Home composting and its role in waste management

Our planet is rapidly becoming overloaded with rubbish. Keen gardeners have long valued the soil conditioner that results from composting domestic waste, but according to **Stephen Smith** and **Olympia Mitaftsi** this practice can also make a significant contribution to reducing environmental pollution.

The UK currently disposes of the majority of household waste (approximately 85 %) by landfilling, equating to about 28 million tonnes of waste annually in England and Wales. This represents a potentially significant environmental problem because of the high biodegradable organic content, which is responsible for the principal pollution risk from greenhouse gas emissions and water contamination from landfill sites. The European Landfill Directive has established mandatory targets for the phased reduction of biodegradable municipal waste disposal to ultimately cut the amount landfilled to 35 % of that produced in 1995. In England and Wales, the Government and National Assembly have also set targets to recycle or compost at least 25 % of household waste by 2005, increasing to at least 33 % by 2015.

Natural waste treatment

Composting is the aerobic microbial degradation of bulky organic waste, which usually generates heat, to produce a stabilized residue with significant value as a soil conditioner. The advantages of this natural process for treating biodegradable waste have placed it in a priority role for delivering the Government's target reductions in household waste disposal to landfill. Many householders with horticultural interests have traditionally composted and re-used their garden waste (Fig. 1). Encouraging and developing participation in home composting schemes also has major potential advantages in providing a low-cost approach to waste management and facilitating the sustainable recycling of biodegradable organic waste (Fig. 2). However, there is uncertainty about the effectiveness of home composting as a method of diverting organic waste from landfill disposal in practice, and the treatment and stabilization of waste in small capacity composting systems has received little scientific investigation or optimization.

Testing the value of home composting

Research at Imperial College London has quantified the amount of waste deposited in home compost bins by householders, which is therefore diverted from landfill disposal, in a study trial within the suburban setting of Runnymede Borough Council (RBC), Surrey. The microbiological activity in home compost bins in relation to organic waste degradation processes in these systems was also studied.

Sixty four households within the study area were approached to participate in the 2-year research project. A statistically designed trial was established with the co-operation of participating householders to quantify the potential reductions in domestic waste disposal to landfill by home composting. Householders were offered a subsidised compost bin for purchase and were supplied with experimental equipment to record the amounts of kitchen, paper and garden waste placed in the compost bins. Treatments were assigned in factorial combinations by dividing the group

◄ A landfill site in the UK. *Simon Fraser / Northumbrian Environmental Management Ltd. / Science Photo Library*

► Figs 1 & 2. Composting biodegradable household and garden waste using a home compost bin. *Stephen Smith*

Table 1. Waste inputs to home compost bins for the period May 2000 – March 2002

	Kitchen waste	Paper waste	Garden waste*	Total
Monthly mean, kg (Total no. of possible monthly deposits, n=1472; none deposits set to zero)	9	0·8	24	34
Monthly 95 percentile	27	4·0	88	103
Monthly mean recorded deposit, kg (None deposits omitted)	11	1·6	39	39
Frequency of actual monthly deposits (n)	1205	736	909	1275
Frequency (%)	82	50	62	87
Total annual deposit, kg	108	9·5	290	410
Input (percentage of total)	26	2	72	100

*Estimated from the density of grass clippings, 200 kg m^{-3}.

into large and small garden size classes. Additional treatments were randomly assigned within each garden size class and included: ± mixing, ± proprietory accelerator, ± earthworm inoculation.

A mass balance was produced for each compost bin at the end of the first and second year (May 2001 and 2002) of the trial. Materials in each compost bin were collected and weighed in buckets using a hanging scale. Material recovered from the bins was divided into three distinctive layers based on the extent of decomposition [fresh (A), semi-decomposing (B) and compost (C)] and the mass of each of these components was measured. Representative composite samples from each layer were collected to determine the moisture content and material from Layer C was subjected to a more extensive suite of chemical analyses.

