1 INTRODUCTION

1.1 HOME COMPOSTING OVERVIEW

Composting is a well-established method for stabilising and sanitising biomaterials and its application as a major treatment technique in waste management is expanding rapidly in response to new legislation aimed at reducing landfill disposal of biodegradable wastes.

Composting is the microbial degradation of organic solid material that involves aerobic respiration and generally includes a thermophilic stage (Finstein and Morris, 1975). The main products of the aerobic microbiological transformation of putrescible, bulky organic waste are CO_2, and a humus-like material which is comprised primarily of stable, lignicellulose compounds. The residual compost has been described as the stable, sanitised and humus-like material rich in organic matter and free from offensive odours resulting from the composting process of separately collected biowaste (EC, 2001a). The definition of composting may also be broadened to include cooler aerobic breakdown of bulky wastes in small scale composters, as is the case with small pile composting in the domestic context, and by 'slow-stack' treatment methods, where temperatures are in the psychrophylic (0-20 ºC) to mesophilic (20-45 ºC) ranges.

Home composting (HC) is traditionally considered as a horticultural recreational activity. However, more recently, it has been identified as a potential major opportunity for managing part of the domestic biodegradable waste stream, to minimise the amount of waste collected for landfill disposal and therefore contribute to achieving compliance with reductions in biodegradable waste disposal to landfill required by the Landfill Directive (CEC, 1999). A unique aspect of this approach is that homeowners take responsibility for treating and recycling their biodegradable waste. Many factors influence the effectiveness of this approach, but encouraging homeowners to participate in HC schemes has major potential advantages in providing a low cost approach to waste management and facilitating the sustainable recycling of biodegradable organic waste. Home composting is a potentially unique waste management practice in that it offers the only means by which the producer can be the processor as well as the end-user of the recycled product.

1.2 HOME COMPOSTING IN WASTE MANAGEMENT

The geology of the UK has allowed long-term reliance on landfilling as the principal method of solid waste disposal (DETR/WO, 2000). However, the sustainability of this method of waste disposal has been questioned and the availability of landfill space is becoming critical in some areas, particularly in SE England. European policy is striving to achieve more sustainable, alternative methods to landfill for managing waste to conserve the remaining landfill space and reduce the potential public health and environmental implications associated with landfilling biodegradable waste. Biodegradable waste disposal in landfill potentially has major implications for climate change due to emissions of greenhouse gases, causes landfill subsidence and potential pollution of surface and ground water. Undue reliance on disposal to landfill is also considered to have inherent risks including missing opportunities for recovering value from waste and being too inflexible to meet changing needs (DETR/WO, 2000).

The potential importance of composting as a sustainable biodegradable solid residue (biowaste) disposal option is emphasised by the following drivers:

- EU Landfill Directive targets to progressively reduce biodegradable waste disposed to landfill.

- Waste Strategy 2000 stated that an essential part of achieving municipal waste recovery targets was to increase household waste recycling and composting. The UK Government's target for 2005 was to recycle or compost at least 25 % of household waste, increasing to at least 30 % by 2010.

- Landfill tax will increase the cost of disposal and encourage the recycling of organic materials.

- Rapidly declining landfill space - It is estimated that at current rates of landfilling, voids could, in parts of the country, be filled within 20 years.

- Recycling Credits - Financial incentives for local authorities to recycle all types of waste. This was replaced by the Landfill Allowance Trading Scheme in April 2005.

- Government objective to increase the replacement of peat with alternative waste-derived materials for use as soil conditioners and in growing media.

1.3 BENEFITS OF HOME COMPOSTING ORGANIC WASTE

Household recycling and composting has a key role in the UK Government's waste management strategy. The importance of developing HC as part of an integrated waste management strategy is being increasingly recognised by local authorities; their associated financial, environmental and technical benefits are considered below.

1.3.1 Financial

Importantly, HC can provide local authorities potential waste management cost savings in terms of refuse collection and disposal. In addition, home produced composts reduce the need for proprietary soil conditioning and mulching products. The householder may also gain greater satisfaction from improved growth and quality of plants in compost-amended soil.

1.3.2 Environmental

Home composting satisfies the proximity principle and is arguably the most sustainable management option available for dealing with biodegradable household waste in that the producer is responsible for the segregation, treatment and ultimate end-use of the waste.

