4 EFFECT OF HOME COMPOSTING ON THE DIVERSION OF BIODEGRADABLE HOUSEHOLD WASTE FROM LANDFILL

4.1 INTRODUCTION

This section examines the reduction in waste collected for landfilling that has potentially been achieved by the RBC Home Composting Study Trial based on measured waste inputs to home compost bins. Waste additions to compost bins have been measured and related to household occupancy and garden size. Historical records of waste collection in the Study Area were also compared with recent waste analysis information collected during the trial monitoring period to assess the impact on landfill diversion. Potential cost savings attributed to reduced waste disposal have also been calculated. The rationale and background for the study and procedural aspects of monitoring activities during the investigation are described in Section 1 and 3, respectively.

4.2 WASTE INPUTS TO HOME COMPOST BINS

Householders recorded the amounts of kitchen, paper and garden materials deposited in the compost bins for a period of 23 months. The general statistical properties of the recorded monthly total waste input data per household for this period are presented in Table 4.1. The relative contribution of kitchen, paper and garden waste to the total waste input was 29, 3 and 68 % by wt, respectively.

Table 4.1 Statistical properties of monthly total waste inputs to home compost bins for the period May 2000 – March 2002

Statistic	Kitchen waste (kg/household/month)	Paper waste (kg/household/ month)	Garden waste	
			(m^3 per household per month)	(kg per household per month)[1]
Weighted average	9.0	0.8	0.12	21.5
Total annual deposit[2]	108 kg y^{-1}	9.6 kg y^{-1}	1.44 m^3 y^{-1}	258 kg y^{-1}
Waste proportion	29 %	3 %	68 %	

[1]Estimated from the density of grass clippings, 200 kg m^{-3} (NRAES, 1992; TCA, 2001)
[2]Overall total annual deposit = 375 kg/household

4.2.1 Kitchen waste

The amount of kitchen waste added to the compost bins each month was relatively consistent (Figure 4.1) and, on average, homeowners deposited 10 kg of kitchen waste per month over the duration of the monitoring period (Table 4.1). The largest average input of kitchen waste recorded in October 2001 was 14 kg per household. Kitchen waste inputs on average were typically > 8 kg per household. The smaller value recorded in May 2000 was explained because, at that stage, not all homeowners had followed the advice circulated at the beginning of the Study encouraging the deposit of kitchen waste (vegetable and fruit peelings) (Appendix 2).

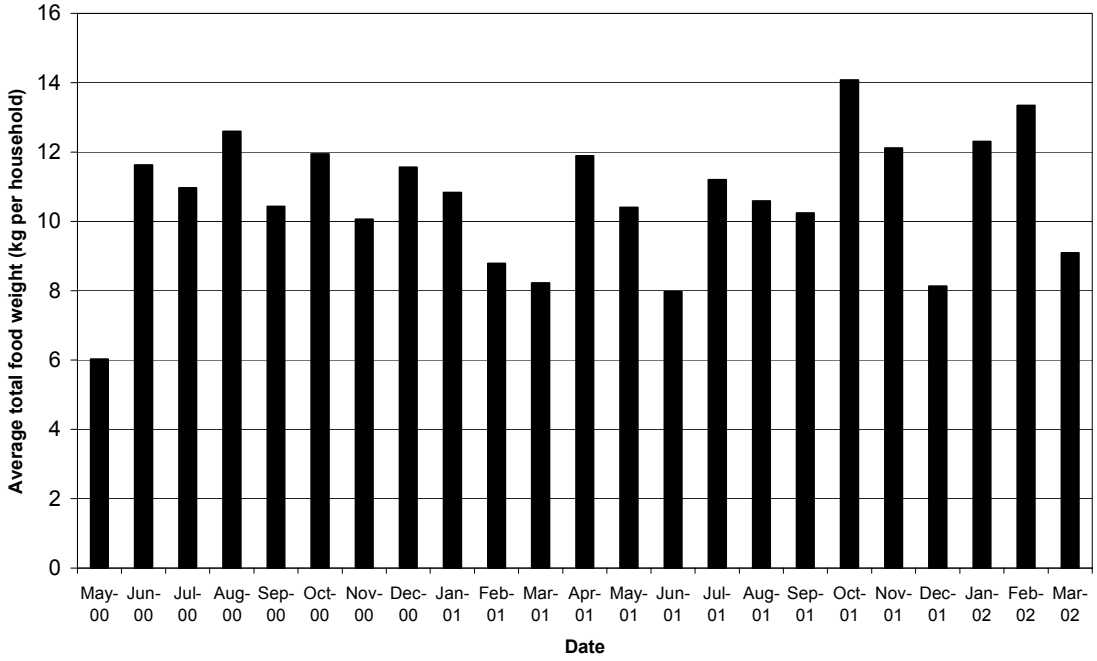

Figure 4.1 Monthly average total kitchen waste deposited in compost bins, May 2000 – March 2002

Kitchen waste arisings derived from DoE (1994) ranged from 1.4 kg per person per week to 2.9 kg per person per week (5.6-11.6 kg per household per month), which is consistent with results reported here. In addition, the monthly kitchen waste amounts are consistent with a 6 month investigation by Eco-linc (2002) involving 35 volunteer households in Moray, Scotland where the average kitchen waste diversion by home composting was 11.6 kg per household per month (Eco-linc, 2002).

The relationship between the total amount of food waste deposited per household during the first and second years of the monitoring period and household occupancy, is presented in Figure 4.2. This showed that the amount of food waste added to the compost bins was generally independent of the number of individuals living at a property when there were 2 or more occupants. Households with five occupants deposited the largest amounts of food waste during the first year of the monitoring period, equivalent to 14 kg per household. However, the input of food waste dropped to 10 kg per household for this group in the second year. In comparison to the other household occupancy groups, those with two occupants deposited the largest amounts of food waste throughout the monitoring period. This was particularly the case during the second year when the average input by this group was approximately 12 kg per household. Two occupant households were generally represented by retired couples and the larger food waste deposit in compost bins measured here (Figure 4.2) may be explained because this group may spend more time preparing fresh foods compared to the other occupancy groups. As may be expected, food waste deposits were smallest overall for single occupancy dwellings and in this case the average monthly kitchen waste input was 7-8 kg. With the exception of the high value recorded for 5 occupant households in 2000/01, there was a general trend of declining kitchen waste inputs with increasing household occupancy above two individuals. This was particularly apparent in the representative second year when inputs of food waste to the bins declined by approximately 25 % with increasing occupancy from 12 kg per month for 2 occupant households to 9 kg per month in 6 occupant households.

