality control such that the market can have confidence in the product's consistency and reliability.
2. Communications – overcoming barriers due to lack of awareness and understanding of the possible benefits of recycled materials and their availability by creating dialogue and co-operation between stakeholders.
3. Economic – supporting innovation and product development and cross-sectoral initiatives between those managing the waste and those creating new products.

8.2.1 Market Outlet Options

Compost can be made or 'manufactured' to suit a wide range of uses. Some of the most common applications for compost include:

- soil improvers that are incorporated into the soil to improve the soil structure and provide organic matter and nutrients;
- mulches that are spread on the surface of the soil to retain moisture, suppress weeds, prevent erosion and as decoration for landscaping purposes;
- as an ingredient in growing media to provide good bulk density, porosity, water retention capacity and cation exchange capacity;
- as an ingredient in manufactured topsoil when mixed with other materials such as sand or subsoil to produce topsoil for landscaping applications;
- top dressings for turf where fine compost can be applied to surface of grass to improve soil structure and grass growth on sports pitches and golf courses.

(CRÉ, 2008, p.311)

Market outlets for compost are normally considered in terms of value and volume. Van der Werf et al. (2000) have developed the below hierarchy of putrescible

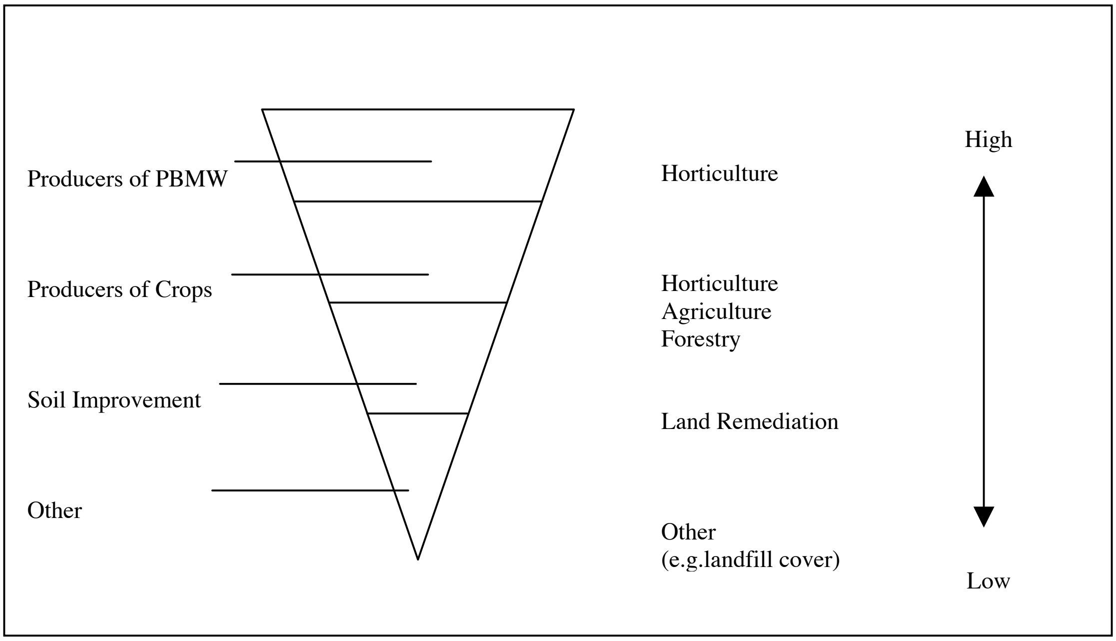


Figure 8.1. Hierarchy of putrescible biodegradable municipal waste compost utilisation.

Source: Van der Werf et al., 2000, p.xiii.

biodegradable municipal waste (PBMW) utilisation which shows the nature of this value relationship in relation to compost quality per segment (see Figure 8.1).

Typically, high-quality compost can earn a high economic value for low volumes while low quality compost will earn a lower return for larger volumes. However, 'it should be noted that the market is constantly changing, and so is competition. Even our general descriptions of market segments, 'value' and 'volume', have changed over time. Typical volume markets, such as agriculture and highway maintenance, have proven to be value and volume markets in specific regions of the country' (Alexander, 2007, pp.32–4). Alexander is referring to the compost market in the USA but makes the point that to develop new markets or create new compost products or applications the particular requirements of the specific end user must be understood in detail, which can lead to an increase in value.

Across Europe the agricultural sector is the largest market sector due mainly to the link with sustainable farming and improvement in soil organic matter, and the cross compliance nature of this link. For example, in Italy a number of regions have designated policy and financial support for the build up of organic matter and carbon in soils through compost use as part of rural development plans on sustainable agriculture. The home gardening or hobby gardening sector is the lowest volume but highest value market sector, demonstrating the value of composting initiatives. Compost quality is considered critical in development of products for this sector (Gilbert, 2007). The main market segments and potential applications per segment are identified in Table 8.1.

Over 90% of available land in Ireland is arable, the largest potential market sector is agriculture. Application to arable land must take into account the various requirements of farm management plans, the Nitrates Directive (European Council, 1991), which sets limits for fertiliser application rates, and the ABP regulations.

8.2.2 Quality and Economic Value

Compost product quality must be matched to the markets and end-uses planned for the final compost product. As identified in Section 6 and Appendix, types of feedstock, levels of contamination and effective process control are central to producing a quality compost product. Whatever

Table 8.1. Compost market segments and applications per segment.

Nurseries	Landscaping	Residential Retail	Local Authority	Roads
Potting mixes Plant growth Topsoil blend Nutrient replenishment Sod production Tree production	Sports fields Cemeteries Topsoil supply Lawns Garden areas Golf courses	Vegetable gardens Flower beds Window boxes Lawns Community projects School play areas	Flower gardens Road development Parks Picnic areas	Roundabouts Motorway and dual carriageway verges Embankments

Agriculture	Land Remediation	Forestry	Other
Vegetable crops Field crops Nutrient replenishment Land reclamation Seeding Grass growth	Landfill cover/ capping Contaminated sites Nutrient deficient sites Bogland remediation	Nutrient replacement Weed reduction Land preparation Sapling growth Biomass crops	Acoustic barriers Export Biofilters

Table 8.2. Typical properties of composted material suitable for use in growing media.

