CAN SUSTAINABLE BEHAVIORS BE "DESIGNED-IN?": EFFECTS OF COMPOSTING TYPE ON MUNICIPAL SOLID WASTE PRODUCTION AND COMPOSTING ATTITUDE

A Thesis

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by

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ABSTRACT

Introduction: Food waste poses a threat to environmental, economic, and human health. Composting can reduce the threat, yet there is a dearth of research on household-level composting participation.

Methods: A within-subjects, randomized-to-order experimental field study with baseline and repeated measures was conducted in an Upstate New York apartment complex. Self-reported weekly trash weights and composting attitudes were collected from 27 households who used three composting types over 14 weeks.

Results: A mixed model ANOVA revealed a significant reduction in waste from baseline for all three composting types. Indoor and outdoor composting reduced waste more than off-site food scraps recycling. An interaction was found for composting type by *stage in family lifecycle*, *composting experience*, *ecological behaviors*, and *proximity* but not *environmental concern* on waste reduction. Qualitative analysis revealed a general preference for indoor composting yet attitudes ranged widely.

Discussion: The results suggest different composing types are suited to different household types.

BIOGRAPHICAL SKETCH

Since a young age I have watched and studied people. I observed how the physical environment could directly influence human behavior and spent years of study centered on harnessing that power through environmental design. In 2007 I graduated from Miami University in Oxford, Ohio with a Bachelor of Fine Arts in Interior Design then subsequently worked at FRCH Design Worldwide in Cincinnati, Ohio as a core member of the international department store design team. I designed high-end retail interiors for clients such as Lotte and Hyundai in Korea and Liverpool in Mexico. Although the experience was worthwhile, I felt not only a need for evidence-based design but also a path that would not perpetuate materialistic and unsustainable consumption. I studied Human Factors Psychology briefly at Wright State University in Dayton, Ohio in 2010 before joining the department of Design and Environmental Analysis (DEA) at Cornell University in 2011 to pursue my interest in sustainable design. Namely, I was interested in how the built environment could foster healthy and sustainable lifestyle behaviors. I graduated Magna Cum Laude from Cornell in 2013 with a Master of Science in Human-Environment Relations with a concentration in Environmental Psychology and minor in Nutritional Studies. The following quote was part of my Statement of Intent when I applied to Cornell's DEA program and I still consider it relevant to my research philosophy today:

"The constitution of man's body has not changed to meet the new conditions of his artificial environment that has replaced his natural one. The result is that of perpetual discord between man and his environment. The effect of this discord is a general deterioration of man's body, the symptoms of which are termed disease.

-Hilton Hotema, Man's Higher Consciousness

This research is dedicated to my loving family.

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INTRODUCTION

Food Waste: Environmental Problem or Solution?

Waste management is a growing environmental concern in industrialized nations. Specifically, food waste does not break down in the anaerobic environment of landfills, but instead decomposes and releases methane, a greenhouse gas that has 21 times the global warming and climate change potential of carbon dioxide (U.S. Environmental Protection Agency, 2012). Air and water are polluted from landfill leaching and run-off. Food waste undermines not only environmental health but economic and human nutritional health (Blair & Sobal, 2006) through energy losses from production, distribution, consumption and disposal in addition to individual nutrition loss and community food insecurity (Hamm & Bellows, 2003). Food waste reduction through composting, the process of controlled organic matter decomposition, can be dually beneficial to the environment by 1) reducing the volume of municipal solid waste (MSW) streams to landfills and 2) rebuilding soil capital through mineral and live organism enrichment. Also known as 'living soil,' compost not only reduces the need for chemical pesticides, but also captures and destroys 99.6 percent of volatile organic compounds from the air, remediates solids contaminated by hazardous wastes, oil, grease, and heavy metals, facilitates the restoration of forests and wetlands (U.S. EPA, 2012), and has potential to increase agricultural crop yields by two-fold (Shiralipour, McConnell, & Smith, 1992). Despite the benefits of composting, only 2.7 percent of food waste is estimated to have been composted in the U.S in 2010 with a remarkable 27 percent of the MSW stream having consisted of compostable food waste (U.S. EPA, 2010).

Household-Level Waste Management

Unlike recycling behaviors, there is a dearth of academic research on composting behavior (McKenzie-Mohr, Nemiroff, Beers, & Desmarais, 1995), particularly in the United States. Consequently, researchers have generally used determinants of recycling behavior to gain insight into household composting participation (Edgerton, McKechnie, & Dunleavy, 2009). However, Oskamp, Harrington, Edwards, Sherwood, Okuda, and Swanson (1991) suggest that each form of responsible environmental behavior has a separate set of predictors and therefore cannot be generalized. While the U.S. Environmental Protection Agency (1989) groups recycling alongside composting as an effective strategy for MSW reduction, recycling is an inherently distinct act from composting and will therefore not be the focus of the present review. Specifically, home composting significantly reduces or eliminates the amount of material that ever enters the MSW stream so can be considered more of a source reduction behavior than recycling (Edgerton et al, 2009; McKenzie-Mohr, et al, 1995). Considered the ultimate goal in the waste reduction hierarchy, source reduction presents a unique set of challenges including both individual and family behavioral change (EPA, 1989).

Municipal-level trends towards composting have faced major problems with material cross-contamination. As a result, 'local composting,' also known as 'household-level composting,' has become the focus of attention in countries such as Sweden (i.e. Åberg, Dahlman, Shanahan, & Säljö, 1996; Sterner & Bartelings, 1999), which produced about 70% of the waste per capita as the U.S. in 2010 (3.1 lbs./person/day in Sweden compared to 4.43 lbs./person/day in the U.S.) despite comparable standards of living (Organization for Economic Co-operation and Development, 2010). The potential benefit of household composting is exemplified by an analysis of an Upstate New York community waste stream found that consumers generated 60% of the 10,205 tons of food waste produced annually compared to 20% generated by production, 19% by distribution, and 1% by processing (Griffin, Sobal, and Lyson, 2009).

The Attitude - Action Gap

Although a positive environmental attitude (i.e. concern for the state of the natural environment) is generally widespread (Gifford, 1987), it is not consistently associated with pro-environmental behavior (Scott & Willits, 1994). Further, favorable attitudes toward waste management are not necessarily accurate predictors of waste management behaviors such as composting (Oskamp et al, 1991). Several common analytical frameworks that aim to clarify the gap between environmental attitude, awareness, and knowledge were reviewed by Kollmuss and Agyeman (2002), which included early U.S. linear progression models, models of altruism, empathy, and pro-social behavior, and sociological models. However, no overarching framework emerged.

Literature Review

Although the solution to the attitude-action gap may be too complex to ever be visualized by one single framework, Kollmuss and Agyeman (2002) suggested it may be useful to contextualize the problem by organizing the most influential factors on pro-environmental behavior into the following categories: 1) demographic factors (e.g. *age, gender, income, education*), 2) internal factors (e.g. *motivation, pro-environmental knowledge, awareness, values, attitudes, emotion, locus of control, responsibilities and priorities*) and 3) external factors (e.g. *institutional, economic, social and cultural*). Thus, the current review mirrors the categorical structure by Kollmuss and Agyeman (2002) to organize, summarize, and analyze current literature surrounding household-level composting participation specifically. A summary of the predominant household composting participation literature reviewed here, with keyed factor categories, is presented in Table 1. In addition, as internal factors are the most commonly utilized approach to pro-environmental behavior research, the review will approach the literature from the perspective of environmental psychology, a field of study which aims to identify environmental factors that affect human health, productivity, and wellbeing (Gifford, 1987). Lastly, a broader definition of 'environment' is adopted, which encompasses not only the physical built environment, but the entirety of space outside the person (Sallis & Owen, 2002).

Table 1. Summary table of major studies of household composting[1]