Compost and organic matter is a renewable and sustainable resource and HC will assist in conserving natural peatland habitats. Peat substitution by home compost at no increased cost to the homeowner is achievable for soil improving and mulching by HC. Reliance on landfill and negative environmental associations with waste disposal by this method will be reduced. Compost is an effective soil conditioner replacement, which conserves soil organic matter and maintains and improves soil physical properties.

1.3.3 Technical

Composted materials have a beneficial liming value, and the organic matter improves moisture retention and soil structure. Nitrogen availability is relatively low in stabilised composted residues and this allows large rates of organic matter application to be supplied to improve soil physical properties without adding excessive amounts of labile nutrients. Therefore, nutrient leaching losses are minimised. Properly composted waste is a stable material with low odour. There is also evidence that organic composts are effective at suppressing some plant and soil-borne diseases (Barkdoll *et al*., 1992).

1.4 SIGNIFICANCE OF THE RESEARCH

Home composting has potential to divert a proportion of the biodegradable waste produced by households from landfill disposal. However, HC is a voluntary occupation and requires the active and sustained participation of a significant proportion of homeowners in the community to impact waste diversion rates. Approximately 75 % of Local Authorities have promoted HC by offering subsidised compost bins to homeowners, but the effectiveness of HC at waste diversion is uncertain due to the major practical difficulties involved in monitoring the process. Consequently, HC is not currently recognised as a performance indicator by Government for assessing the rates of recycling achieved by local authorities. Therefore, important questions remain about the role and contribution of HC as part of an integrated approach to waste management.

There is general guidance available on practical aspects of HC operations (HDRA, 1999), but a critical review of literature has identified a lack of published scientific research on waste treatment and stabilization in small capacity composting systems. Most research on HC has focussed on questionnaire-based surveys of the general public and local authority activities and is therefore of a general and qualitative nature (Burnley and Parfitt, 2000). However, no robust data are available that specifically quantify the actual effectiveness of this approach at diverting organic domestic solid waste from landfill under UK conditions.

1.5 OBJECTIVES

Imperial College established a research programme to obtain quantitative information on the potential extent of waste diversion by HC in collaboration with Runnymede Borough Council (RBC) with financial support from the Norlands Foundation through the Landfill Tax Credit Scheme. A 2 year Home Composting Study was based on 3 refuse collection rounds in the Chertsey, Thorpe and Hythe areas of the Borough of Runnymede. The principal objectives of the study were to:

1. Assess the demographic and socio-economic factors that determine the participation rate and potential extent of HC in the community;
2. Determine the contribution of HC to waste diversion from landfill in RBC;
3. Determine the key biological and chemical processes and management factors that control the effectiveness of composting biodegradable garden and kitchen waste in small compost bins;
4. Assess fruit fly population densities and their potential contribution to nuisance in the vicinity of home compost bins;
5. Quantify the airborne release of *Aspergillus fumigatus* from home compost bins;
6. Assess the end-use of the material as a soil conditioner and fertiliser product and as an alternative to peat.

1.6 OUTLINE OF THE REPORT

Section 2 presents a review of the literature of those areas that are of relevance to the research. Section 2.1 discusses the role of HC in waste management in terms of EU/UK policy and legislative context. Section 2.2 explores HC practice and experience in national and international environments. Section 2.3 explains Runnymede Borough Council's waste management practices and how the HC initiative affects the borough's waste strategy. Section 2.4 describes the management principles that determine composting processes and Section 2.5 reviews the potential benefits of home compost use and Section 2.6 examines compost quality standards.

Section 3 describes the general experimental and analytical techniques employed in the Study. Section 4 presents quantitative results collected on the extent of material additions, organic matter degradation and compost production by HC during the 2 year

trial period. The potential contribution to savings in waste disposal costs associated with HC is also assessed. The biochemical processes operating within the home compost bin in terms of temperature and gas monitoring are examined in Section 5. Section 6 characterises the chemical properties of composted residues from home compost bins. The potential health hazard posed to homeowners due to exposure to airborne *Aspergillus fumigatus* during HC activities is examined in Section 7. Section 8 presents the results from a study quantifying the association of fruit flies with home compost bins. In Section 9, the end-use of composted materials is investigated in a statistically designed field experiment to determine the effects of compost additions on plant growth and nutrient status, and on soil properties. Section 10 examines the socio-economic and demographic factors influencing participation in HC within the suburban setting of the Borough of Runnymede, based on questionnaire feedback from homeowners before and during the study. Section 11 summarises the characteristics and potential of HC in managing biodegradable solid waste and outlines the main achievements and outputs of the research. Key recommendations for future work are presented and practical guidance to local authorities is offered.