Parameters	Reported as (unit of measure)	Recommended range
pH	pH units (1:5 water extract)	8.5 maximum
Electrical Conductivity	µS/cm or mS/cm (1:5 water extract)	<1000 µS/cm or 100 mS/cm maximum
Moisture Content	%	35–55
Organic Matter	% dry weight basis	25% minimum
Particle Size	% of air dried sample passing through the selected mesh aperture size	<10 mm
Bulk Density	Grams per litre	600 maximum

the intended compost end use, minimum compost standards must be applied to ensure products are safe and fit for purpose, do not cause any environmental harm and provide end user confidence in the compost product.

Compost facility operators need to understand both the characteristics of their products and the requirements of the end user. Regular laboratory testing and product trials will identify the properties and strengths of the compost produced.

Once the compost operator has established with confidence the properties and characteristics of their product this information can then be used to market the compost effectively to specific end users. Research by the European Compost Network (ECN) has shown that 94% of professional compost users want 'a standardised and independently supervised high quality product accompanied by exact specifications for use' (Barth, 2008).

Fact-based information sheets can also help in market development by aiding compost end users to clarify what type of compost product is required depending on the end use. A number of Member States have developed compost use fact sheets, including Germany, Belgium, Sweden and the UK. WRAP in the UK for instance have published a range of fact sheets for agriculture and landscaping industries, including information on the use of compost in planting bed establishment, turf establishment and renovation, tree and shrub planting, manufacturing topsoil, fruit production etc. which are available free to download (fact sheets available from http://www.compost.me.uk/html/compost_fact_sheets.html, accessed 11 Nov 2008).

Each fact sheet specifies recommended ranges of parameters, for example, from WRAP Factsheet 09 on use of composted material in growing media for professional growers (see Table 8.2).

Figure 8.2. Garten-kompost bagged for sale in Germany and other quality marks. Note the compost quality mark clearly visible on the front of the bagged compost.

The properties of the Ballymun Compost as identified in Section 7 highlighted low levels of N, in comparison to commercially available products and recommended use as a soil conditioner and improver rather than a multi-purpose product replacement. Application rates were favourable between 10 and 30% when used *in situ* and in a potting mix.

8.2.3 Certification and Marketing

Developing a market development plan for a compost product is dependent not only on compost quality but also how the quality and properties are communicated to the end user. The ECN considers that compost with defined high-quality product properties is marketable on a large scale. The establishment of a quality label or mark for the industry, similar to the examples shown in Figure 8.2, alongside national product standards and a quality assurance scheme, is a key step in both building end user confidence in compost products and in developing a marketing plan.

8.3 Methodology

In order to properly position the Ballymun Compost product to the right market segment, data on potential users within the geographical area was required. For the purposes of marketing the Ballymun Compost within the local area, a survey was prepared for current and potential end users to identify quantitative and qualitative requirements and also attitudes in relation to their compost use.

The survey was designed to provide specific quantitative data on:

- who the current compost users are;
- where their current compost is sourced;
- in what application(s) the compost is currently used (landscaping, nurseries, horticulture, roads, etc.);
- how much compost is used;
- is the compost used certified and if so by whom;
- what is the requirement for low, high or general grade compost product;

- how much is currently paid per tonne or bag of compost;
- what is the future demand for compost product;
- how much would the compost end users be willing to pay for a compost product meeting PAS 100 or national standard requirements.

Surveys were sent to local authorities parks departments, local community environmental groups, a local landscape gardener and a nearby golf course and university identified by the project team as potential compost users. Follow-up calls were made to survey respondents in relation to perceptions of food waste-derived compost.

8.4 Results

8.4.1 Questionnaire Results

Surveys were sent to 12 organisations in the wider Ballymun area. A total of 7 completed surveys were returned (58.33% response rate). Tables 8.3–8.12 outline the survey results.

Table 8.3. Organisations currently using compost.

Yes	No
7	0

Table 8.4. Where compost currently used is sourced.*

Tully Nurseries	2
Bord Na Móna	1
Nortons	2
Enrich	1
Green King	1
Westland	1
Homebase	1
Supervalu	1
Other (varies)	1

* Some respondents used compost from more than one source.

Table 8.5. Main feedstock material for compost used – food waste, green waste or peat.

Green Waste	4
Food Waste	1
Peat Based	2

Table 8.6. Applications in which organisations surveyed used compost.*

Landscaping	5	Horticulture	2
Nurseries	1	Residential retail	0
Local authority parks	2	Roads	0
Land remediation	0	Forestry	0

* Some respondents used compost in more than one application.

Table 8.7. Number of organisations surveyed using certified compost.

Yes	No	No answer
0	3	4

Table 8.8. Amount (litres) of compost used per month.

0 – 500 L	1
500 – 2,500 L	4
2,500 – 10,000 L	1
* Varies	1

* 3 respondents indicated volume of compost used per month varies depending on season and workload; 2 of these respondents provided an average monthly estimate.

Table 8.9. Main use for compost by grade.

Low Grade (mulch)	1
General Grade (mixed use)	4
High Grade (specialised use)	2

Table 8.10. Amount currently paid per bag of compost product.

50 L bag	€4.80
70 L bag	€5.30,
80 L bag	€6.00, €7.50, €7–8, €8
Not specified	1

Table 8.11. Monthly planned compost use for the year following survey.