Author(s)	Year	Country	Participants	Study design & methods	Main results
Edgerton, McKechnie, & Dunleavy	2009	Scotland	345 individuals: Composters (56% male), non-composters (44% male)	Cross-sectional survey. Logistic regression analysis of 8 predictor variables aimed to differentiate two groups: those who registered for a free compost bin ('composters') and those who did not ('non-composters')	Significant composting predictors: 1) *composting attitude (i)*, 2) *composting knowledge (i)* & 3) *stage in family lifecycle (d)* Not significant: *NEP (i), ecological behavior (i), being a gardener (d), social norm (e), social diffusion (e)*
Tucker, Speirs, Flecher, Edgerton, & McKechnie	2003	Scotland & England	276 individuals: no information available	Cross-sectional survey and open-ended questioning. Factor analysis for composting participation take up and drop-out for two groups: those who accepted a free or subsidized compost bin and those who did not	Primary reasons to take up composting: 1) *to reduce/ use waste (i)*, 2) *low cost of bin (e)*, 3) *to make/ use compost*/ soil amendment (e). Reasons to drop out: 1) *moving (e)* and 2) *lack of composting success*/ negative experience (i)
Gillian, Leland, Davies, & Walsh	2003	New Zealand	37 households: mix of high SES (N=19) and low SES (N=18)	6-week between-subjects field experiment with 2 week baseline. Experimental group received composting resources & information and control group did not	Curbside waste for exp. group who received composting info/ *knowledge (i)* significantly decreased 29% from baseline compared to 12% for control group who did not receive info
Park, Lamons & Roberts	2002	United States	865 households: single-family	Cross-sectional telephone survey. Logit regression analysis of 5 factors groups/ independent variables. Random selection	Significant back-yard composting predictors: 1) *Being a gardener (d)*, 2) level of effort/ *attitudes* (i), & 3) family & friends/ *peer influence* (e) Not significant: *knowledge (i)*
Sterner & Bartelings	1999	Sweden	456 individuals: *M* age = 51; age range 24-91. All resided in single family households	Secondary data analysis of waste disposal weights and mailed waste-management attitude surveys collected after a 'green-shopping' campaign & weight-based waste billing system was implemented and recycling center were opened	Significant waste reduction determinants other than kitchen composting: 1) *living area (e)*, 2) *age (d)*, & 3) *attitudes* (i) Composting determinants: 1) *existing participation in garden waste composting (i)* Not significant: 1) *income (d)*, 2) *age (d)*, 3) *education level (d)*, & 4) *number of people in household (d)*
Åberg, Dahlman, Shanahan, & Säljö	1996	Sweden	52 households: each with a fenced-in garden	1-year field experiment with repeated measures. 3 interviews & observations. 3 sizes of composters varied by # of household members	Significant composting barriers: 1) *lack of knowledge (i)*, 2) *technical misfits (e)*, & 3) *internal household dynamics (e)*
McKenzie-Mohr, Nemiroff, Beers, & Desarais	1995	Canada	144 individuals: *M* age range 31-50; *M* income $50,000-$59,000 (CA)	Cross-sectional telephone survey of 14 composting predictors comparing 4 levels of composting experience: 1) year-round, 2) Random selection	Year-round composters reported higher positive composting *attitudes (i)* & overall waste management than non-composters Not significant: 1) *education (d)*, 2) *income (d)*, 3) *age (d)* & 4) *home ownership* (d)

[1] **Table Key.** *(d)emographic factor, (i)nternal factor, (e)xternal factor*

Demographic factors

In general, basic demographic factors such as *age, gender, income, race,* and *education level* are collected when surveys and experimental studies are conducted, then subsequently analyzed as predictor variables even when not explicitly considered in the original research design. The majority of studies about household composting however did not report several basic demographic variables, presumably due to the household-level unit of analysis. Two cross-sectional survey studies did suggest that *education, age*, and *income* are non-significant factors in home composting participation as well as *home ownership* (McKenzie-Mohr et al, 1995) and *number of people living within a household* (Sterner & Bartelings, 1999). A factor analysis that compared demographic variables to various general household waste management behaviors in the UK found that people of an older *age*, who *own a home*, have a *democratic political affiliation*, and a *community group membership* were more likely to participate than males (*gender*) or those with a lower *income* (Barr, Gilg, and Ford, 2005). However, composting was grouped in the survey with all forms of household waste reduction strategies including recycling, purchase decisions, and energy conservation. Additionally, *age* was found to have a high association with overall reduction in waste (which included both recycling and composting) when a weight-based waste billing system and 'green-shopping' campaign were implemented in a Swedish town (Sterner & Bartelings, 1999). Therefore, although age may be associated with household waste management strategies such as recycling, it may or may not be associated with composting.

A cross-sectional survey aimed to differentiate respondents of Swedish households who had registered to receive a free or subsidized compost bin (i.e. 'composters') from those who had not registered (i.e. 'non-composters'). Of the eight predictor variables tested which included 1) *level of environmental concern*, 2) *being a gardener*, 3) *composting attitude*, 4) *pro-environmental behavior*, 5) *composting* *knowledge*, 6) *stage in family lifecycle*, 7) *social norms* and 8) *social diffusion*, logistic regression revealed that one of the three significant determinants of participation in a home composting scheme was a demographic characteristic-- *stage in family lifecycle* (Edgerton et al, 2009). Specifically, households with young children were nearly five times less likely to participate in a home composting scheme than retired individuals. In addition to *stage in family lifecycle,* the only other demographic factor of the eight predictors analyzed, *being a gardener,* was not found to be a significant predictor of home composting participation (Edgerton et al, 2009). It is noteworthy that although the study by Edgerton and colleagues (2009) is not only the most recent study but one of the most comprehensive studies surrounding composting participation, it may be limited if, as it appears the respondents considered to be ‘composters’ were differentiated from the respondents considered to be ‘non-composters’ based solely on the act of registering for a free or subsidized compost bin. Conceivably, respondents who did not register for the offer may have simply already owned a compost bin and therefore may actually be ‘composters.’

In summary, study findings surrounding demographic factors suggest that *stage in family lifecycle*, specifically having children, is associated with less composting participation, *age* may or may not be associated with composting participation, and *income, education level, home ownership, the number of people living in a household,* and *being a gardener* are not associated with participation in composting.

Internal Factors

Manipulations of internal factors appears to be the most common approach to pro-environmental behavior research and are believed to be strongly associated with composting participation (Diekmann & Preisendorfer, 2003). However, the gap between general environmental concern and pro-environmental behaviors appears to extend to household composting. Although an initial survey conducted by Tucker, Speirs, Fletcher, Edgerton, and McKechnie (2003) suggested *waste use/reduction*, which was considered a facet of environmental concern, was a primary reason for respondents to begin household composting, the follow-up survey-based study by a few of the same authors (Edgerton et al, 2009) utilizing a logistic regression analysis found no significant correlation between composting participation and *environmental concern*, as measured by the commonly used and validated New Ecological Paradigm (NEP) questionnaire (Dunlap, Van, Mertig & Jones, 2000). In addition to NEP score, participation in other *pro-environmental* (a.k.a. *ecological) behaviors* was also found to be an non-significant predictor of household composting. That said, Sterner and Bartelings (1999) mentioned that *existing participation in garden waste composting* was a significant predictor in the take up of kitchen food scraps composting once a municipal weight-based waste billing system was initiated. A reason for the contradiction in results of the two studies may be the association of an existing garden to resource access (an external factor); still, further research regarding specific, rather than general, pro-environmental behaviors on composting participation may be warranted.

Both *environmental awareness* and *knowledge of environmental issues* tend to exist when pro-environmental behaviors are present; however, neither tends to play a significant role in predicting pro-environmental behavior (SGuin, Pelletier, & Hunsley, 1998). The disconnection may be due to a lack of association between general environmental attitudes and behavior-specific attitudes and knowledge. For example, a positive attitude towards waste management has been identified as a significant predictor of waste reduction behaviors (Sterner & Bartelings, 1999), just as a positive attitude towards the act of composting has been identified as a significant determinant for household composting participation (Park, Lamons & Roberts, 2002; Mckenzie-Mohr et al, 1995). The aforementioned study by Edgerton and colleagues (2009) revealed that in addition to 1) *stage in lifecycle*, that 2) *having a favorable attitude toward what home composting involves*, and 3) *being knowledgeable about home composting* were the three primary predictors in home composting participation. The authors developed a ‘composting attitude’ scale which included items such as “*Composting takes up a lot of time,”*, as well as a ‘composting knowledge’ scale that utilized a single question in which participants subjectively rated his/her own level of composting knowledge (*0= not at all, 5 = very*). Both *composting-specific attitude* and *composting-specific knowledge* were highly significant predictors of household composting participation. The results supported the findings of the initial survey by a few of the same authors in which *lack of composting success* was found to be a primary reason for dropping out of a home composting scheme (Tucker et al, 2003). Interestingly, authors of the initial study also mentioned that few of the participants who dropped out actively sought help.

In addition, the results of a 6-week New Zealand home composting intervention revealed that participants who received informational brochures about composting strategies sustained composting behaviors significantly longer than those who did not (Gillan, Leland, Davies, & Walsh, 2003). One conflicting piece of evidence from the U.S. comes from a cross-sectional survey study which suggested *composting knowledge* was not significantly related to home composting participation (Park, Lamons, & Roberts, 2002). However, the survey only measured composting knowledge through a four-item dichotomous (yes/no) questionnaire that covered waste decomposition trivia, waste reduction law, awareness of the master composting program, and awareness of bin subsidation. Clearly, none of the items actually examined composting behavioral knowledge.

Lastly, the role *knowledge* plays not in participation but participation persistence is thought to be a stronger indicator of some pro-environmental program success (e.g. Vining & Ebreo, 1992). More specifically, the theoretical model of repeated behavior developed by Ronis, Yates, and Kirscht (1989) suggested there are two stages of primary importance in habit formation (i.e. participation persistence) for both composting and recycling: *initiation* and *persistence*. While initiation is strongly influenced by internal factors such as *expectancies*, *attitudes*, and *values*, persistence is strongly influenced by internal factors such as skills (i.e. *knowledge/ experience level*), and *memories*, as well as *obstacles* (barriers). Lastly, additional internal factors are associated with pro-environmental behaviors, which include *intrinsic satisfaction* (DeYoung, 2000), *motivation*, *emotional involvement*, *locus of control*, and *responsibilities and priorities* (Kollmus & Agyeman, 2002), and household waste prevention behaviors, which include *values, personal responsibility, self-efficacy, costs,* and *habits* (Cox, Giorgi, Sharp, Strange, Wilson, & Blakey, 2010). However, the literature surrounding household composting participation has yet to explicitly examine the predictive value of the additional internal factors.