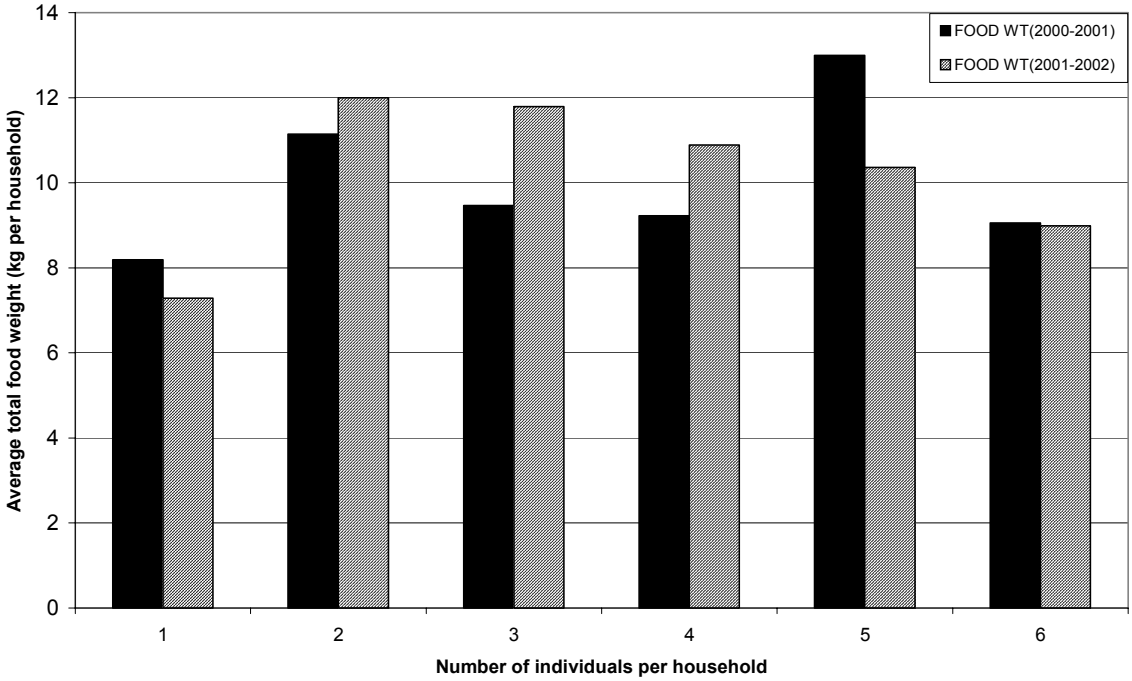

Figure 4.2 Average total food waste deposited in compost bins during May 2000 – March 2002 in relation to household occupancy

4.2.2 Paper

Inputs of waste paper were more variable than for food waste (Figure 4.3) and householders were generally reluctant to add paper to the compost bin. Homeowners were advised during home visits of the benefits of adding paper for the composting process and this may explain the intermittent increases in the amounts of paper added. The average paper input by a household per month was 1.5 kg during the trial (Table 4.1).

The relationship between household size and average total weight of paper per household added to the bins during the monitoring period is shown in Figure 4.4. Paper inputs were generally consistent amongst the different household size groups in the first year at approximately 1.5 kg per month although 3 and 6 person occupancy groups added very small (0.2 kg per month) or much larger (2.4 kg per month) amounts of paper waste, respectively. No specific explanation can be given to the variations observed in the first year except that, during this period, homeowners were gaining confidence and greater knowledge of the suitability of different materials for composting and the benefits of adding paper to home composters to balance the moisture regime (Section 2.4). In the second year, all higher occupancy groups (≥2) showed a consistent pattern of paper inputs. Single person households added 0.75 kg of paper waste into the bins and paper inputs approximately doubled for the higher occupancy groups.

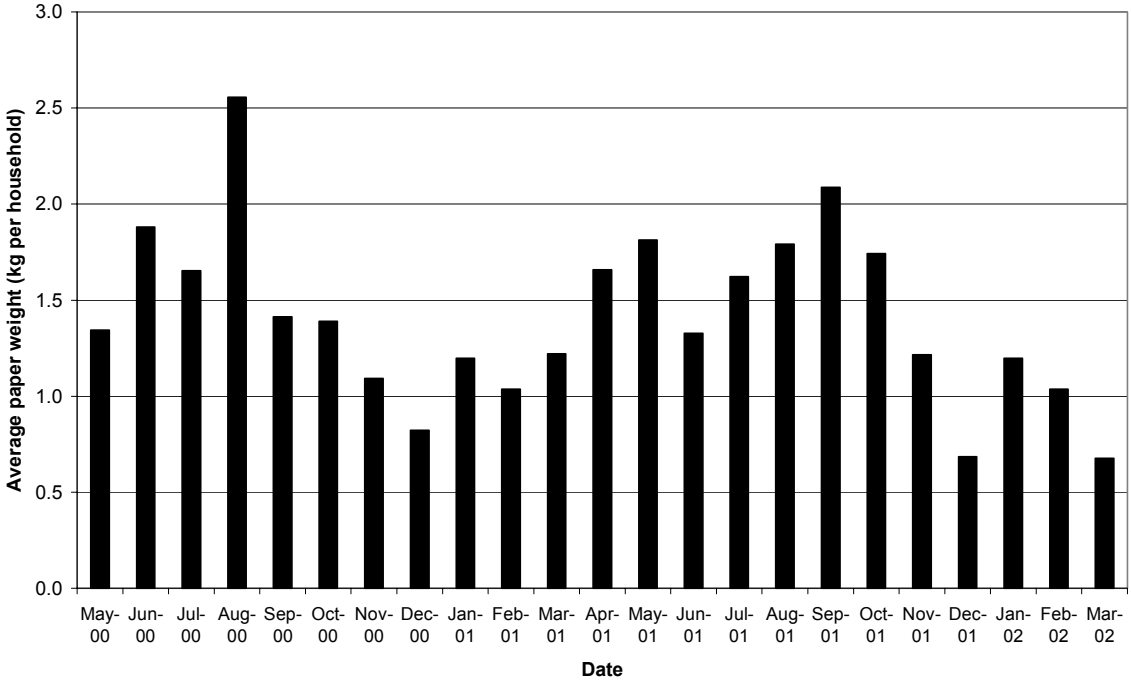

Figure 4.3 Monthly average paper waste deposited in compost bins, May 2000 – March 2002