0 – 500 L	1
500–2,500 L	4
2,500–10,000 L	1
Can't predict	1

Table 8.12 How much survey respondents would be willing to pay per bag for a compost product meeting PAS100 Certification or forthcoming Irish Compost Standard

50 L bag	€3.00
70 L bag	€5.00
80 L bag	€7.50, €10–12
No more than present	2
Not specified	1

8.4.2 Perceptions of Waste-derived Compost

In a follow-up call to survey respondents, they were asked if they had any reservations in relation to using a food waste-derived compost product. Of the four respondents who were contactable, all replied that as long as it was clear that the compost to be used was free of any harmful bacteria (*E. coli*, *Salmonella*) and phytotoxic elements they would consider it fit for use. Two respondents commented that if there was a notable difference in levels of N, P or K in comparison to their current product they would have to trial the new product and this was in relation to specialised use (e.g. plant nurseries). One respondent also commented that in their experience food waste-derived compost contained higher levels of electrical conductivity, which could be problematic for some applications and, depending on rate of application, it was added that EC levels would reduce with first watering. Another respondent also commented that an effective public composting education and awareness campaign would help to increase the use of waste-derived compost and this campaign should also include a communication on peat replacement.

8.5 Discussion of Findings

All respondents who returned the survey currently use compost during the year. Most compost used in the wider Ballymun area is derived from green waste and the main application or use is in landscaping. Most respondents used a general grade (mixed use) product; however, 2 respondents reported using a high grade (specialised use) product in nurseries and landscaping.

The amount of compost used per month varies from *c.* 400 litres up to *c.* 7000 L seasonally. The average amount of compost used per month per respondent is approximately 1,305 L. This is equivalent to approximately 16–17 x 80 L bags or 48–50 x 25 kg bags. An average total demand per month for the 7 respondents of 7,830 L or 300 x 25 kg bags can therefore be established. However, within this figure there will be seasonal variations.

Demand for compost for the next year after the survey (2009) is relatively the same as current use, which would indicate that there is presently a regular market demand for compost in the Ballymun area.

Four respondents were not able to confirm that the compost they currently use was certified and another two respondents do not use a certified compost product. Only two respondents indicated that they would be prepared to pay more for a certified compost product. This could be taken as an indication that most respondents are satisfied with the current quality of the compost or that there is a lack of knowledge relating to quality assurance standards. In order to verify this further research is required.

To further develop a marketing plan for Ballymun Compost a follow-up questionnaire with the same respondents could be conducted to ascertain exactly what their requirements are in terms of nutrient availability, stability and other compost product characteristics.

8.6 Summary

- An initial market development survey of the area has shown there is a current regular market demand for compost of approximately 7,830 L per month.
- A quality uncertified compost product could expect to sell at between €4.50–€6.00 for a 50 L or 60 L bag and between €6.00 and €8.00 for a 70 L or 80 L bag based on current market rates.
- A certified compost product may be able to earn a slightly higher market rate: however, most respondents would be unwilling to pay more than at present.
- The Ballymun Compost will have to compete favourably with commercially available green-waste-derived compost products to impact on the market.

9. Conclusions and Recommendations

9.1 Key Findings

The findings of this report present a comprehensive picture of the key elements of community composting.

- The waste collection process highlighted the need for an effective communication strategy, management company buy-in and sustained commitment from all stakeholders. Waste collection data has shown that if similar small-scale composting initiatives were implemented in all apartment complexes in Dublin, approximately 14,680 tonnes of organic waste could be diverted from landfill each year.[1]
- The results also highlight the significance of operational and educational support particularly in relation to composting process management and product verification. Compost quality was specifically dependent on adherence to process feedstock (quantity and quality), temperature, and moisture and cycle-duration parameters.
- The results provide proof that quality compost, with significant horticulture benefits, can be produced from household organic waste in an urban setting. Plant response, as expected, is dependent on nutrient content but also on compost stability.
- Market analysis concluded that a local market exists for the material produced and that waste-derived compost would be considered as an alternative to commercially available compost products.

9.2 Discussion

The diversity of composting sector activities means that it often cuts across different government policy areas, for example landfill diversion (Department of the Environment, Heritage and Local Government), climate change (Department of Communications, Energy and Natural Resources) and food waste processing (Department of Agriculture, Fisheries and Food) all of which have a key role to play in supporting the composting industry to make a real and significant impact on achieving landfill targets.

The quantity of biodegradable municipal waste disposed of to landfill increased by 4% to 1,475,077 tonnes in 2007. This contrasts with the 2010 target set by the Landfill Directive of 967,433 tonnes and demonstrates that despite concerted action from a number of organisations (such as CRÉ) to develop the composting sector over the last number of years, Ireland is moving further from meeting its obligations under the Landfill Directive.

Table 9.1 summarises the components of biodegradable waste generated and recovered in 2007. The principal component of biodegradable waste disposed of to landfill is organic waste, accounting for 839,806 tonnes of the total. Organic waste has a lower recovery rate (8.6%) than any biodegradable waste fraction, other than textiles.

While the separate collection of household food and garden waste at kerbside increased by 20% to 18,705 tonnes in 2007, the reduced collection of household food and garden waste at civic amenity sites resulted in a decrease in the overall collection rates by 1,000 tonnes. This is despite the recognition in the 2006 *National Waste Report* that the separate collection and diversion from landfill of organic waste must be accelerated. In addition to establishing services for the separate collection of organic waste, Ireland must now prioritise the development of an adequate infrastructure to treat this waste.

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[1] Based on household organic waste arising of 4 kg/hhd/week and 2006 Census figures

Table 9.1. Biodegradable municipal waste generation and management, 2007.

Material	Gross quantity available (tonnes)	Quantity landfilled (tonnes)	National landfill rate (%)	Quantity recovered (tonnes)	National recovery rate (%)
Wood	240,675	16,994	7.1	223,681	92.9
Paper	914,069	384,245	42	529,824	58
Organics	918,423	839,806	91.4	78,617	8.6
Textiles	244,924	234,033	95.6	10,891	4.4
Total	2,318,091	1,475,077	63.6	843,013	36.4

Source: Le Bolloch et al., 2009, p.13.

9.3 Recommendations

This report recommends the co-ordination and rationalisation of legislation, regulation and operational procedures for small-scale composting activities with low environmental impact. Adherence to the gamut of stipulations associated with the ABP regulations adds restrictive costs to small-scale projects and is impeding the development of community composting initiatives in Ireland. Community composting initiatives should be exempt from these regulations, or failing that, separate regulations should be developed that would encourage small-scale composting whilst mitigating potential risks.