In summary, study findings surrounding internal factors suggest that having a higher level of *composting-specific knowledge* and positive *attitudes towards composting*, rather than general environmental knowledge or attitudes, are associated with increased composting participation and that other *ecological behaviors* may or may not be associated with composting depending on the behavior. In addition, *level of environmental concern* is not associated with composting participation and research has yet to examine the effects of *intrinsic satisfaction*, *motivation*, *emotional involvement*, *locus of control*, *responsibilities and priorities, values, self-efficacy, costs,* and *habits* on participation in composting.

External Factors

Environmental Factors. External infrastructural factors are often overlooked yet can enable or inhibit people from participating in pro-environmental behaviors (Fietkau & Kressel, 1981). Kollmuss & Agyeman (2002) suggested external institutional barriers towards pro-environmental behaviors are primarily overcome through the actions of concerned citizens; however, the suggestion neglected the role architects and designers play in shaping the behavioral landscape. Specifically, principles from the field of behavioral economics, which combines behavioral models of psychology with decision-making models of economics, aim to utilize information about how decisions are made in order to consciously manipulate the mechanisms (e.g. internal or external factors) that drive choice. Specifically, the conscious manipulation of external environmental design factors, such as *specificity, proximity, convenience* and *salience,* have been used to encourage behavior change to a greater effectiveness than the traditional antecedent (behavior prevention) strategies of information and prompts alone (Ester & Winett, 1982). For example, public health efforts have recently shifted from primarily targeting individuals with educational strategies to broad-based interventions aimed at policy change and environmental design to promote healthy behaviors (Cabinet Office, 2010). The so-called 'persuasive environments' have been successfully implemented in school cafeterias to encourage healthy eating behaviors (e.g. Wansink, 2004; Wansink, & Just, 2009) as well as informed nationwide recycling programs. The environments succeeded by leveraging individual thought processes to steer, or 'nudge,' people towards making self-beneficial decisions while still providing individual choice, thus promoting self-attribution (Mullainathan, Thaler, & National Bureau of Economic Research, 2000; Thaler & Sunstein, 2008).

An external environmental factor found to be a significant determinant of household composting participation is *convenience*, which has been considered both in terms of the ability to obtain the necessary composting equipment, which may include space, as well as the perceived convenience of continuing the act of composting (McKenzie-Mohr et al, 1995). For example, when compost bins in a field examination were delivered directly to households or distributed from a centralized location, composting participation increased significantly (Compost Management, 1993). Similarly, a curbside recycling intervention aimed to reduce two previously identified participant barriers to the act of recycling, 1) *inconvenience* (Ewing, 2001) and 2) *lack of time* (McCarty & Shrum, 1994), by eliminating the necessity of participants to transport recycling to a drop-off center. The availability of curb-side recycling bins was found to be a better predictor of increased self-reported recycling participation than general environmental attitudes (Guagnano, Stern, & Dietz, 1995). The results suggest nearby access to waste management equipment (i.e. resource access in close *proximity)* played a role in participation. To take the point one step further, the *proximity* of an outdoor composting unit to the source of food waste production—the kitchen—may be a facet of *convenience* and therefore associated with composting participation. However, no composting studies have yet to address the predictive value of *proximity* directly.

A comparison of MSW weight and composting attitude scores for single-family households in the U.S. was conducted by Sterner and Bartelings (1999) in which a local weight-based waste billing system was initiated. The authors suggested that *existing participation in garden waste composting*, and therefore access to appropriate carbon-to-nitrogen balancing composting materials (i.e. 'green' food scraps to 'brown' leaves), was a more significant predictor of household composting than economic benefits (Sterner & Bartelings, 1999). However, neither *being a gardener* nor the *product of composting* (i.e. soil amendment) has been found to be consistent predictors of household composting (Edgerton et al, 2009). Indeed, to suggest garden access is the only way in which nitrogen-rich 'browns' such as leaves can be obtained is less than convincing as food scraps such as pastas, grains, breads, nuts, and dried flowers, as well as wood chips or purchased sawdust pellets can provide adequate levels of nitrogen-rich materials for a home compost bin. However, when considered from the perspective of environmental psychology, the findings may have related to either basic *convenience* in terms of *resource and/or spatial availability*, the *proximity* of compost bins to the source of waste production, or the *salience* (i.e. prominence) of the compost bins within the context of the landscape-- which could have acted as behavioral prompts (i.e. Geller, Winett, & Everitt, 1982). Thus, households that have garden access may also inherently have more control over additional external environmental factors that influence composting participation than households who do not have garden access.

Kollmuss and Agyeman (2002) suggest that economic factors, particularly monetary incentives, can influence pro-environmental behavior; however, the mechanisms are complex, poorly understood, and often intertwined with other external, internal, and social factors. The study in which Tucker and colleagues (2003) used a cross-sectional survey and open-ended questioning to identify factors that influence people to take up composting found that *monetary incentives*, in the form of a free or subsidized compost bin, was effective. It is not clear however, if the initial economic incentives were enough to maintain composting participation over time. In addition, policy changes aimed at waste reduction, such as waste fees alongside subsidized recycling, have shown conflicting results (Kollmuss & Agyeman, 2002).

In summary, study findings surrounding external environmental factors suggest that *convenience* is associated with increased composting participation, that *garden access* and *monetary incentives* (for which the mechanism(s) may be *resource access and/or availability*) may or may not be associated with composting participation, and that research has yet to examine the effects of *specificity, proximity* and *salience,* from the field of behavioral economics on participation in composting. Yet, *proximity* may be considered a facet of convenience and therefore have a strong potential to increase participation.

Technical Factors. Within the field of environmental psychology, the theory of design affordances expresses a relationship between the actionable properties of an environment and the actors within that environment (Gibson, 1977). More specifically, an ‘affordance’ has been described as any quality, or possibility, of an object or environment which allows an individual to perform an action and is readily perceived by an individual to perform an action. A conflict can occur when the design of an object or space does not match the users' perception of its intended use, which potentially leads to misuse of lack of use (Norman, 1988). A practical application of the theory of design affordances is particularly relevant when considering the association of external technical factors on household composting participation as the theory suggests the physical design of a product, such as a compost bin, can either enable or disable participation through the product's intuitive ease of use.

For example, a year-long composting field experiment with repeated measures among 52 Swedish suburban households revealed one of the three the most significant barriers to household composting to be an external technical factor (Åberg et al, 1996). Specifically, *technical misfits*, which included *equipment problems* such as the emptying of the composting unit and *sanitation problems* which included odor and the attraction of flies and vermin, was a significant external technical factor which decreased participation. The results are supported by the findings of Edgerton and colleagues (2009), which included an association between composting participation and a positive attitude towards the act of composting. In addition, the study by Åberg and colleagues (1996) is significant within the larger body of literature surrounding household composting behavior as the study utilized a longitudinal experimental research design, which is a more rigorous design than the common cross-sectional survey. Additionally, the study was one of only two composting-specific longitudinal interventions found to exist, the other being the six week New Zealand composting intervention in which no environmental factors were recorded (Gillan, Leland, Davies, & Walsh, 2003). While *technical misfits* would appear to be a significant external barrier to composting participation, Åberg et al (1996) noted that *technical misfits* most often occurred simply due the user's *lack of composting-specific knowledge*; however, the point may simply underscore the importance of design considerations of composting technologies that support *ease of use*, thereby reducing the need for a user to attain specific knowledge in order to take advantage of the affordances present. Indeed, Åberg and colleagues

(1996) also emphasize the importance of the ‘fit’ between composting unit technologies and the *internal household dynamics* (a social factor) of members of a household participating in composting.

The aesthetics and size of compost bins can also be considered external technical factors. Within the ‘composting attitude’ scale developed by Edgerton and colleagues (2009), which was found to significantly predict household composting participation, two of the items specifically addressed the unsightly *appearance* and excessive physical *space requirements* of outdoor compost bins. Unfortunately, each item was not analyzed individually so it is unclear to what extent each item was separately associated with household composting. However, the more rigorous field intervention utilizing 52 Swedish households revealed *aesthetic* considerations regarding the design and placement of the composter to be an insignificant factor in participation (Åberg et al, 1996). The results suggest that while aesthetics may not be a significant external factor associated with household composting, more information is needed to determine if spatial requirements are associated with household composting.

Lastly, *direct feedback mechanisms* such as visual cues reflecting user behavior at the time of execution have demonstrated success in pro-environmental behavior interventions (Hipolito, 2011) such as energy conservation. Composting, being a source reduction behavior, has the potential to demonstrate direct feedback not only within the technical design of a compost bin—for example visual access to the process of transformation from food waste to valuable soil amendment—but also as a significant decrease in overall trash weight and volume. No household composting studies have yet allowed participants to track his/her own household MSW weights, which may serve as a powerful direct feedback mechanism alone. Tucker and colleagues (2003) have noted that the inefficiency or inability to produce adequate compost can hinder the potential for direct feedback to play a major role in composting participation, which only underscores the importance of technical designs for compost bins which afford intuitive *ease of use*.