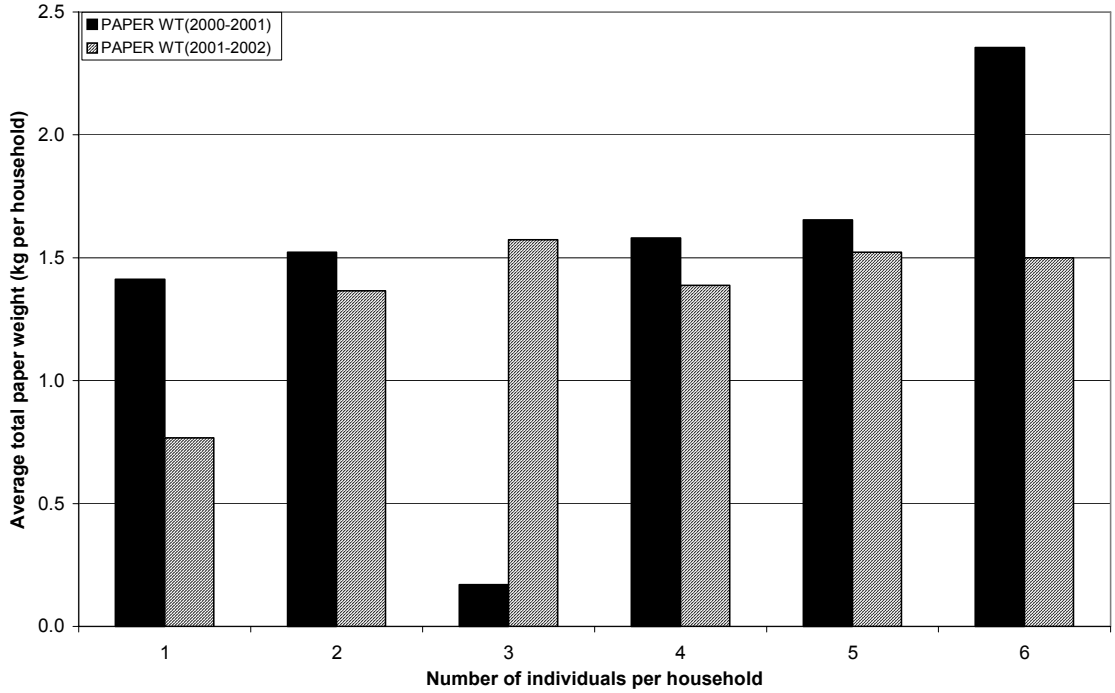

Figure 4.4 Average total paper waste deposited in compost bins per month during May 2000 – March 2002 in relation to household occupancy

4.2.3 Garden waste

The average monthly volume of garden waste added to the compost bins is shown in Figure 4.5. As would be expected, a seasonal trend was observed in garden waste inputs and homeowners deposited the largest volumes of garden waste during the summer period (April-October). During the first year of the trial, the majority of householders deposited up to 0.1 m^3 of garden waste in the compost bin at any one

time, but there was also a significant number of homeowners adding much larger volumes of garden waste of up to 0.25 m^3. In the second year the mean input of garden waste per household was in the range 0.15 – 0.2 m^3 per month. Garden waste is the predominant input to home compost bins representing 72 % of the total mass deposited.

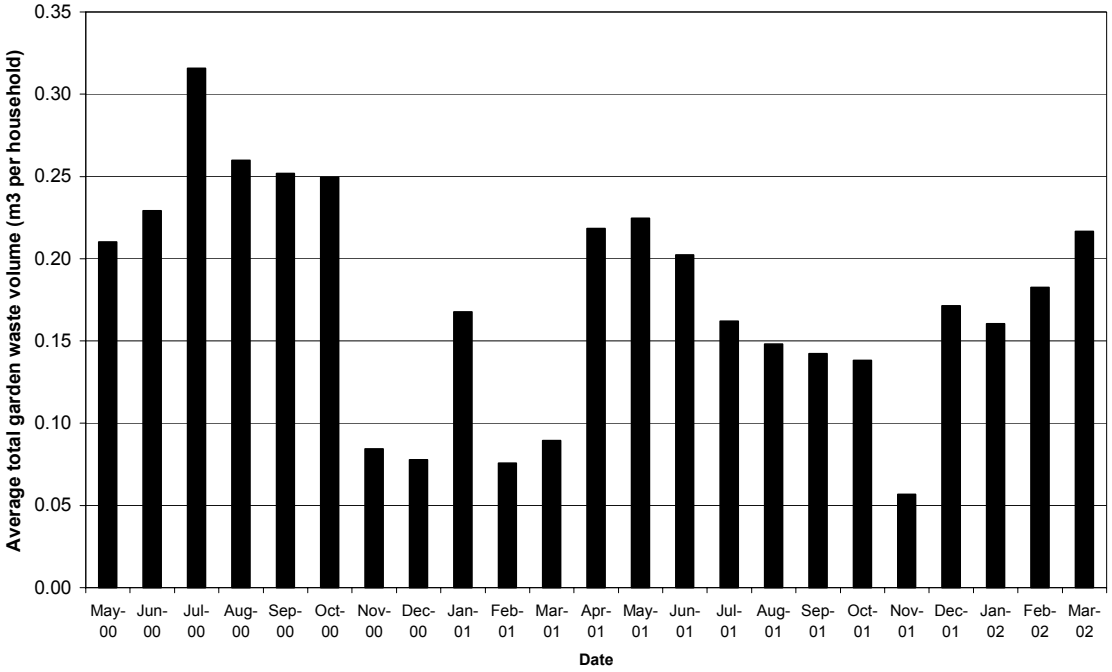

Figure 4.5 Monthly average volume of garden waste deposited in compost bins, May 2000 – March 2002

No significant correlation (P>0.05) was detected between the total volume of garden waste deposited in the bins and garden size (Figure 4.6). This suggested that the capacity of the bins was exceeded with respect to the amounts of waste produced from the range of garden sizes in the Study.