National waste management policy should also be revised to clearly define composting as a preferable waste management option over anaerobic digestion and energy recovery, based upon its potential to improve degraded soils, and reduce chemical fertilisers, pesticides and peat-based products. The development and implementation of a specific EU directive on biowaste, as proposed in the 2002 European Commission Communication on the Soil Strategy, would result in a definite shift from landfill disposal of biowaste to composting, harmonise standards and encourage community composting and therefore should be encouraged.

This report recommends the development of an awareness raising and skills training programme to support and empower residents to take control of their waste management, and if necessary of their management companies. Waste charges and alternative options should be made transparent to tenants. A change in the structure of waste charges to tenants and their inclusion in decision-making processes relating to waste management is necessary to encourage recycling, composting and environmental responsibility.

In particular, it is recommended that waste management fees for apartments are charged on a pay per use basis rather than apartment size to facilitate a shift in attitudes towards resource management.

Due to the complex nature of the composting process, the development of a 'Master' composter group to support community composters and the establishment of an Irish Community Composting network is also recommended. Observed variance between compost stability standards identified in this report also highlights the need for an agreed standard method for testing compost maturity.

Further research should be carried out on compost application to identify the product characteristics, agricultural benefits, and potential role within a peat replacement policy for Ireland.

Clearly, one of the main obstacles to community scale in vessel composting systems is cost. The cost of purchasing, installing and operating the systems are difficult to justify given current landfill disposal costs and the absence of financial recovery incentives. Financial incentives such as increased landfill rates, the introduction of organic recycling levies or recovery subsidies, voluntary sector access to environment funds and tax incentives for purchasing of waste treatment technologies should be introduced.

Finally, a national education and awareness programme should be developed to highlight the benefits of organic waste recycling and waste-derived compost production. The positive effects of compost use in horticultural applications and for improving soil health should be highlighted. Furthermore, awareness campaigns should be implemented to promote the potential contribution, responsibility and value of the voluntary sector in achieving landfill diversion targets.

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Acronyms and Annotations

ABP	Animal By-Products
BD	Bulk density
BRL	Ballymun Regeneration Limited
BSE	Bovine spongiform encephalopathy
BSI	British Standards Institution
CCN	Community Composting Network
CRE	The Composting Association of Ireland
DAFF	Department of Agriculture, Fisheries and Food
EAP	Environmental Action Plan
EEB	European Environmental Bureau
EC	Electrical conductivity
ELCRP	East London Community Recycling Partnership
EPA	Environmental Protection Agency
ERTDI	Environmental Research, Technical Development and Innovation
FM	Facility management
GAP	Global Action Plan
HACCP	Hazard analysis and critical control point
MFD	Multi-family dwelling
MSW	Municipal solid waste
NGO	Non-governmental organisation
OUR	Oxygen uptake rate
PBMW	Putrescible municipal biodegradable waste
QAS	Quality assurance system
SFD	Single-family dwelling
TPA	Tonnes per annum
VAT	Value Added Tax

Appendix: Quality Assurance in Community Composting

Contents

1. Scope

The following document is intended for use as a reference document for small scale composting of source separated food waste or catering waste in schools, hospitals, prisons, apartment complexes, housing and community areas.

We'll start with getting the compost mix right, moving on to monitoring the composting process and through to testing and using the finished compost.

Feedstock > > Monitoring >> Testing >> Use

2. Feedstock – Getting the Mix Right

2.1 What You Can Compost

- Fruit and vegetables
- Flour, cereals and sugar
- Eggs (including shells)
- Cheese
- Bread, buns and cookies
- Tea bags and coffee grinds
- Potatoes and root vegetables
- Flowers from pots and vases (no soils)
- Plate Scrapings
- Meat *(in-vessel composting only, no large bones)
- Fish *(in-vessel composting only)
- Chicken *(in-vessel composting only, no large bones)

* Whether or not you can compost meat, fish and chicken depends on what composting technologies you are using. For example these materials should not be composted using outdoor only processes such as windrows as vermin could be attracted.

2.2 What You Can't Compost

- Dry recyclables (cans, plastics, magazines, beverage cartons, glass etc.) – bring these to your recycling bin or nearest recycling centre
- Waste electronic (WEEE) items – bring to recycling centre or retailer
- Food packaging – any plastic wrappers, films, coatings, tetra pak etc.
- Metals including kitchen cutlery, blades etc.
- Batteries – bring to recycling centre
- Clothes – bring to recycling centre / clothes bank
- Liquids – soups, teas, soft drinks, alcoholic drinks etc. – will upset the micro-biological balance in the composter
- Oils – waste cooking oil, car engine oil etc.

2.3 How to Reduce Contamination

- **Check that the feedstock materials can all be composted**
- **Remove any materials which can't be composted**

In the case where contamination is found in the feedstock, highlight it to the person responsible, or if you are unsure inform the whole group.

Explain why the material in question can't be composted

As you'll notice after you've been composting for a while, any plastics, food packaging and harder fruits such as pineapples etc. will go through the composter and come out fairly intact at the other end. To make quality compost and to save time spent removing these items at the end of the process it's much easier to reject these as non-compostable from the start.

Try to be as clear as possible about what materials can and can't be composted. The differences between the brown bin system and a local composting system should also be explained.

2.4 Monitoring Feedstock W eights

It's relatively easy to measure or record how much material you're composting just by locating a weighing scale next to your composter. This data can be useful in a number of ways, for example;

- it can give you an idea of how much compost you can expect to make at the end of the process
- it can be used to tell how much food waste by weight you're diverting from your black bin or landfill (which can be used to reduce waste charges and numbers of bins), and;
- it can be used as an indicator of your project's success if you're looking for some extra support or funding

Weigh your feedstock material daily – record it in a chart or spreadsheet like this:

Date	Name / Apartment Number	Food waste (kgs)	Wood pellets (kgs)

3. Monitoring the Composting Process

After you've checked that the right materials have been put into the composter or compost mix there are a few things to keep an eye on during the composting process to make sure your finished compost will be of good quality and safe for use.