Monthly and annual total waste inputs to the compost bins per household are summarized in Table 1. The total average annual input was approximately 400 kg, which is considerably larger than the default value assumed for home composting of 100 kg y^{-1} per household. The average monthly recorded deposits of kitchen and garden wastes were 11 and 39 kg, respectively, although, as would be expected, there was a seasonal trend in garden waste inputs (Fig. 3). The relative contribution of kitchen, paper and garden waste to the total waste input was 26, 2 and 72 %, respectively. The average moisture and dry matter mass balance for the bins determined from the 2-year study is illustrated in Fig. 4. The results showed that approximately 60 % of the fresh matter deposited in the bins was removed through moisture and volatile solids losses during the microbial composting process, equivalent to 147 kg (37 %) and 84 kg (21 %) of the total input mass, respectively. Home composting clearly offers a highly effective approach to processing and stabilizing domestic biodegradable waste.

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The potential benefits

The RBC Home Composting Study indicated that home composting could potentially divert up to 10 % of the domestic solid waste stream from landfill disposal on the basis that approximately 20 % of households in the community become engaged in the activity. This level of participation would achieve about 35 % of the waste diversion required to fulfil the immediate target set by the Government of composting or recycling 25 % of household waste by 2005. Cost savings to be gained by the waste disposal authority are also potentially considerable and were estimated as almost £82,000 in RBC on the basis of the diversion rates measured during the study. Therefore, home composting can provide a significant contribution to household waste diversion from landfill disposal and should be included as an integral part of an overall strategy for the collection, treatment and disposal of biodegradable waste.

Biological activity

Temperature and gas measurements of materials undergoing decomposition were taken to indicate the nature of the biochemical processes operating within the home compost bins and the rate of microbial activity. Participants in the RBC study were supplied with a soil/compost temperature probe (0–80 °C) and recorded the temperature of material in the compost bins (Fig. 5). This was complemented with more detailed monitoring of temperature conditions and gas profiles using an electronic thermometer and gas sampling probe (Fig. 6).

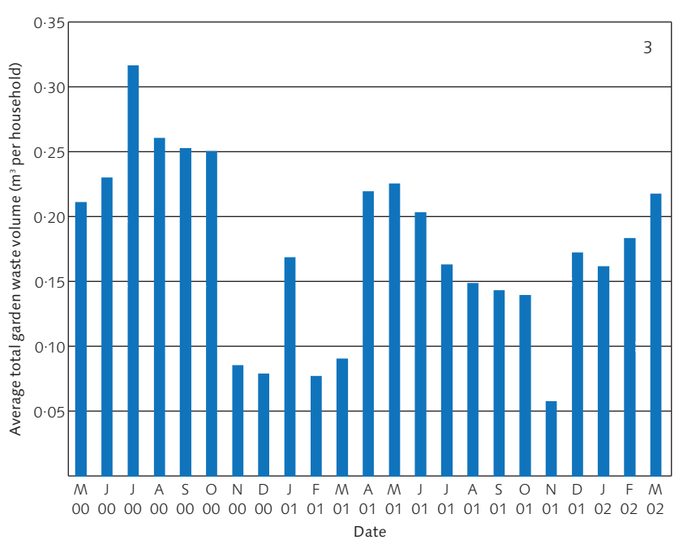
Temperatures recorded by householders were highly variable, but there was an underlying seasonal trend relating to ambient temperature conditions (Fig. 5). Temperature profiles generally varied between 6 and 50 °C and were usually above ambient in the psychrophilic (0–20 °C) to mesophilic (20–45 °C) ranges, indicating active biological degradation. The warmest conditions were generally found in recently deposited waste, associated with high rates of microbial activity in this layer, and temperatures declined with increasing depth in more stabilized material. Oxygen concentrations were typically close to ambient values and showed that waste degradation was predominantly by aerobic processes. Only traces of methane were occasionally found so home composters are not an important source of this greenhouse gas.