4.3 MASS BALANCE OF WASTE INPUTS AND OUTPUTS FROM HOME COMPOST BINS

Total amounts of waste material deposited into the 64 compost bins participating in the monitoring programme were weighed by homeowners. Material was sampled for chemical analysis (see Section 6) for each compost bin after the first year (Y1) and second year (Y2) periods in May 2001 and April 2002. The material in the bins was divided into three distinctive layers based on extent of decomposition: fresh (A), semi-decomposing (B) and composted (C) layers. The moisture content of the component layers was also measured (Section 3.5.1). Dry matter and moisture losses after Y1 and Y2 were calculated. Moisture contents of the waste inputs were based on the mean value measured for Layer A, representing recently added material. Total annual and average mass balances of compost bins were constructed for each year; a summary is presented in Table 4.2 and further detail is given in Figures 4.7 – 4.10; an overall mean mass balance per compost bin is shown in Figure 4.11. The slightly smaller moisture content measured in Y2 could be attributed to the addition of more fibrous material compared to Y1. The total annual amount of kitchen waste deposited in all the compost bins monitored in the Study was raised by approximately 15 % in Y2 (7 t FW) compared to the inputs of this waste type in Y1 (6 t FW). However, inputs of paper decreased overall by 24 % in Y2 (497 kg) compared to Y1 (650 kg). This could be partly explained

because Y1 was a 12 month period (May 2000-April 2001) whereas Y2 represented a slightly shorter 11 month period (May 2001-March 2002), although waste inputs were small and not representative in the first month of Y1, so overall the data from both years' are probably directly comparable. Inputs of garden waste in Y2 (16.5 t FW) were raised by approximately 9 % compared to Y1 (15 t FW) and there was also an input of residual uncomposted material in Y2, equivalent to approximately 1 t FW of material to all of the compost bins (64) in the Study, that was transferred from Y1 to Y2. Consequently, there was an overall increase (14 %) in the total amount of waste deposited in the bins in Y2 (25 t FW) compared to Y1 (22 t FW). Removing the transferred residual material (1018 kg) from the mass balance in Y2 indicated there was approximately an overall increase of 10 % of fresh waste inputs into the compost bins in the second year compared to Y1. The average fresh waste input per bin was 360 kg per year (Figure 4.11). Note the values in Figure 4.11 and Table 4.1 are calculated in different ways; Figure 4.11 gives an overall weighted annual average based on the measurements over the experimental period (23 months) and the total estimated in Table 4.1 is based on the monthly weighted average value x 12, to give the annual figure.

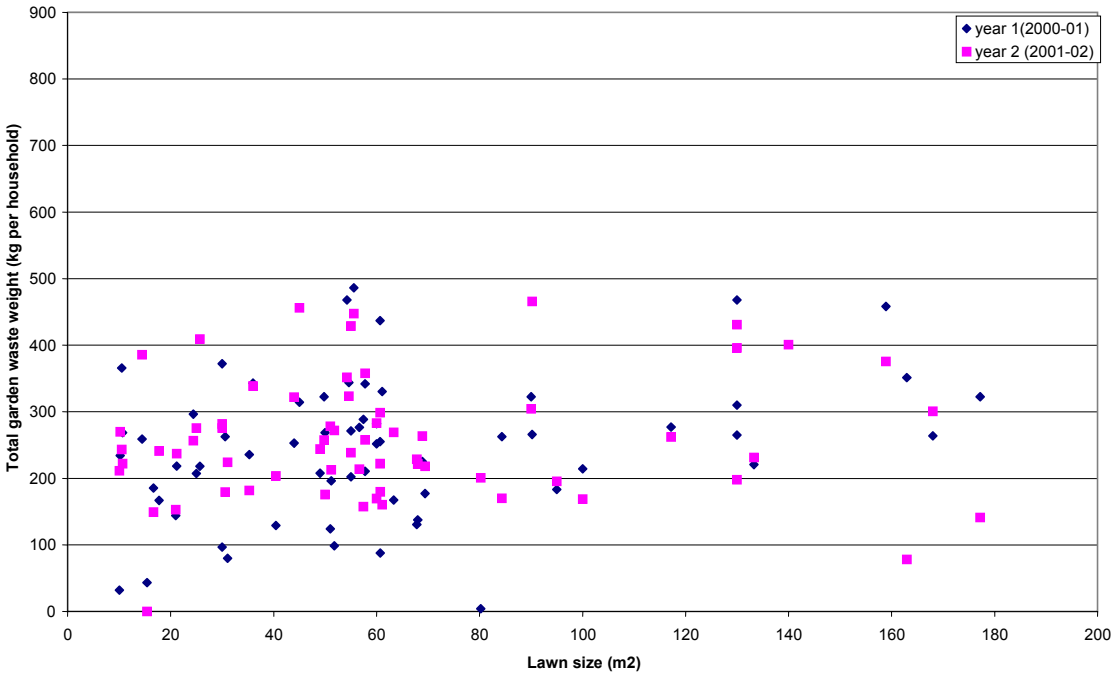

Figure 4.6 Average total weight of garden waste deposited in compost bins during May 2000 – March 2002 in relation to lawn size

The results showed that 53 % of the fresh matter deposited in compost bins was removed through moisture and volatile solids losses during the composting process (Figure 4.11), equivalent to 121 kg (34 %) and 70 kg (19 %) of the total input mass, respectively. In contrast, dry solids losses up to approximately 40 % are typically reported for mechanical, centralised composting systems with refuse and sewage sludge (Diaz *et al*., 1982). The degree of decomposition may be greater in HC systems due to the addition of soft green waste feedstock, which is readily biodegraded compared to woody wastes with higher lignin contents (Chandler *et al*., 1980), and also the longer processing duration in HC systems, albeit at lower temperatures, compared to large-scale composting methods.

Table 4.2 Total input/outputs and different components of waste material (fresh weight) for all compost bins in the Home Composting Study in year 1 (April 2000-May 2001) and year 2 (May 2001-April 2002)

Variate	Year	Total all bins	Per compost bin			
			Min	Max	Mean	Median
Total waste input (kg)	1	22000	43	707	344	347
	2	25122	123	659	393	370
Total waste output (kg)	1	10255	33	319	160	147
	2	11445	96	260	179	175
Fresh waste layer (A) (kg)	1	998	0	32.4	15.6	16.6
	2	948	2.4	51.9	14.8	14.8
Semi-composted layer (B) (kg)	1	3721	0	202	58.1	49.9
	2	2815	7.5	112	44.0	42.9
Compost layer (C) (kg)	1	5536	21.3	217	89.3	78.6
	2	7683	39.5	195	120	123

4.4 IMPACT OF HC ON WASTE GENERATION IN THE STUDY AREA

Refuse collection in the Study Area is divided into 3 regional rounds: Pooley Green, Hythe and Thorpe and waste generation in the area during the past five years is presented in Table 4.3. Since 1997, waste collection in the Study Area has increased by 1%, in contrast to the 3 % annual increase in household waste generation estimated by DETR (DETR/W0, 1999). Total monthly waste arisings in the Study Area are shown in Figure 4.12, before and after the distribution of HC bins in April 2000. A comparison of means test (Student t-test) showed there was no statisitically significant change in the mean monthly quantity of waste collected from the rounds included in the Study Area due to home composting.