The most important parts of the composting process to check regularly are the time and temperature profile, the carbon to nitrogen ratio, the moisture content and the particle size.

3.1 How Long will it Take to Make Compost?

The length of time it takes to make a stable compost product is dependent on lots of different things – if you're composting outdoor or indoor; time of the year; amount of material; technologies used etc. The average length of time for the compost process is somewhere between 8-20 weeks where one or combinations of the main composting technologies are in use (windrows, aerated bays, in-vessel). The first 2-8 weeks are the most intensive or active phase, following which a further 4-12 weeks are required for curing and maturation.

During the active phase the process creates heat. Monitoring the temperature of the compost can be used to confirm the process is working properly.

3.2 Time and Temperature

Often known and shown in graphs as time/temperature profile, this is simply… *how long the materials have been composting for and what temperature the composting pile has reached during the process.*

EPA approved composting facilities must meet as a minimum these Irish EPA Waste Licence requirements below:

Document	Type of Composting	Min. Temp	Min. Time	Particle Size	Cover / Enclosed process
Irish EPA Waste Licences	In-vessel composting	60 ºC	1 week	None	Not required (closed reactor)

Temperature data should always be recorded at a minimum once per day. Depending on your compost system there may be a few ways to do this. Most new in-vessel composters have built in sensors and even enable remote monitoring via a laptop computer. Alternatively you can use a simple hand held temperature sensor with a probe.

Temperature monitoring is a good way of telling if there are problems with your compost, for example if temperatures are consistently low there is a problem with one or more of the main composting ingredients, such as too much carbon or nitrogen rich materials and/or not enough oxygen or moisture.

Monitor your temperature data at least once per day – record it in a chart or spreadsheet like this:

Date	Time	Temp A*	Temp B*	Temp C*

*Temps A, B and C in the above table refer to different temperature monitoring points in the compost pile. All temperature recording equipment should be checked (calibrated) once a year to ensure it is working accurately.

3.3 C:N Ratio

The ratio of carbon to nitrogen in the compost is very important. A mix balance of materials rich in nitrogen and carbon is needed to create the right conditions for the composting process to take place. The recommended ratio is 25-30 parts carbon to 1 part nitrogen.

Materials rich in nitrogen are sometimes referred to as “greens” including for example grass, plant leaves, fruit and vegetables and materials rich in carbon as “browns” including for example newspapers, twigs/branches and wood chips.

A deficiency of carbon in the process can lead to increased odours due to release of ammonia from the nitrogen rich materials. It’s common in most cases where mainly food waste is being composted to add wood pellets to the process to keep the C:N ratio at 25-30:1.

Check the feedstock to see how nitrogen heavy it is (e.g. is there a lot of grass, plant leaves, fruit and vegetables).

Add carbon rich materials (e.g. wood pellets) as required.

3.4 pH

The composting process is relatively insensitive to pH (measure of acidity/alkalinity) due to the broad spectrum of microorganisms involved. The preferred pH is in the range of 6.0 to 8.0. The pH of the finished compost product is normally stable and close to neutral.

3.5 Particle Size

The composting process works better with greater available surface area for bacteria to colonise. If there are a lot of large materials in your feedstock it’s probably worthwhile considering some sort of shredder or cutter to break down the larger items as turnips and pumpkins, etc.

Most in-vessel units have the option of fitting a shredder. A range of external shredders / cutters are available. You can also ask people to cut up large items before they bring material to the composter.

Compostable bags that meet EU standard EN13432 are a great way of keeping kitchen kaddies clean. However these or any similar materials such as plastic bags should not be inserted into the shredder as they can get caught in the rotating blade, causing the shredder to jam and possibly further damaging the motor mechanism.

Wrapping food waste in newspaper is another common method of keeping caddies clean and also adds carbon to the composting process.

Use a shredder to reduce particle size or ask people to cut up larger items.

3.6 Moisture Content

The microorganisms at work during the composting process need a moist and warm environment to move about and to enable chemical reactions and nutrient transport during composting. For this reason as well as checking the feedstock materials and temperature and right, the moisture content of the composting pile should be checked daily. Between 40-65% moisture is the optimum level. Below this the microbes will work more slowly and above this water will start to displace air in the pore spaces of the compost pile.

Check the moisture content daily and add water if required.

Measure the moisture content as follows: grab and clench a handful of compost in a gloved hand for approximately ten seconds. Then, open your fist and assess the moisture content using the following assessment index:

Index Number	Sample Moisture behaviour	Interpretation
1	Water seeps out	Too wet
2	More than one droplet appears	Too wet
3	One droplet appears	Ok
4	Compost particles remain packed together and no droplets appear	Ok
5	Compost particles fall away from each other	Too dry

3.7 Curing and Maturation

After the active phase of the composting has taken place the compost needs to be cured or matured. If you are using an in-vessel composter, when the finished compost is emptied from the machine move the compost immediately to an outdoor location (garden or concrete bay) for curing. Turn the compost daily to ensure that the pile is aerated. While the temperatures will be lower than during the active phase, microbes are still active and the chemical reactions of the composting process are still ongoing during this phase. Don't leave the compost to sit in plastic sacks or bags once it leaves the compost machine as this will generate heat and the compost will be starved of oxygen, so will not mature or cure properly.

Move the compost to the maturation area once the active composting phase has finished.

4. Compost Testing

Once you've been keeping an eye on your compost feedstock, time and temperature profile etc. for a while and you've been making some finished compost product, it's advisable to carry out an analysis of the compost to check that the compost is stable and free of pathogens.

4.1 How to Take a Compost Sample

Taking a compost sample consists of a number of steps including selecting the right equipment, preparing the sample and sending and archiving the sample.

4.1.1 When to take a compost sample

Take a compost sample at least once per year and send for analysis.

Compost facilities licensed by the EPA set out minimum frequencies for compost analysis based on the size of the compost facility. Facilities producing more than 500 tonnes and up to 1000 tonnes per year are required to carry out analysis every six months. So, based on this it could be recommended for facilities producing between 25 and 100 tonnes of compost per year to carry out an analysis once a year as a guideline.