In summary, study findings surrounding external technical factors suggest that *technical misfits* (i.e. equipment and sanitation problems) are associated with less composting participation, which may be the result of either a lack of human capital (i.e. *composting-specific knowledge*) or that the poor technical design of composting units leads to an inability for users to perceive all of the material capital (i.e. affordance and *ease of use*) present. In addition, *spatial requirements* (i.e. size of a compost bin) may or may not be associated with composting participation, *aesthetics* is not associated with composting participation, and research has yet to examine the effect of *direct feedback mechanisms* on participation in composting.

Social Factors. Although social factors could be considered a separate category from internal and external factors that overlaps the two, the inclusion of social factors as a sub-category of external factors mirrors the organization suggested by Kollmuss and Agyeman (2002) for pro-environmental behavior research. As such, *normative beliefs* (e.g. subjective/ social/ cultural norms) and *social diffusion*, which are social factors associated with recycling participation, have not been found to apply to home composting as it is largely a ‘hidden’ performance (Edgerton et al, 2009). However, social factors within a smaller context, specifically *internal household dynamics* which includes chore allocation and the collective adoption of new technologies within the home, have been found to play a significant role in household composting participation (Åberg et al, 1996). Åberg and colleagues (1996) conducted and analyzed the results of the field study through a framework of the Household Ecological Model. The framework considers all members of a household as the unit of analysis and suggests that in order for long-term changes in household behaviors to be sustained, the processes by which individuals within that household respond and adapt to his/her own perceived waste management barriers must be identified (Paolucci, Hall, & Axinn, 1977).

In summary, study findings surrounding external social factors suggest that household composting participation is less dependent upon more external social factors of diffusion and 'norms' than social dynamics of the internal household environment.

Conclusion

Key Findings. The household composting literature reviewed can be summarized by the following: 1) solutions to the gap between positive environmental attitudes, awareness, and knowledge and pro-environmental behavior are complex and therefore have been addressed by categorizing behavioral determinants into categories of demographic, internal, and external factors; 2) *stage in family lifecycle* emerged as the most relevant demographic factor; 3) *composting knowledge, composting attitude* and, to a lesser extent, other waste-management specific *ecological behaviors* emerged as the most relevant internal factors and; 4) *technical design* and *convenience*—perhaps in specific regard to *proximity*-- emerged as the most relevant external factors to consider as predictors of household composting participation.

Gaps and Limitations. The most prominent gaps within the composting literature included: 1) the complete absence of studies involving any type of composting system other than the typical kitchen food scrap collection bucket with outdoor compost bin; 2) the majority of cross-sectional survey studies aimed at identifying determinants of composting participation from experienced rather than novice composters; 3) the absence of studies which manipulated or even specifically measured external factors such as *specificity, proximity, convenience* and *salience*; and 4) only two composting-specific waste reduction interventions were identified, neither of which used a within-subjects methodology, took place in the United States, or used apartments rather than single-family households as the unit of analysis. In addition to the Swedish intervention study by Åberg and colleagues (1996), authors of the New Zealand intervention, Gillan and colleagues (2003), stated, “Naturally, reduction strategies [for conservation research in high-density urban settings] did not include householders composting their organic waste, as the average house lacked the necessary outside area” (p 320). Similarly, one survey-based study excluded apartment dwellers from the participant pool due to “the low likelihood that they would compost” (McKenzie-Mohr et al, 1995, p 147).

Study Objectives. The current study primarily sought to examine the effect of composting participation on MSW production by utilizing a within-subjects experimental field study with baseline and repeated measures in which apartment dwellers were given the opportunity to use three distinct composting types. Each composting type varied in technical design and environmental proximity to the source of waste. A conceptual model of the research questions can be found in Figures 1 and 2.

Research Question 1. *How does composting type affect municipal solid waste (MSW) production?*

Research Question 2. *Do the factors of stage in family lifecycle, composting experience, ecological behaviors, environmental concern, and proximity moderate the relationship between composting type and MSW production?*

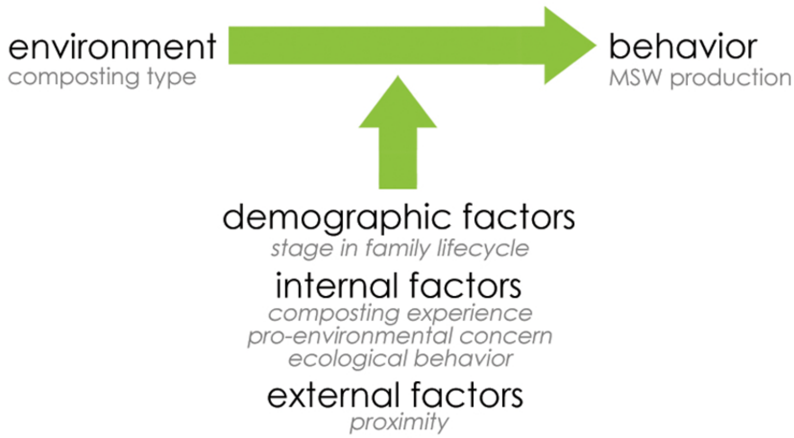


Figure 1. Conceptual model of research questions 1 and 2

Research Question 3. *How does composting type affect attitudes about composting?*

Figure 2. Conceptual model of research question 3

METHOD

Participants

Twenty-seven households (32 adults) participated in the study. The mean age was 32 years (*SD* = 6.77), 63% were female, and 38% were Caucasian, 38% Asian, 9% Indian, 6% Hispanic, and 9% other ethnicities. Each participating household contained at least one current Cornell University graduate or professional student and up to one additional adult and two children. All participants had completed some higher education (6% Associate, 38% Bachelors, 41% Masters, 3% Professional, and 12% Doctorate,) and most had a low-to-moderate income level (41% ≤$29,999; 34% $30,000-$49,999; 19% ≥$50,000; and 6% unknown). The majority of participants were part of a family with at least one child living in the household at the time of the study (50%), while others lived alone (22%) or with a roommate or significant other but no children (28%). The majority of participants had little-to-no previous experience with composting.

Table 2. Demographic summary table

Demographic variable	Total participant group (N = 32)
Age	*M =32.4 yrs; SD = 6.77, range = 23-54 yrs*
Gender	*63% female*
Race	*38% Caucasian, 38% Asian, 9% Indian; 6% Hispanic; 9% other ethnicities*
Education	*6% Associate; 38% Bachelors; 41% Masters; 3% Professional; 12% Doctorate*
Income	*41% ≤$29,999; 34% $30,000-$49,999; 19% ≥$50,000; 6% unknown*
Stage in family lifecycle	*47% young adults, no child(ren); 50% family, child(ren); 3% family, child(ren) not at home*
Composting experience	*47% Never; 19% rarely; 16% sometimes; 9% often, 9% very often*

Setting

The study was conducted in upstate New York, U.S. at the Cornell University graduate student housing complex, Hasbrouck Apartments. The complex was located on the perimeter of north campus and housed over 700 residents in 338 furnished and unfurnished single (studio), one-bedroom, or two-bedroom apartment and/or townhouse units. Each household is allowed up to two adults and two children, and no pets. On-site amenities included a community garden with outdoor compost bins for resident use as well as parking, four playgrounds and a centralized Community Center with Service Center, multipurpose and TV room, conference room, and laundry facilities (see Figures 3, 4 & 5). The community garden with compost bins was located at the southern perimeter of the complex, providing a quantifiable range of walking distances from participant residences to the outdoor compost bins.

Figure 3. Apartment exterior (Cornell University, 2013)

Figure 4. Studio kitchen (Cornell University, 2013)

Figure 5. Outdoor compost bins

Recruitment

Participants were primarily recruited via list-serve emails, flyer postings, and community events. Low initial response rates resulted in the creation of two separate participant 'waves,' which differed in recruitment marketing strategy as well as study start date and length. Wave 1 participants (15 households) were recruited first, via an "*Interested in Composting? Join a Research Study!"* marketing campaign which used flyers posted in the Community Center, distributed in-person at the apartment community Welcome

Event, and e-mailed to all residents via the community list-serve. Wave 2 participants (12 households) were recruited via an altered "*Go Green Hasbrouck!* " marketing campaign. The campaign strategy was expanded to include door hangers, flyer postings on dumpsters throughout the complex, and two dedicated recruitment events that incorporated child activities. Three participants were recruited via snowball sampling.

Participants were screened for compliance using an 'Eligibility Survey' for the following selection criteria: 1) current residency in Hasbrouck apartment complex, 2) over 18 years of age, 3) not currently composting at home, and 4) good written and spoken English-language skills. No participants were excluded as all of the individuals who completed the Eligibility Survey met the selection criteria. However, six participants (three from Wave 1 and three from Wave 2) dropped out of the study during the baseline data collection due to perceived lack of time.

Experimental Design

A within-subjects, randomized-to-order experimental field study with baseline and repeated measures was conducted. Data were collected over 14 weeks, beginning in late August, 2012. Trash weight measurements obtained at baseline and for each of the three independent variable conditions (composting type phases) served as comparison measures to detect household-level (N = 27) differences in trash weight. Composting attitude scores obtained at baseline and at the end of each composting phase served as quantitative and qualitative comparison measures to detect individual-level (N = 32) attitude differences between each composting type.

Independent Variables

The independent variable (IV) was *composting type* and was active with three levels: 1) indoor composting, 2) outdoor composting, and 3) off-site food scrap recycling. Each household participated in each IV level, which are described below (see Figure 6).