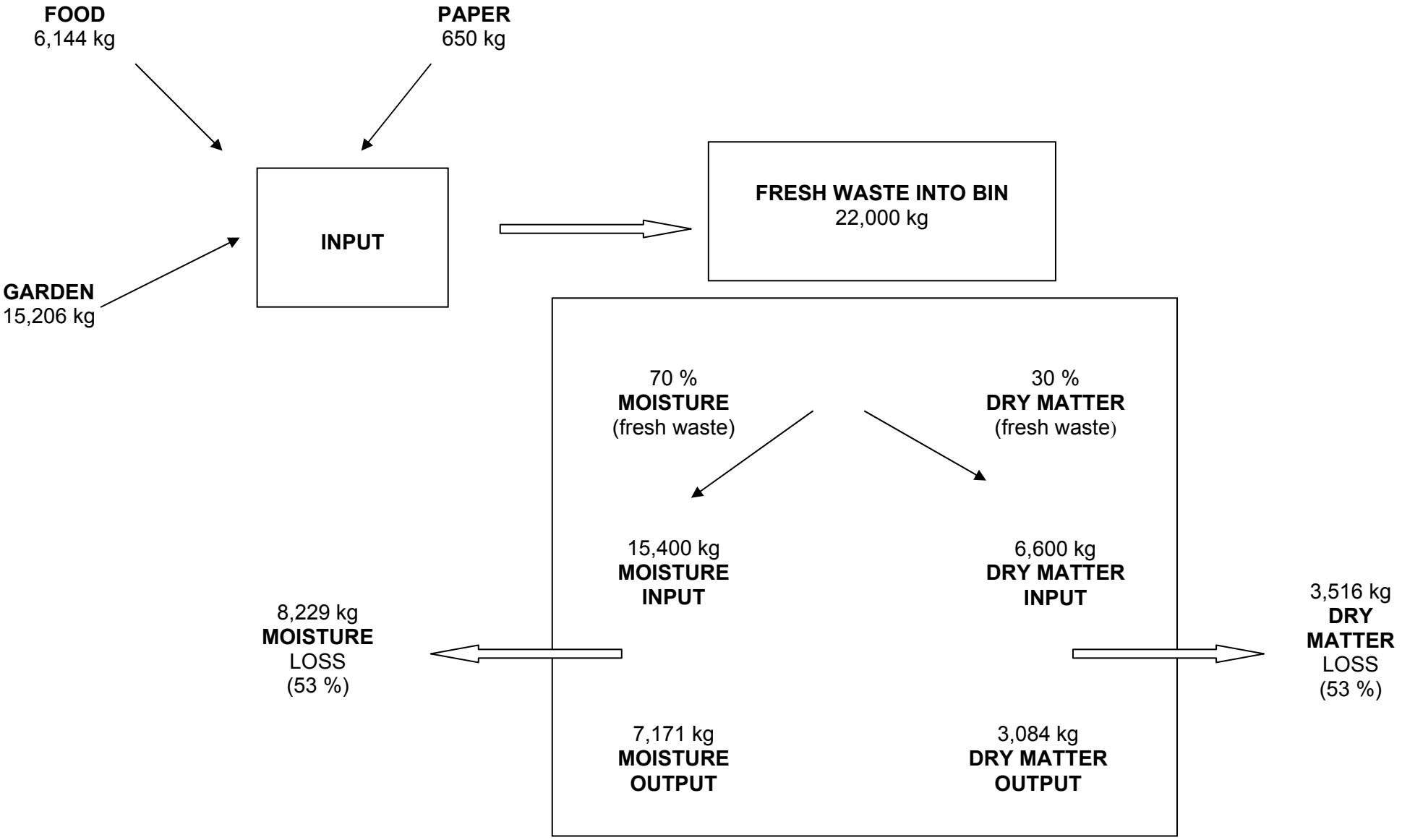

Figure 4.7 Total mass balance of waste processed in compost bins during May 2000 – April 2001