The compost should be sampled at the end of the process following maturation and curing.

4.1.2 Sampling equipment

Typical equipment required for sampling are a spade or trowel, a large plastic sheet for mixing on or a plastic bag, gloves, sample bags, sample labels and a robust container for transporting the sample to the laboratory. All equipment used must be clean and dry so as not to alter the characteristics of the compost.

All sampling should be carried out over a sufficiently short period of time and in such a way as to avoid any alteration in the characteristics of the compost delivered. For instance, don't prepare a sample on a Monday and leave it to sit in the sampling container for 3 days before sending to the lab.

4.1.3 How many sampling points are needed?

Take 5 grab samples from different points along the compost pile and mix them together to make one composite sample. Repeat three times to make 3 composite samples.

4.1.4 Preparing the sample

Ensure that the volume of each sample taken and the number of samples are together sufficient to provide two samples of equal amount, one for the lab and the other for your archive.

'Combine the incremental samples to form a combined sample'. Thoroughly mix all samples, for example by placing them on a clean plastic sheet and mixing with a spade, or by placing them in a large plastic bag and carefully tumbling the material for a short period of time.

'Reduce the combined sample by coning and quartering...' i.e. take two equally sized quarters and combine sample them to form the final sample and send it to the laboratory. Take the other two quarters and combine them and keep this as your 'archive sample'. This is important in case the sample sent to the laboratory is lost in transit, the laboratory experiences analytical difficulties, and if sample re-testing is needed in the event of failure on any parameter.

4.1.5 Sending the sample to the lab

Testing must be carried out in approved laboratory facilities only. It is advisable to contact the laboratory beforehand to agree how the sample should be presented.

The final sample for testing by the laboratory must be labelled, and packaged in such a way that characteristics are unaltered on arrival at the laboratory. If the sample is to be tested for pathogens, use a service that will deliver it to the laboratory within 24 hours.

Place the archive sample(s) in a suitable, labelled container and store it in a dark, dry, cool (ideally less than 10°C but not below 1°C) place, to minimise any changes in characteristics over time. Keep each archive sample for not less than 6 months.

4.2 Compost Analysis

The proposed Industry compost quality standard for Ireland (EPA, 2009) specifies maximum limit values for heavy metals, pathogens, impurities, stability and organic matter.

The compost standard is for compost made from source separated biodegradable materials.

4.2.1 Maturity

Oxygen uptake rate (OUR) – 13 (mmol O_2/kg organic solids/h).

By 2014 there is an objective of reducing this limit value to 10 mmol O_2/kg organic solids/h in Ireland.

4.2.2 Foreign matter

Compost must not contain any sharp foreign matter measuring over a 2 mm dimension that may cause damage or injury to humans, animals and plants during or resulting from its intended use.

The maximum amount of foreign matter allowed under the proposed Irish standard is 0.5%.

4.2.3 Trace elements

Maximum Trace Element Concentration Limits for Compost (proposed Industry compost quality standard for Ireland):

Trace Elements (mg/kg, dry mass)	Irish Industry Standard
Mercury	0.4
Cadmium	1.3
Nickel	56
Chromium	92
Copper	149
Lead	149
Zinc	397

4.2.4 Pathogens

Pathogenic organism content must not exceed the following limits:

- there can be no *Salmonella* present (0 in 25 g)
- the quantity of E. coli present must be less than 1,000 cfu/g fresh mass

5. Storage and Labelling of Finished Compost

Store finished compost in a designated separate storing area

Compost produced should be stored in a suitable area so that no contact occurs between the feedstock (input) materials and the finished compost product (output).

Where the compost conforms to the appropriate standard or certification, verification of compost classification and certification information may be included on the product label.

Labels should include also the following information:

- the name or trade name or trademark and the address of the person responsible
- for marketing
- the name and address of the site of production
- the feedstock for all components
- detailed information on compost parameters
- information for a correct application and use with special regard to ABPR and the
- maximum quantities that can be spread on land
- if relevant, specific information to the professional end use

The following or similar statement should be included on the finished product label:

> 'Every effort has been made to ensure this product contains no germs, sharp fragments, toxins or regenerative plant parts. However, the manufacturer cannot guarantee they will never be present. As with all compost, wear gloves when handling and wash hands after use. During handling, avoid inhaling any dust from it or ingesting any of it.'

6. Glossary of Terms

Animal By-Products Regulations – (ABP) regulations control the processing of food waste and other organic wastes

Batch – Quantity of product manufactured by the same process under the same conditions, labelled in the same manner and assumed to have the same characteristics

Biodegradable – Material capable of undergoing biological decomposition

Carbon to Nitrogen Ratio – The ratio of total organic carbon to total nitrogen

Calibration – To check, adjust, or determine by comparison with a standard (the graduations of a quantitative measuring instrument)

Combined sample – combination of all incremental samples taken from one sampled portion

Compost – A stabilised, sanitised soil-like material, rich in organic matter, produced as a result of composting separately collected organic materials

Composting – A biological degradation process, under aerobic conditions, of organic material producing a stabilised organic product

Contaminants – Materials which are not in the accepted list of feedstock materials

Consignment – Quantity of goods dispatched or received at one time and covered by a particular contract or shipping document. A consignment may be composed of a part of a batch...or one or more batches...of the same material or different materials (products).

Feedstock – The input materials for the composting process e.g. food waste, green waste

Final sample – Representative part of the combined sample taken from the sampled portion obtained, where necessary, by a process of reduction

Incremental sample – Quantity of material taken from one sampling point

In-Vessel Composting System – A term adopted to cover a wide range of composting systems in which the material being composted is contained and, usually enclosed

Kitchen kaddy – Composting container for collecting feedstock materials in the home, available in different sizes

Laboratory sample – Representative part of the final sample prepared for testing

Mature compost – Compost that does not have a negative effect on seed germination or plant growth

Maturity – Maturity is the degree of biodegradation at which composted material is not phytotoxic or exerts negligible phytotoxicity in any plant

Micro-organisms – Microscopic organisms, which are capable of living on their own. They are often simply called ‘microbes’.