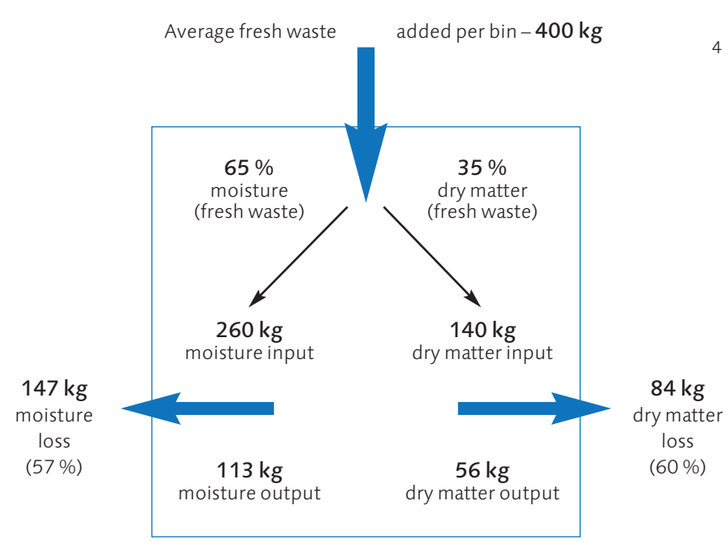
The stabilization of frequent inputs of small amounts of mixed organic residues in small-scale composters does not follow the normal ecological progression observed with conventional batch-operated, industrial-scale

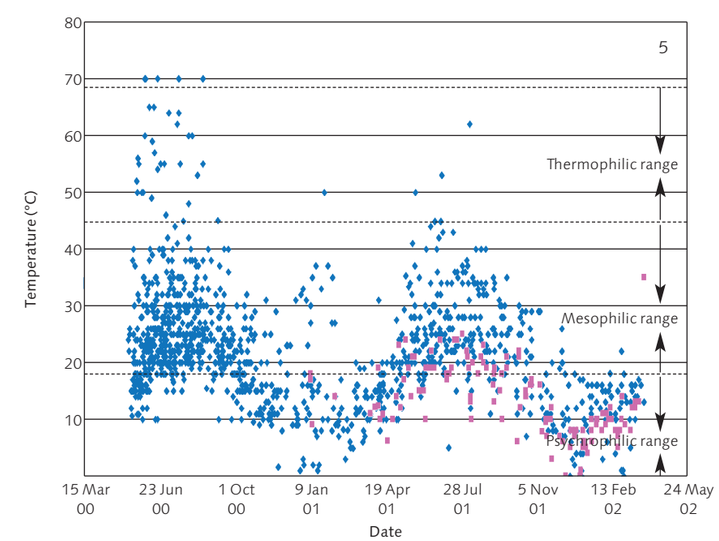
◀ Fig. 3. Mean monthly garden waste inputs to home compost bins, May 2000–March 2002. *Stephen Smith*

◀ Fig. 4. Average mass balance of waste processed in home compost bins during May 2000–March 2002. *Stephen Smith*

▼ Fig. 5. Compost temperature recorded by participants in the RBC Home Composting Study, May 2000–March 2002. ◆, temperature in bin; ■, ambient temperature. *Stephen Smith*







▲ Fig. 6. Measuring microbial activity based on interstitial gas composition in home compost. *Stephen Smith*

▲ Fig. 7. Preparing garden, food and paper waste samples in a field experiment investigating waste biodegradation processes in small-scale home compost bins. *Stephen Smith*

composting systems. Waste treatment in small-scale units is highly biodynamic and organic matter is present at different stages of decomposition, which depends on microbial activity as well as invertebrate animals, particularly earthworms. Regular small inputs of complex mixtures of different waste types (kitchen, paper and garden waste) to small-scale composting systems provide a stable and well buffered environment for the biodegradation of putrescible household solid waste.

What next?

The direct measurement of waste diversion rates from landfill disposal by home composting and other household waste recycling methods is a principal objective of a further phase of research at Imperial College London, supported by The Norlands Foundation and RBC. This will be achieved using an automatic weighing apparatus fitted to the refuse collection vehicle to determine the effects of home composting and kerbside collection on the residual waste produced from a large sample of properties in the Borough. The project represents the first application of advanced weighing technology to quantify the impacts of household waste management practices on diversion rates in a statistically designed investigation and will establish the fundamental relationship between the distribution of home compost bins in the community and the extent of waste diversion from landfill disposal. A controlled field experiment is also assessing the extent of potential waste throughput by small-scale home composters and is further quantifying the rates of microbial activity during the biodegradation of organic waste in these systems (Fig. 7).

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