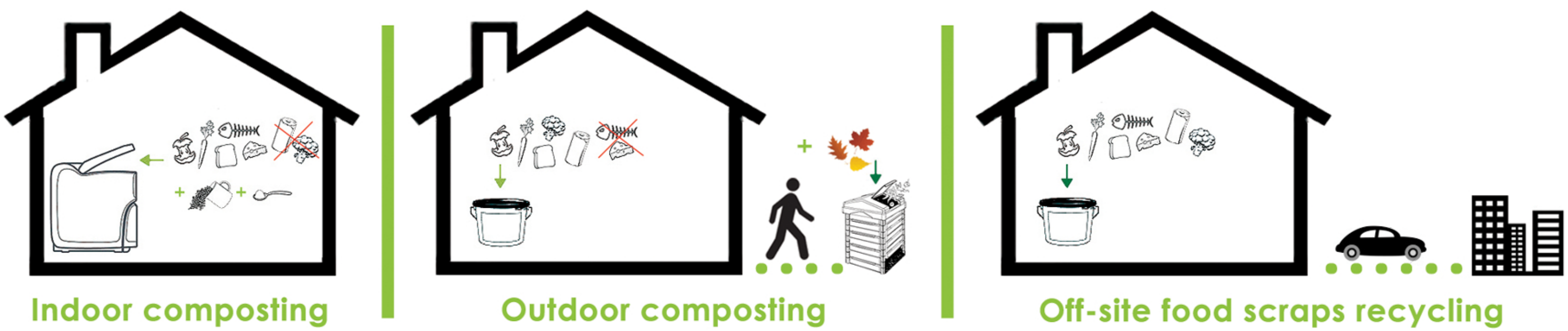


Figure 6. Graphic representation of three active IV composting types

Indoor composting. Each household was provided with a NatureMill© Neo automatic composter. Each self-contained unit measures 20" x 12" x 20"H (50 x 30 x 50cm) and electronically-controls oxygen, heat, and moisture levels as well as turning the compost. The technology was chosen specifically for its potential to reduce barriers towards household composting to a greater extent than traditional composting systems. Participants were instructed to dispose of acceptable food scraps directly into the top chamber of the unit, as well as to add baking soda and sawdust pellets to maintain proper compost pH levels. Each household was provided with the following indoor composting supplies and educational materials: 1) manufacturer's instruction manual and 'quick start guide,' 2) study-specific indoor composting chart (i.e. what to compost vs. recycle vs. trash), 3) plastic kitchen scrap bucket with lid averaging 0.75 gallons in capacity, and 4) a continuous supply of baking soda and sawdust pellets. Due to restrictions on materials able to be composted by the indoor electronic unit (i.e. no paper products, cruciferous vegetables, acidic fruits, or hard or stringy items), participants were permitted to use the off-site food scraps recycling option in addition to the indoor compost bin while participating in the 'indoor composting' phase.

Outdoor composting. Outdoor composting, which is the traditional and most well-studied form of composting, consisted of collecting food scraps and other compostable materials indoors in a kitchen scrap bucket, emptying the bucket contents in one of the two existing on-site Hasbrouck garden compost bins, and covering with dry leaves. Each household was provided with the following outdoor composting supplies and educational materials: 1) plastic kitchen scrap bucket with lid averaging 0.75 gallons in capacity, 2) a continuous supply of dry leaves and hay located next to the bins, 3) a study-specific outdoor composting chart, 4) a map to the outdoor compost bins, and 5) a series of composting education handouts provided by Cornell Cooperative Extension of

Tompkins County. Additionally, the existing outdoor compost bins were cleaned up and informational and directional signage was installed prior to the start of the study.

Off-site food scraps recycling. Similar to outdoor composting, food scrap recycling consisted of collecting food scraps in a kitchen bucket; however, the bucket had to be emptied at one of many city-wide off-site collection (i.e. recycling) locations for municipal-scale composting. Each household was provided with 1) a plastic kitchen scrap bucket with lid averaging 0.75 gallons in capacity, 2) a list of acceptable drop-off locations, which included many on-campus dining facilities, and 3) a study-specific off-site food scrap recycling chart.

Dependent Variables

The two dependent variables (DV), household municipal solid waste volume and composting attitude, are described below.

Household municipal solid waste (MSW). MSW was measured through self-report of household trash bag weight in pounds (lbs.). Participants weighed each trash bag just prior to dumpster disposal using an American Weigh SR-20 Yellow Digital Hanging Scale, then recorded the weight on a calendar-type paper Trash Log. Each week, one participant from each household transferred the trash weights to an online Trash Record.

Composting attitude. Composting attitudes were measured at the end of each of the four study phases (baseline, indoor composting, outdoor composting, and food-scrap recycling) as part of the 'Composting Survey.' For quantitative analysis, a 5-point Likert-type scale (Strongly agree, agree, neither agree nor disagree, disagree, strongly disagree) was used. The survey was a nine-item sub-scale derived from a composting measure developed by Edgerton, McKechnie, and Dunleavy (2009) to assess behavioral determinants of household participation in a home composting scheme. Survey items included, "*Composting takes up a lot of time," "Composting takes a lot of effort,"* and *Compost bins attract flies and vermin."* For qualitative analysis, two open-ended questions, "*Describe any positive (questions 2: negative) experiences with composting over the past 3-4 weeks*," were included in the survey.

Moderating Variables

Additional data were collected for later analysis as potential moderators of the effect of composting type on household MSW production. Statistically, moderation occurs when the strength of the relationship between the IV and DV depends upon a third (moderating) variable. For example, the strength of the relationship between each type of composting on MSW may depend upon specific characteristics of the participants such as his/her demographic profile. A summary of each moderating variable with corresponding analytical categories is present in Table 3 and additional information for each variable including corresponding measure(s) are described below.

Table 3. Summary table of moderating variables with analytical categories

Demographic	Participating households (N = 27)
Stage in family lifecycle	*56% young adults/family, no child(ren); 44% family, child(ren)*
Composting experience	*48% None; 33% low / medium; 19% high*
Ecological behavior	*44% high (> M); 56% low (< M); M = 62% behavior compliance*
Environmental concern	*33% high (> M); 67% low (< M); M = 2.37 or 48% NEP agreement*
Proximity	*33% Zone 1 (<500'); 48% Zone 2 (500'-1000'); 19% Zone 3 (>1000')*

Stage in Family Lifecycle. Collected as part of the initial 'Environmental Survey,' information about each household's stage in family lifecycle consisted of a single question with five categories, 1) young adults, no kids, 2) family with young children, 3) family with older children, 4) family with children left home, and 5) retired. The question was taken from the composting measure developed by Edgerton, McKechnie, and Dunleavy (2009) used for the survey measuring the composting attitude DV. Analytical categories were grouped as follows: 1) young adults/ family with no children (N=12), 2) family with child(ren), who may not live at home (N=15).

Composting experience. Collected as part of the initial 'Environmental Survey,' past composting experience level measurement consisted of one single question, '*How often have you composted kitchen food scraps in the past?'* with a five-point response scale (*Never, rarely, sometime, often, and very often).* Analytical categories were grouped as follows, 1) never (N=13), 2) rarely/ sometimes (N=9), and 3) often/quite often (N=5).

Ecological behavior. Also known as pro-environmental behavior, ecological behavior was measured by the 49-item dichotomous (yes/no) General Ecological Behavior Scale (GEB) (Kaiser & Wilson, 2000), which was adapted from the original scale by Kaiser (1998) for use in cross-cultural contexts. The questionnaire uses a probabilistic measurement approach of eight sub-scales including 1) *pro-social behavior,* 2) *ecological garbage removal,* 3) *water and power conservation,* 4) *ecologically aware consumer behavior,* 5) *garbage inhibition,* 6) *volunteering in nature protection activities,* 7) *ecological automobile use*, and 8) *miscellaneous*. Sample items include *'I wash dirty clothes without prewashing,'* and *'for shopping, I prefer paper bag to plastic ones.'* Analytical categories were divided into two groups, 1) scores above the mean score, and 2) scores below the mean score or 62.3% of ecological behavior.

Environmental concern. Measured by the five-point Likert-type 15-item New Ecological Paradigm (NEP) scale (Dunlap, Van, Mertig & Jones, 2000), questionnaire items assessed the level of agreement with a general 'planet earth' perspective and contained five sub-scales including 1) *Limits to growth*, 2) *Anti-anthropocentricism,* 3) *fragility of nature's balance,* 4) *rejection of exemptionalism,* and 5) *possibility of eco-crisis.* Sample items include *'the balance of nature is very delicate and easily upset,* and *'plants and humans have as much right as humans to exist.'* Analytical categories were divided into two groups, 1) scores above the mean score, and 2) scores below the mean score or 47.5% of agreement with NEP.

Proximity. Referring to the walking distance of each household to the outdoor compost bins, proximity was determined by using an aerial map to hand measure radii from the outdoor compost bins to each household's location within the apartment complex, which were divided into three 'distance zones' 1) Zone 1 (near); < 500', 2) Zone 2 (medium); 500'-1000', and 3) Zone 3 (far); > 1000' (see Figure 7).