Moisture Content – The mass of water in a sample, usually expressed as a percentage on a mass per mass basis (%m/m)

Monitoring – The checking and collection of data in relation to composting process parameters

Pathogen- are living micro organisms, such as a bacteria or fungi that can cause plant, animal or human disease, e.g. *E. coli* and *Salmonella spp* pH – A measure of the acidity or alkalinity of a solution, numerically equal to 7 for neutral solutions, increasing with increasing alkalinity and decreasing with increasing acidity. The pH scale commonly in use ranges from 0 to 14.

Sampling point – Point from which the incremental sample is taken

Sampled portion – Maximum quantity of the same material (product) from the same batch from which one representative combined sample is to be taken

Shredding – The process of breaking up large input material fragments into smaller fragments so that the structural properties are more conducive for composting

WEEE – Waste Electronic and Electrical Equipment

Annex A – Standard Operating Procedures (Big Hanna T120)

How to Operate the Composter

Based on Hazard Analysis and Critical Control Point (HACCP) analysis there are a number of critical control points (CCP) that must be checked very time the machine is in use.

CCP 1 – Input Materials

Check the materials left or brought in for composting are suitable for composting. Reject any materials that can't be composted – place in recyclable / black bin.

Remember to check for and remove any plastic or biodegradable bags, string etc. that could potentially get stuck in the shredder / motor.

CCP 2 – Carbon:Nitrogen Ratio

Check the C:N ratio of the input materials. Wood pellets and/or bulking agent may need to be added depending on the amount of food and garden waste.

CCP 3 – Time/temperature Profile

Take a temperature reading of your compost pile. Add or log the temperatures to your records. Check the temperatures are above the critical limits for the required length of time.

CCP 4 – Moisture Content

Check the moisture level of the compost using the squeeze test. Add water if necessary from the water butt or nearby tap.

CCP 5 – Fan/Biofilter

Check the fan on the machine is clear of debris, the fan is at the correct speed and the bio-filter media is moist enough. There should be none or only slight/trace odour in the shed.

CCP 6 – Finished Compost

Make sure the finished compost at the end of the machine does not get mixed in any way with the input materials or any dirty kitchen kaddies. Move the bagged compost to the maturation bay without any of the compost coming into contact with any of the input materials.

CCP 6 – Housekeeping

Check the feed hopper is clear and no materials are left in the hopper. Make sure the area around the composter is clean and no full or dirty kitchen kaddies are left in the shed.

Annex B – Guidelines on Compost Use

Growing Plants Using the Compost

After the compost has matured it is then ready to be used to grow plants. There are two ways to use the compost in a residential area. Generally the compost can be used in pots and containers or used in outside flower or vegetable beds.

Pots and Containers

The compost is too strong (rich in nutrients) to use unmixed in pots containers as the compost will burn the roots of the plants. It is recommended to use a mix of 10-25% compost along with some multi-purpose compost and/or sterilised topsoil. This mixture is the optimum amount to encourage the plant growth rate. The mixture should be mixed through ensuring there are no lumps of compost in the mix. When mixed add the plants.

Planting in the Ground

When planting into outdoor flower beds it is important to dig up the bed a little to check the quality and drainage of the soil. The colour should be a light brown colour, however often outdoor flower beds contain excess matter from building work. This can leave the soil compacted and of poor quality. This can be easily rectified by adding perlite and compost to the soil. Perlite is a natural form of rock that is very light and it will simply add air to the soil so the roots can grow deeper and stronger. Again the recommended amount of the compost is between 10 -25%. Ensure everything is mixed through and that there are no lumps of the compost as this may burn the plant roots. When mixed add the plants.

Annex C – Audit Check List

A check list for auditing a compost quality assurance scheme is outlined in the table below. Relevant documentation should be available for inspection.

Item to Check	Tick Box
Process to monitor input materials	
Compost Process Monitoring – Temp/Time	
Compost Process Monitoring- moisture	
Compost Process Monitoring – C:N ratio	
Compost Process Monitoring – Particle size	
Sampling compost	
Passing the testing for compost quality standards	
Storage of compost to prevent cross contamination	
Good housekeeping	

An Ghníomhaireacht um Chaomhnú Comhshaoil

Is í an Gníomhaireacht um Chaomhnú Comhshaoil (EPA) comhlachta reachtúil a chosnaíonn an comhshaol do mhuintir na tíre go léir. Rialaímid agus déanaimid maoirsiú ar ghníomhaíochtaí a d'fhéadfadh truailliú a chruthú murach sin. Cinntímid go bhfuil eolas cruinn ann ar threochtaí comhshaoil ionas go nglactar aon chéim is gá. Is iad na príomh-nithe a bhfuilimid gníomhach leo ná comhshaol na hÉireann a chosaint agus cinntiú go bhfuil forbairt inbhuanaithe.

Is comhlacht poiblí neamhspleách í an Ghníomhaireacht um Chaomhnú Comhshaoil (EPA) a bunaíodh i mí Iúil 1993 faoin Acht fán nGníomhaireacht um Chaomhnú Comhshaoil 1992. Ó thaobh an Rialtais, is í an Roinn Comhshaoil agus Rialtais Áitiúil a dhéanann urraíocht uirthi.