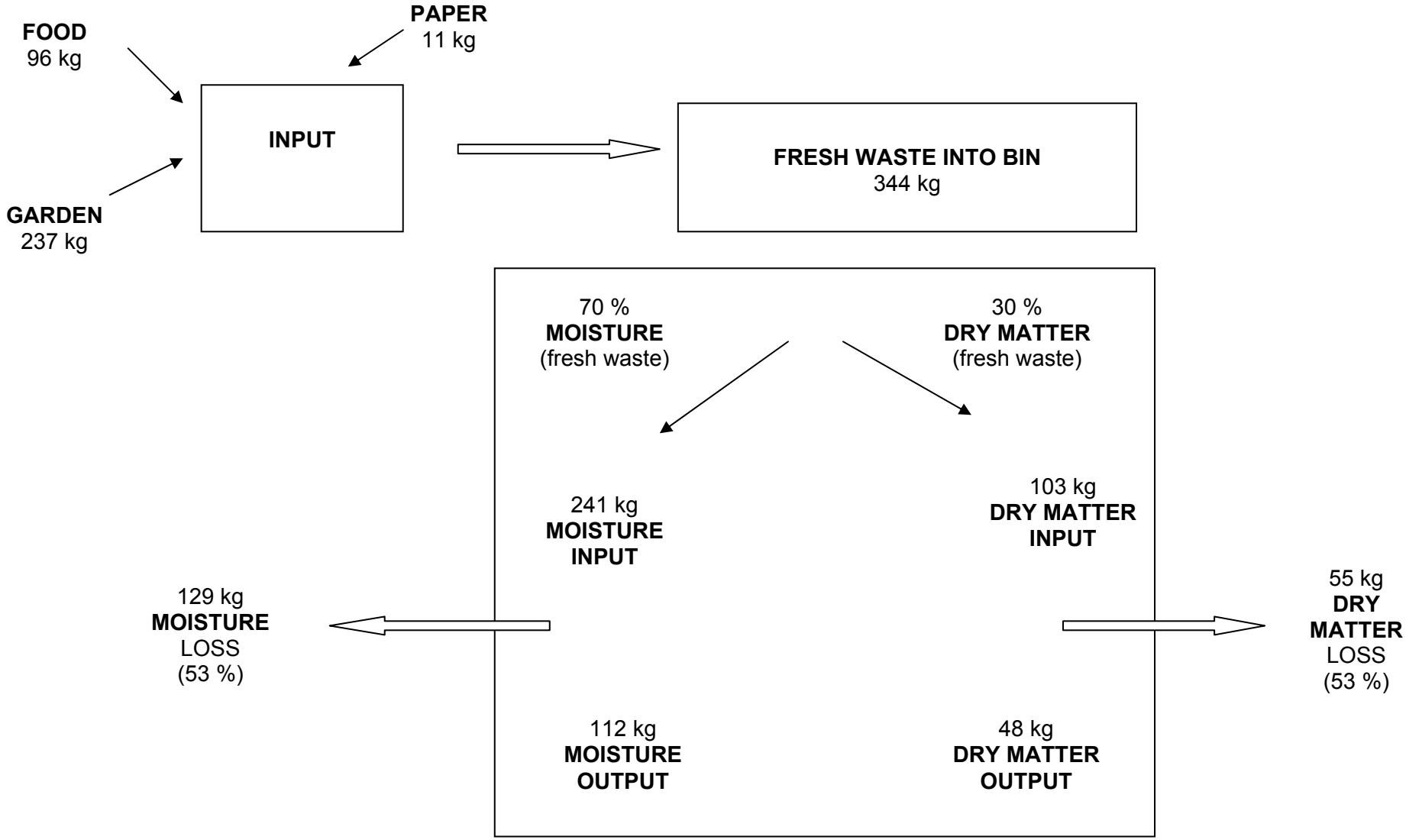

Figure 4.8 Average mass balance of waste processed per compost bin during May 2000 – April 2001

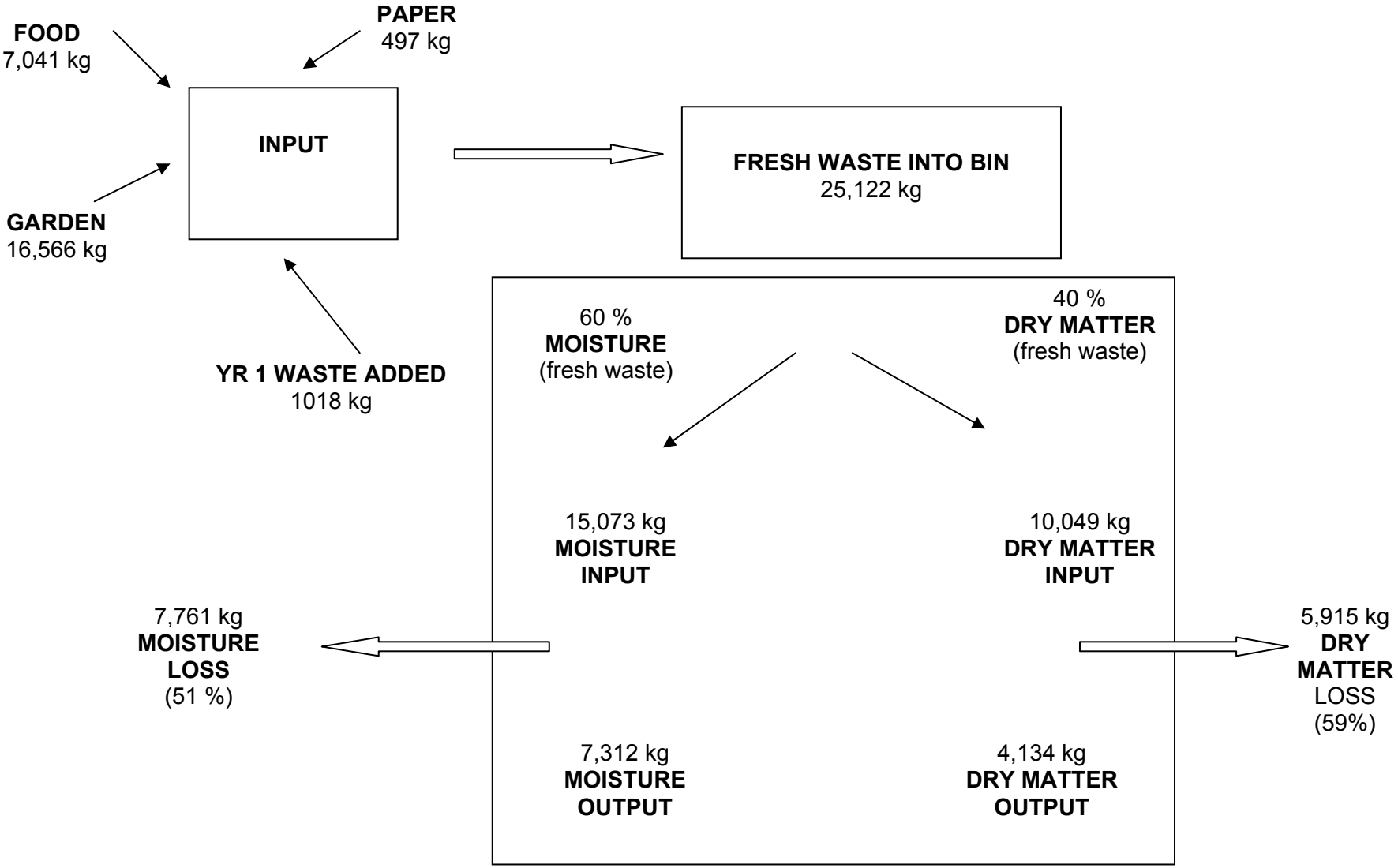

Figure 4.9 Total mass balance of waste processed in compost bins during May 2001 – March 2002