Figure 7. Hasbrouck Apartments map with proximity zones to outdoor compost bins

Procedure

Informed consent was collected in writing before any data were collected. Each participant's demographic information and environmental concern, pro-environmental behavior, and composting attitude scores were collected with an initial 'Environmental Survey' followed by a 2-week baseline (no composting) data collection period of trash weight measurement. All surveys were administered via the online Cornell Survey Tool, *Qualtrics.* For each study Wave, households were randomly assigned to begin one of the three active IV composting types. Wave 1 followed a 4-week rotation schedule and Wave 2 followed a 3-week rotation schedule. Participants were initially randomly assigned to one of the three levels of the IV and then subsequently became part of the following standardized cycle of rotation: indoor composting → outdoor composting → off-site food scraps recycling. Thus, order effects were controlled. Trash weight measurements were collected each week for a total of 14 weeks for Wave 1 and 11 weeks for Wave 2. The study ended for Wave 1 and 2 in mid-December just prior to the start of University exam week. Additional composting attitude scores were recorded at the end of each 3-4 week rotation period (for a total of four separate scores per participant) and additional environmental concern and ecological behavior scores were recorded at the end of the study (See Figure 8 on page 30).

Education. Upon completion of the 2-week pre-test baseline phase, participants were asked to attend one of two one-hour composting workshops led by the local Cornell Cooperative Extension Composting Education Program. The workshops took place indoors and on-site at the outdoor compost bins of the apartment complex's community garden and were primarily directed toward composting basics and outdoor composting. Informational handouts and kitchen food scrap buckets were distributed at the workshops. An online, shared folder entitled *Composting Education* was created to allow participants access to all informational handouts, as well as a video recording of the workshop, throughout the duration of the study. Of the total 32 individual participants, 17 attended one of the workshops and 16 joined the online, shared folder.

Compensation. Upon completion of the study, each participant was given the kitchen food scrap bucket and digital hanging scale used in the study, the opportunity to purchase one of the indoor electronic composters for 40% of the original cost, and

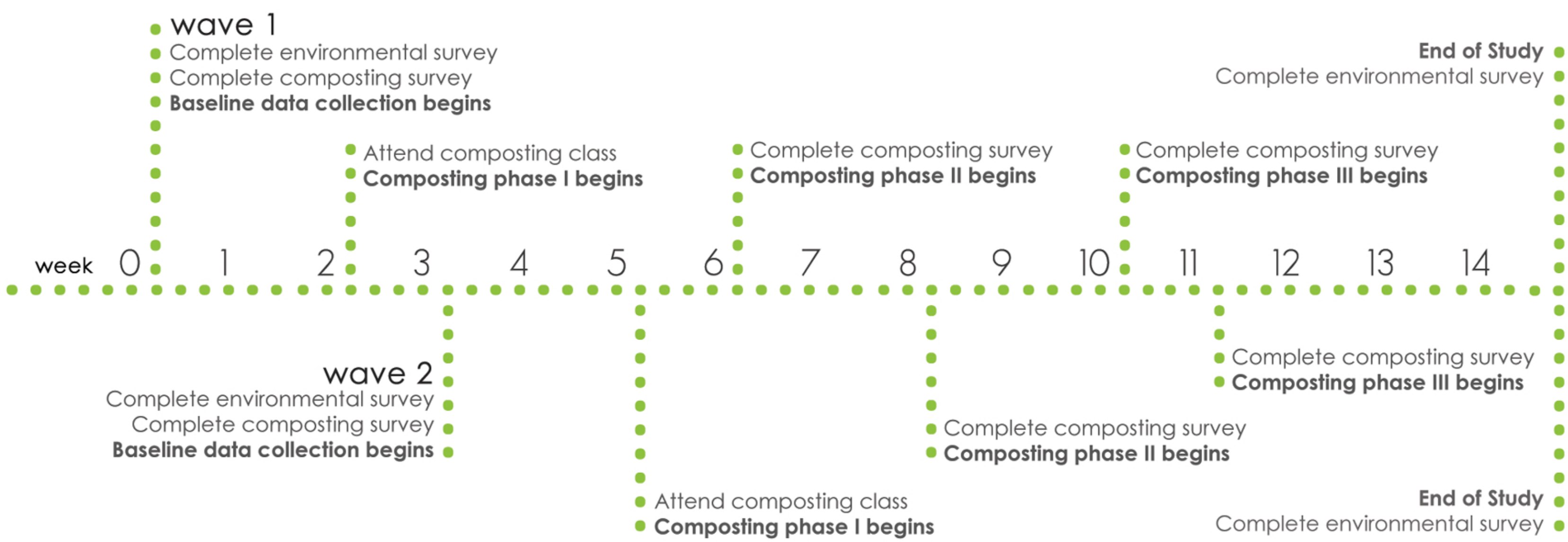


Figure 8. Study timeline

entered in a drawing for one of four $50 gift cards to a local supermarket. Additionally, each individual participant was given choice of either a household fern or chocolate candy. Only one of the 27 households decided to purchase one of the indoor compost bins.

Data Analysis

Research Question 1. *How does composting type affect MSW production?*

Research Question 2. *Do the factors of stage in family lifecycle, composting experience, ecological behaviors, environmental concern, and proximity moderate the relationship between composting type and MSW production?*

Descriptive statistics for continuous and categorical variables were calculated with SPSS 19. A mixed model AVOVA was used to test for significant associations between MSW production, composting type, and other moderating variables entered as fixed effects. Due to repeated measures over time and multiple individual observations from within the same family, a unique family identification (ID) variable was included as the random effect term in the mixed model. All Pairwise comparisons were adjusted with Fisher's Least Significant Difference (LSD). In order to determine the significance of the relationship between MSW production, composting type, and each moderating variable, a three-level mixed model was used with the mean baseline weekly trash weight used as a control variable. Thus, the result for each moderating variable is a prediction of the amount of MSW production expected for a household with an average baseline trash weight of 12.76 lbs. Finally, all moderating variables found to be significant within each respective reduced model were analyzed together in a full mixed model using the same methodology.

Research Question 3. *How does composting type affect attitudes about composting?*

An in-depth qualitative analysis based on individual responses to the two open-ended survey questions was conducted (i.e. *Describe any positive (/ negative) experiences with composting over the past 3-4 weeks*). The qualitative analytical procedure began by compiling and organizing all responses into six categories by participant ID number 1) positive responses about indoor composting, 2) positive responses about outdoor composting, 3) positive responses about off-site food scraps recycling, 4) negative responses about indoor composting, 5) negative responses about outdoor composting, and 6) negative responses about off-site food scraps recycling. If a participant did not respond, or responded in general terms such as ‘trash was reduced,’ the item was later coded as a ‘neutral/ unknown’ attitude response. Comparable responses by members of the same household were coded as one response. Responses were then read and analyzed for themes, resulting in the later coding of each individual response into one or more of the following categories 1) Internal factors, 2) external factors: technical, and 3) external factors: environmental. Each response category is described below. Additionally, select quotations of qualitative comments were reported in the text of the results section in ‘the traditional format’ used in qualitative research texts (Burnard, Gill, Stewart, Treasure, & Chadwick, 2008).

Internal Factors. Responses based on individual, personal differences were included under the category of ‘internal factors’ including intrinsic satisfaction from positive emotions associated with care of the earth, one’s ability to ‘make a difference,’ seeing/using the finished compost, and/or changes in levels of environmental concern. Additional factors included personal motivation, perceived time commitment, anticipation/ excitement for use, relationship, or ‘bond,’ with the composting device/ process including habit formation and/or ‘missing’ the composting type once finished, changes in other ecological behaviors, and finally, improvements in knowledge or educational experience (i.e. the opportunity for him/her to learn or teach others).

External Factors: Technical. Responses associated with the use of each individual composing technology (i.e. machinery/ device itself, collection bucket, instructions and signage, and additional supplemental materials such as leaves, baking soda and/or wood pellets) were included as factors external, technical factors. Specifically, responses related to what Åberg et al (1996) referred to as 'technical misfits' such as odor and pests were included as well as noise, ease of use, appearance, size/weight, volume/capacity, efficiency (i.e. speed of decomposition), energy and material usage, and food input options associated with the composting devices and quality and/or appearance of finished compost.

External Factors: Environmental. Responses that mention characteristics of the built environment such as proximity/ distance, convenience, availability of space (i.e. in fridge or kitchen), availability of resources (i.e. transportation, drop off locations, hours of operation, way-finding signage, etc.), and weather conditions were included. Lastly, the social factor of family dynamics was also included under the 'environmental' category.

RESULTS

Research Question 1. *How does composting type affect MSW production?*

Overall, there was a high level of variability in average weekly MSW production between individual households (see Table 4). Results of the mixed model ANOVA with baseline MSW production analyzed as a control variable revealed that the difference in mean weekly MSW production between baseline (M = 12.76 lbs.), indoor composting (M = 6.53 lbs.), outdoor composting (M = 7.12 lbs.), and off-site food scraps recycling (M = 9.73 lbs.) were all significant at $p \leq .000$ except the difference between indoor and outdoor composting, which was not significant (p = .33). The mean MSW production for all three composting types (7.79 lbs.) suggests that, compared to baseline, composting of any type can reduce household MSW production by nearly 5 lbs. per week, or over 250 lbs. per year (see Figure 9).