ÁR bhFREAGRACHTAÍ

CEADÚNÚ

Bíonn ceadúnais á n-eisiúint againn i gcomhair na nithe seo a leanas chun a chinntiú nach mbíonn astuithe uathu ag cur sláinte an phobail ná an comhshaol i mbaol:

- áiseanna dramhaíola (m.sh., líonadh talún, loisceoirí, stáisiúin aistrithe dramhaíola);
- gníomhaíochtaí tionsclaíocha ar scála mór (m.sh., déantúsaíocht cógaisíochta, déantúsaíocht stroighne, stáisiúin chumhachta);
- diantalmhaíocht;
- úsáid faoi shrian agus scaoileadh smachtaithe Orgánach Géinathraithe (GMO);
- mór-áiseanna stórais peitreail.
- Scardadh dramhuisce

FEIDHMIÚ COMHSHAOIL NÁISIÚNTA

- Stiúradh os cionn 2,000 iniúchadh agus cigireacht de áiseanna a fuair ceadúnas ón nGníomhaireacht gach bliain.
- Maoirsiú freagrachtaí cosanta comhshaoil údarás áitiúla thar sé earnáil - aer, fuaim, dramhaíl, dramhuisce agus caighdeán uisce.
- Obair le húdaráis áitiúla agus leis na Gardaí chun stop a chur le gníomhaíocht mhídhleathach dramhaíola trí comhordú a dhéanamh ar líonra forfheidhmithe náisiúnta, díriú isteach ar chiontóirí, stiúradh fiosrúcháin agus maoirsiú leigheas na bhfadhbanna.
- An dlí a chur orthu siúd a bhriseann dlí comhshaoil agus a dhéanann dochar don chomhshaol mar thoradh ar a ngníomhaíochtaí.

MONATÓIREACHT, ANAILÍS AGUS TUAIRISCIÚ AR AN GCOMHSHAOL

- Monatóireacht ar chaighdeán aeir agus caighdeáin aibhneacha, locha, uiscí taoide agus uiscí talaimh; leibhéil agus sruth aibhneacha a thomhas.
- Tuairisciú neamhspleách chun cabhrú le rialtais náisiúnta agus áitiúla cinntí a dhéanamh.

RIALÚ ASTUITHE GÁIS CEAPTHA TEASA NA HÉIREANN

- Cainníochtú astuithe gáis ceaptha teasa na hÉireann i gcomhthéacs ár dtiomantas Kyoto.
- Cur i bhfeidhm na Treorach um Thrádáil Astuithe, a bhfuil baint aige le hos cionn 100 cuideachta atá ina mór-ghineadóirí dé-ocsaíd charbóin in Éirinn.

TAIGHDE AGUS FORBAIRT COMHSHAOIL

- Taighde ar shaincheisteanna comhshaoil a chomhordú (cosúil le caighdéan aeir agus uisce, athrú aeráide, bithéagsúlacht, teicneolaíochtaí comhshaoil).

MEASÚNÚ STRAITÉISEACH COMHSHAOIL

- Ag déanamh measúnú ar thionchar phleananna agus chláracha ar chomhshaol na hÉireann (cosúil le pleananna bainistíochta dramhaíola agus forbartha).

PLEANÁIL, OIDEACHAS AGUS TREOIR CHOMHSHAOIL

- Treoir a thabhairt don phobal agus do thionscal ar cheisteanna comhshaoil éagsúla (m.sh., iarratais ar cheadúnais, seachaint dramhaíola agus rialacháin chomhshaoil).
- Eolas níos fearr ar an gcomhshaol a scaipeadh (trí cláracha teilifíse comhshaoil agus pacáistí acmhainne do bhunscoileanna agus do mheánscoileanna).

BAINISTÍOCHT DRAMHAÍOLA FHORGHNÍOMHACH

- Cur chun cinn seachaint agus laghdú dramhaíola trí chomhordú An Chláir Náisiúnta um Chosc Dramhaíola, lena n-áirítear cur i bhfeidhm na dTionscnamh Freagrachta Táirgeoirí.
- Cur i bhfeidhm Rialachán ar nós na treoracha maidir le Trealamh Leictreach agus Leictreonach Caite agus le Srianadh Substaintí Guaiseacha agus substaintí a dhéanann ídiú ar an gcrios ózóin.
- Plean Náisiúnta Bainistíochta um Dramhaíl Ghuaiseach a fhorbairt chun dramhaíl ghuaiseach a sheachaint agus a bhainistiú.

STRUCHTÚR NA GNÍOMHAIREACHTA

Bunaíodh an Ghníomhaireacht i 1993 chun comhshaol na hÉireann a chosaint. Tá an eagraíocht á bhainistiú ag Bord lánaimseartha, ar a bhfuil Príomhstiúrthóir agus ceithre Stiúrthóir.

Tá obair na Gníomhaireachta ar siúl trí ceithre Oifig:

- An Oifig Aeráide, Ceadúnaithe agus Úsáide Acmhainní
- An Oifig um Fhorfheidhmiúchán Comhshaoil
- An Oifig um Measúnacht Comhshaoil
- An Oifig Cumarsáide agus Seirbhísí Corparáide

Tá Coiste Comhairleach ag an nGníomhaireacht le cabhrú léi. Tá dáréag ball air agus tagann siad le chéile cúpla uair in aghaidh na bliana le plé a dhéanamh ar cheisteanna ar ábhar imní iad agus le comhairle a thabhairt don Bhord.

National Development Plan 2007 - 2013

Science, Technology, Research and Innovation for the Environment (STRIVE) 2007-2013

The Science, Technology, Research and Innovation for the Environment (STRIVE) programme covers the period 2007 to 2013.

The programme comprises three key measures: Sustainable Development, Cleaner Production and Environmental Technologies, and A Healthy Environment; together with two supporting measures: EPA Environmental Research Centre (ERC) and Capacity & Capability Building. The seven principal thematic areas for the programme are Climate Change; Waste, Resource Management and Chemicals; Water Quality and the Aquatic Environment; Air Quality, Atmospheric Deposition and Noise; Impacts on Biodiversity; Soils and Land-use; and Socio-economic Considerations. In addition, other emerging issues will be addressed as the need arises.

The funding for the programme (approximately €100 million) comes from the Environmental Research Sub-Programme of the National Development Plan (NDP), the Inter-Departmental Committee for the Strategy for Science, Technology and Innovation (IDC-SSTI); and EPA core funding and co-funding by economic sectors.

The EPA has a statutory role to co-ordinate environmental research in Ireland and is organising and administering the STRIVE programme on behalf of the Department of the Environment, Heritage and Local Government.

Environmental Protection Agency
An Ghníomhaireacht um Chaomhnú Comhshaoil

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