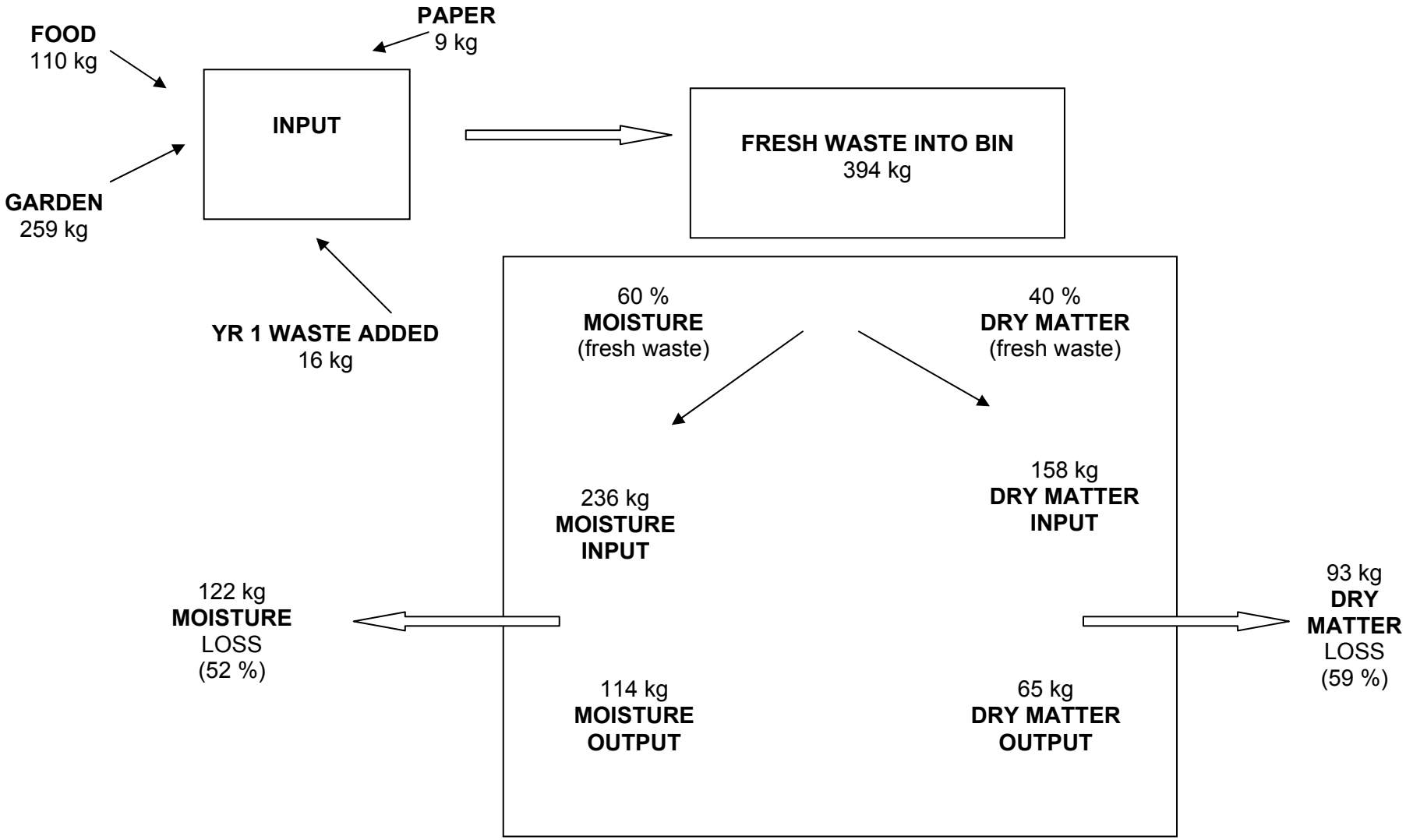

Figure 4.10 Average mass balance of waste processed per compost bin during May 2001 – March 2002

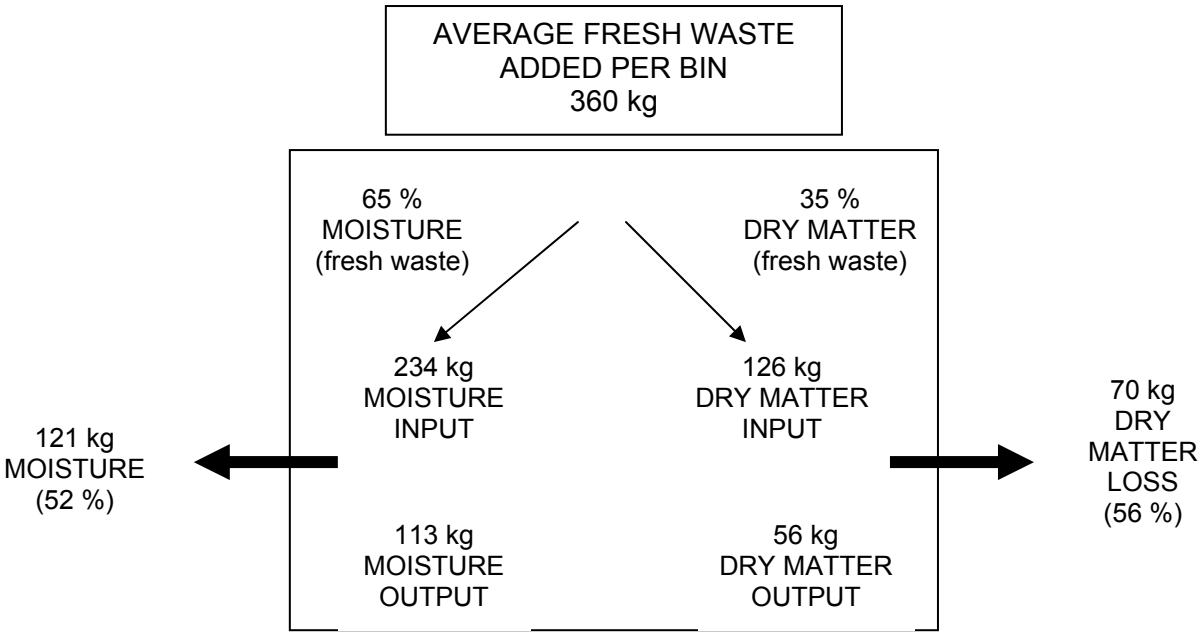

Figure 4.11 Overall mean annual mass balance of waste processed per compost bin during May 2000 – March 2002

Table 4.3 Household waste generation in Study Area, Jan 1997 – Dec 2001 in Study Area

Year	Round 3 Pooley Green		Round 5 Hythe		Round 5 Thorpe		Total	
	t y^{-1}	Increase rel. to previous y (%)	t y^{-1}	Increase rel. to previous y (%)	t y^{-1}	Increase rel. to previous y (%)	t y^{-1}	Increase rel. to previous y (%)
1997	1309		1082		1072		3462	
1998	1357	3.6	1168	7.4	1160	7.6	3685	6.0
1999	1387	2.2	1112	-5.0	1174	1.2	3673	-0.3
2000	1431	3.1	1105	-0.7	1129	-4.0	3665	-0.2
2001	1461	2.1	1109	0.3	1143	1.2	3712	1.2

Note: Negative values indicate a decrease in the amount of waste collected relative to the previous year.