Table 4. Descriptive statistic summary for weekly MSW production by composting type

Composting type	*Mean (M)*	*Std. dev. (SD)*	*Range*
Baseline (no composting)	12.71 lbs.	10.43 lbs.	0.59 - 38.01 lbs.
Indoor composting	7.20 lbs.	6.85 lbs.	0 - 31.35 lbs.
Outdoor composting	7.72 lbs.	7.55 lbs.	0 - 36.88 lbs.
Off-site food scraps recycling	10.35 lbs.	10.29 lbs.	0 - 42.14 lbs.

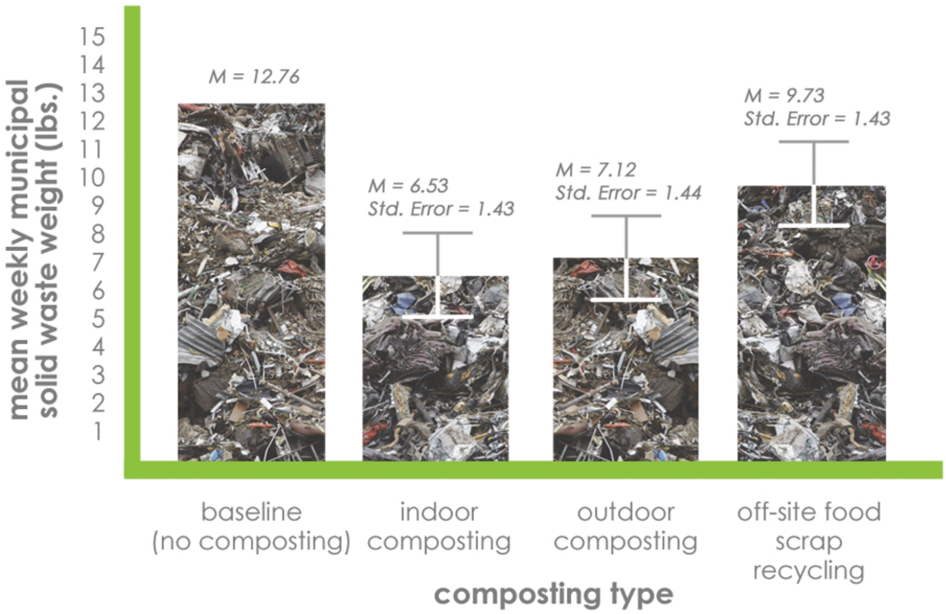


Figure 9. Reduced mixed model analysis of mean weekly MSW production by composting type

Research Question 2. *Do the factors of stage in family lifecycle, composting experience, ecological behaviors, environmental concern, and proximity moderate the relationship between composting type and MSW production?*

A full mixed model revealed no main effects on MSW production for any of the five moderating variables investigated; however, significant interactions were found for three of the five moderating variables including composting type by 1) *stage in family lifecycle* ($p \leq .000$), 2) *proximity* ($p \leq .000$), and 3) *composting experience* ($p \leq .05$). The unique family ID variable explained 40.8% of the between-subjects variance, leaving 59.2% residual within-subjects variance unexplained. Reduced mixed model results for each of the five moderating variables, and when applicable full mixed model results, are described below.

Stage in Family Lifecycle[2]. There was a significant main effect of stage in family lifecycle on overall MSW production (p = .045). Specifically, families with child(ren) produced an average of nearly 4lbs more trash per week (M = 10.79 lbs., SD = 1.148) than individuals and families who have never had child(ren) (M = 6.84 lbs., SD = 1.165). Most notably, a Pairwise comparison showed a significant difference in MSW production between households for off-site food scraps recycling (p = .002). Further, a significant interaction was found for composting type by stage in family lifecycle ($p \leq .000$). Specifically, families with child(ren) experienced a greater reduction in MSW when using the indoor compost bin rather than the outdoor bin, and the least reduction while using off-site food scraps recycling. However, individuals and families without children showed little variation in mean weekly MSW reduction for each of the composting types (see Figure 10).

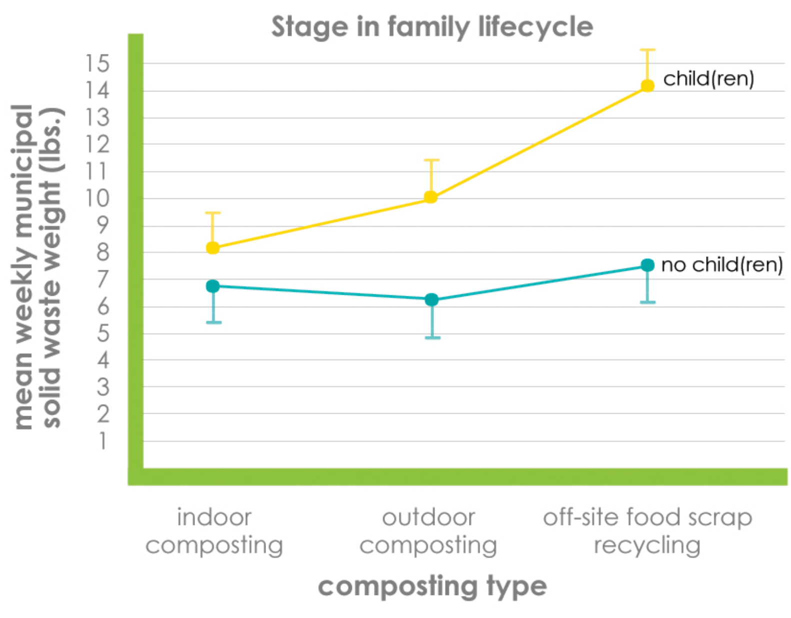


Figure 10. Reduced model of mean weekly MSW production (lbs.) outcome for composting type by stage in family lifecycle interaction ($p \leq .000$) on two levels.

[2] A significant interaction was found for composting type by age ($p \leq .000$) and the relationship between age and stage in family lifecycle was non-collinear; however, the two variables were correlated (.72) so age was not reported separately.

When analyzed as a full mixed model (i.e. controlling for proximity zones and past composting experience), the main effect of stage in family lifecycle present in the reduced mixed model was no longer significant; however, the composting type by stage in family lifecycle interaction remained strong ($p \leq .000$). Standard deviations for families with children reduced by 0.1lbs., the Pairwise comparison showed a slight increase in significance for off-site food scraps recycling ($p = .01$), and mean MSW weights varied slightly; however, overall interaction results remained largely unchanged from the reduced mixed model (see Figure 11).

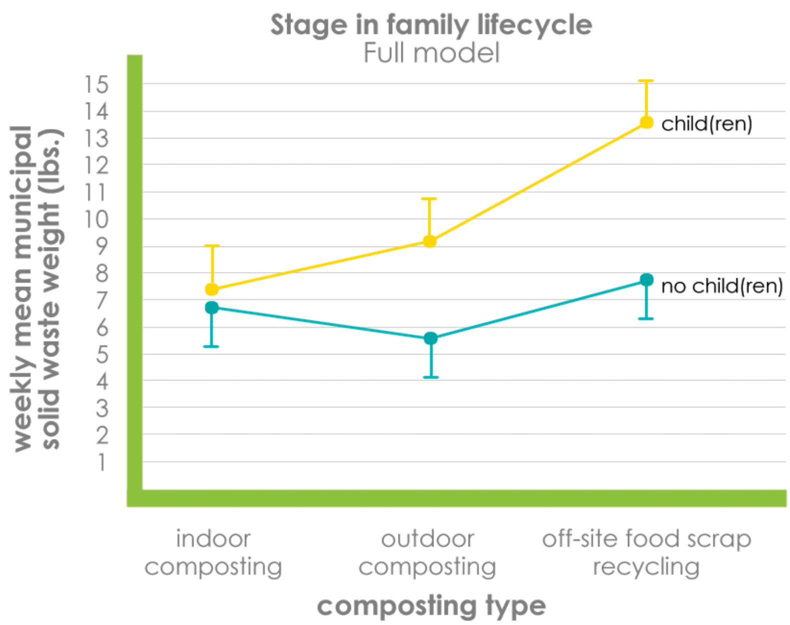


Figure 11. Full model of mean weekly MSW production (lbs.) outcome for composting type by stage in family lifecycle interaction ($p \leq .000$) on two levels with control of proximity and composting experience

Composting experience. No significant main effect of past composting experience level on MSW production was found ($p = .258$); however, there was a general trend towards a decrease in MSW production with increasing levels of composting experience (no experience $M = 9.42$lbs., low-to-medium $M = 9.04$lbs., high $M = 6.93$lbs.). A significant interaction was found for composting type by composting experience (p = .008). Not surprisingly, those with a high level of past experience (presumably with outdoor composting) had the lowest MSW production for outdoor composting as compared to those with low-to-medium or no past experience. The Pairwise comparison showed a significant difference between high and low-to-medium experience levels (p = .046) and between high and no experience levels (p = .006) for outdoor composting. Lastly, although MSW production appears to be greater for households with low-to-medium experience with composting than households with high or no past experience for off-site food scraps recycling the differences are not significant (see Figure 12).