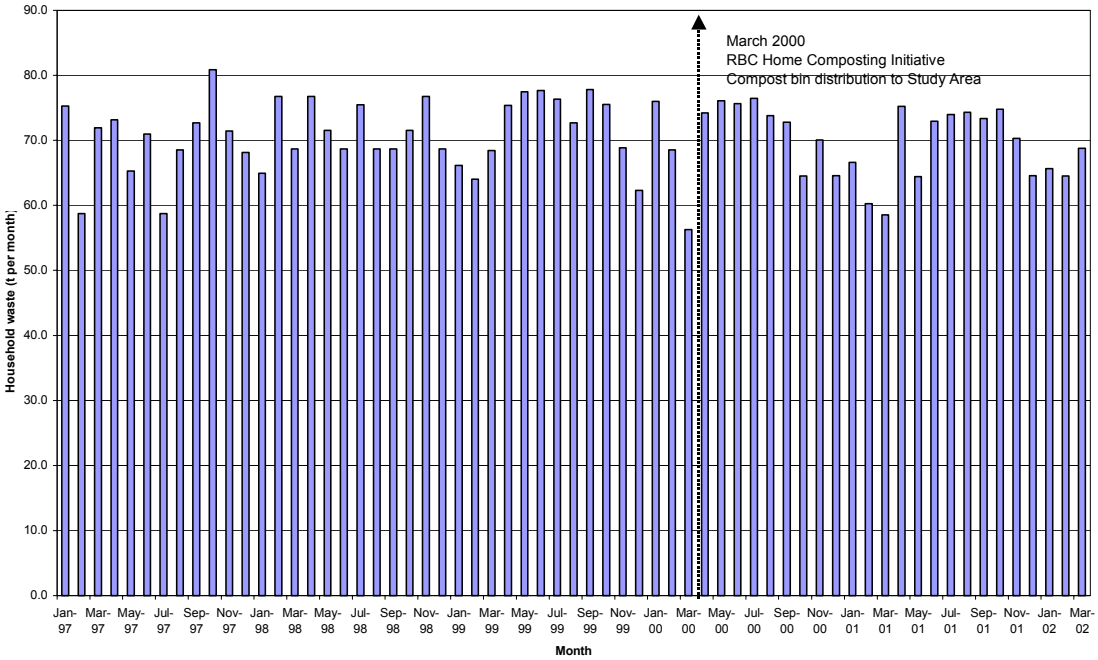

Figure 4.12 Total monthly household waste arisings in RBC study area, January 1997 – March 2002

The numbers of compost bin sales in each refuse round within the Study Area are shown in Table 4.4. The largest participation rate was in Thorpe followed by the Pooley Green area in 2001.

Table 4.4 Summary of Census Area Profile of Pooley Green, Thorpe and Hythe, 1991

Census Profile	Pooley Green	Hythe	Thorpe	Total RBC
Average household size	2.46	2.44	2.57	2.44
Home compost bin uptake	334	169	335	838
Home compost trial participation	19	7	38	64

The waste collection data do not provide a clear indication that the increased HC activity impacted the amount of waste collected for disposal in RBC. However, many factors could explain this. One possibility is that the additional space in the refuse collection bin provided by the removal of biodegradable material for home composting could be utilised by homeowners for the disposal of other material, such as woody garden wastes that they would have otherwise transported for disposal to CA sites. However, the input of kitchen and paper waste to home composters can be specifically identified as material that is diverted from landfill disposal, although this is more difficult to determine for garden waste inputs due to the variety of options that are available to homeowners for the disposal of garden waste (eg home composting, CA site, residual waste bin, burning etc). This research indicates the total amount of waste that is potentially diverted from landfill disposal by HC is 360 kg per household per year (Figure 4.11) (the value was estimated as 375 kg per household per year calculated from the monthly weighted average value; Table 4.1) based on the assumption that garden waste added to HC bins

also represents material diverted from landfill disposal. This information can be used to provide a preliminary assessment of the potential waste diversion from landfill by home composting.

Approximately 21 % of homeowners in the Study Area purchased compost bins during two promotional campaigns and it was assumed for the purposes of calculating the impact of HC on landfill diversion that all of these households were actively engaged in HC activities (see Section 2.4). An additional third campaign was implemented across the entire Borough. However, this did not have a significant effect on the Study Area as the take up of HC bins had been saturated by the previous campaigns and additional sales in the area were limited. On the basis that 21 % of homeowners across the Borough would be willing to compost their waste, this represents, approximately 7 000 homes. Therefore, the total amount of waste composted by 7 000 homes in RBC would be potentially in the region of 2,520 t y^{-1} (7 000 x 0.36t). This is equivalent to approximately 9 % of the total amount of household waste generated from door-to-door collection (29 000 t y^{-1}, See section 2.4) and disposed of by landfilling. Assuming that 50 % of the waste is potentially compostable (SCC, 1991a), this diversion rate is equivalent to 20 % of the biodegradable waste collected from households. This level of activity would therefore achieve up to 40 % of the waste diversion required to fulfil the immediate target that was set by the Government for composting or recycling 25 % of household waste by 2005 (DETR/WO, 2000).

Cost savings to the Waste Disposal Authority (WDA) due to HC activity in RBC are summarised in Table 4.5. The total annual waste disposal cost savings per household would be £11.50 if 360 kg of biodegradable waste was diverted by home composting. On the basis that 21 % of the community would be involved in composting a proportion of their organic waste, the saving in disposal costs would be equivalent to £ 80,500. In addition, there could be potential reductions in waste collection costs, which are currently £28 t^{-1} per household in RBC.

Table 4.5 Waste disposal costs and savings for HC

RBC household waste collected (door-to-door)	29 000 t y^{-1}
Amount of household waste to be removed from landfill in 2005 (25 %) under Waste Strategy 2000 (DETR; 2000)	7 250 t y^{-1}
Waste diverted per household by home composting	360 kg y^{-1}
Total waste diverted if 21 % of households composted at home(1)	2,520 t y^{-1}
Cost of landfill disposal (Landfill tax + disposal) of waste	£ 32/t
WDA(2) cost saving per household if 400 kg waste diverted per year	£11.50
WDA cost saving of diverting waste if 21 % of households composted at home	£ 80,500

(1) Assumes that 7000 homes participate (there are 32,000 homes in RBC)
(2) WDA; Waste Disposal Authority

4.5 SUMMARY

The relative contribution of kitchen, paper and garden waste to the total waste inputs to home compost bins was 29, 3 and 68 %, respectively. The monitoring programme in this investigation demonstrated that 360 kg per household per year of biodegradable household waste may be diverted from landfill disposal. This value is considerably larger

than a suggested default value for HC of 100 kg y^{-1} (DETR/WO, 1999c), which was intended as a minimal diversion figure in uncontrolled environments.

Mass balance analysis indicated that the average loss of material from compost bins was equivalent to 53 % of fresh waste inputs due to moisture evaporation and leaching and volatile organic matter loss during the composting process. Therefore, HC offers an effective method of processing and stabilising domestic putrescible waste and contributes to minimising biodegradable waste disposal in landfill. However, no tangible reduction in the overall amounts of waste collected from households in the Study Area was observed, but this could be explained because of waste substitution in the residual waste collection bin. Home composting could potentially divert up to approximately 10 % of the household waste stream from landfill disposal if 20 % of the community were actively engaged in this activity. Cost savings to be gained by the WDA are also potentially considerable and in the case of the Borough of Runnymede are equivalent to almost £80,500.