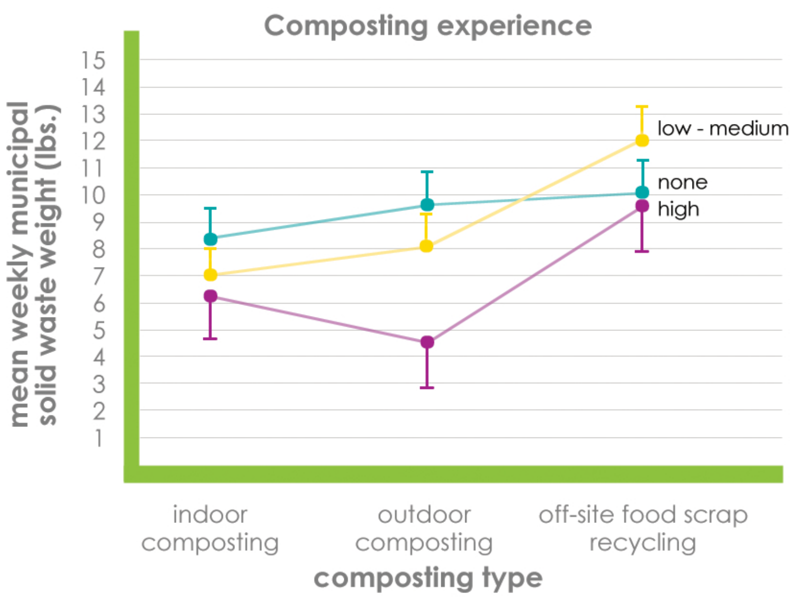


Figure 12. Reduced model of mean MSW production (lbs.) outcome for composting type by composting experience (p = .008) on three levels

MSW production for households with high composting experience levels and overall *SD* levels remained largely unchanged for the full mixed model analysis (see Figure 13); however, in regard to outdoor composting, the Pairwise comparison showed an elimination of significance for differences between high and low-to-medium experience levels (p = .059) as well as a slight reduction of significance for differences between high and no experience levels (p = .008).

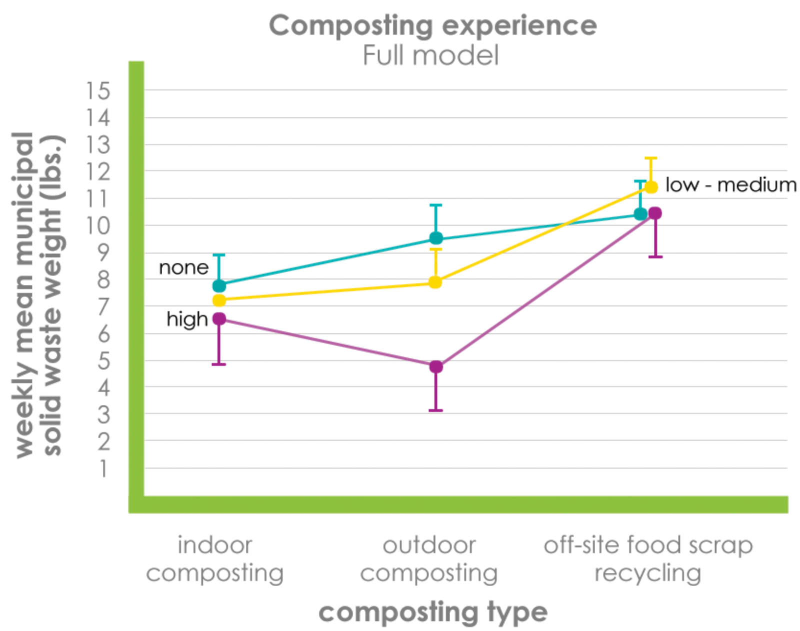


Figure 13. Full model of mean MSW production (lbs.) outcome for composting type by composting experience interaction ($p \leq .05$) on three levels with control of stage in family lifecycle and proximity

Ecological behavior (GEB): Although no significant main effect of participation in other ecological behaviors on MSW production was found (p = .074), households with low levels of other ecological behaviors (M = 9.7 lbs.) displayed a 2lb higher mean trash weight than those with high levels (M = 7.7 lbs.). A significant interaction was found for composting type by ecological behavior (p = .016). Specifically, the Pairwise comparison showed a significant difference between households for outdoor composting (p = .007). Most notably, households with low levels showed little difference in MSW production between outdoor and off-site food scraps recycling yet a slight decrease in MSW production for indoor composting (see Figure 14). However, households with high levels showed significantly lower MSW levels with outdoor and indoor composting than off-site food scraps recycling (p = .000).

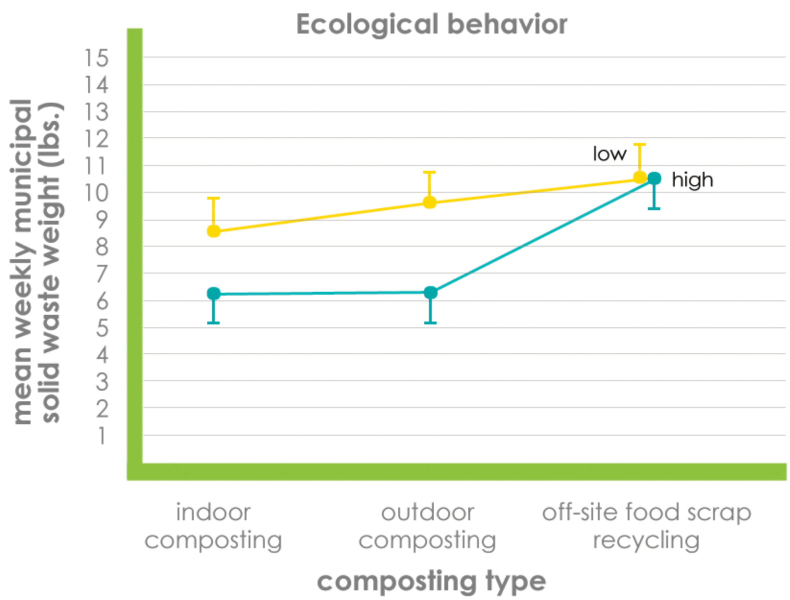


Figure 14. Reduced model of mean MSW production (lbs.) outcome for composting type by other ecological behavior participation on two levels

Environmental concern (NEP): Neither a significant main effect of level of environmental concern on overall MSW production (p = .996) nor a significant interaction for composting type by environmental concern (p = .056) were found to exist.

Proximity. As expected, no significant main effect of proximity zone (i.e. household walking distance to the outdoor compost bins) on overall MSW production was found (p = .825), which implies households with varying MSW production levels were fairly evenly distributed throughout the apartment complex. A significant interaction was found for composting type by proximity ($p \leq .000$). Specifically, households in Zone 1 (closest to outdoor compost bins) produced less MSW during the indoor and outdoor composting phases than Zones 2 and 3, which showed little-to-no difference in mean trash weight between all composting types. Interestingly, the Pairwise comparison showed a significant difference between Zone 1 and Zone 2 for indoor composting ($p \leq .05$). Lastly, although Zone 1 households appear to have produced more MSW for off-site food scrap recycling compared to Zones 2 and 3, the differences were not significant (see Figure 15).

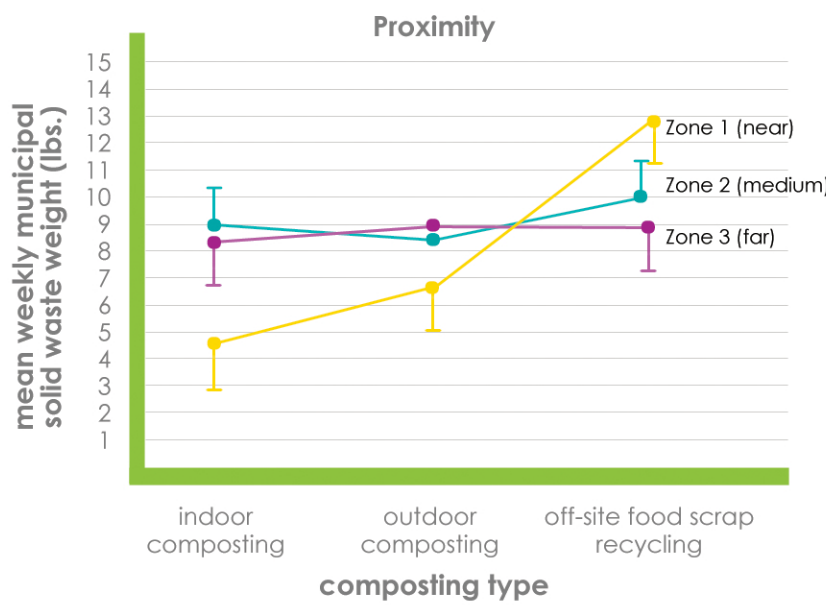


Figure 15. Reduced model of mean MSW production (lbs.) outcome for composting type by proximity zone interaction ($p \leq .000$) on three levels.

When analyzed as a full mixed model (i.e. controlling for stage in family lifecycle and past composting experience), the composting type by proximity interaction remained strong ($p \leq .000$). The *SD*s increased slightly, the cross-over interaction between Zones 2 and 3 was eliminated for outdoor composting and off-site food scraps recycling, and the difference between Zones 2 and 3 for indoor composting became more pronounced though still non-significant. The Pairwise comparison for indoor composting with Zone 1 showed a slight increase in significance ($p = .036$) (see Figure 16).

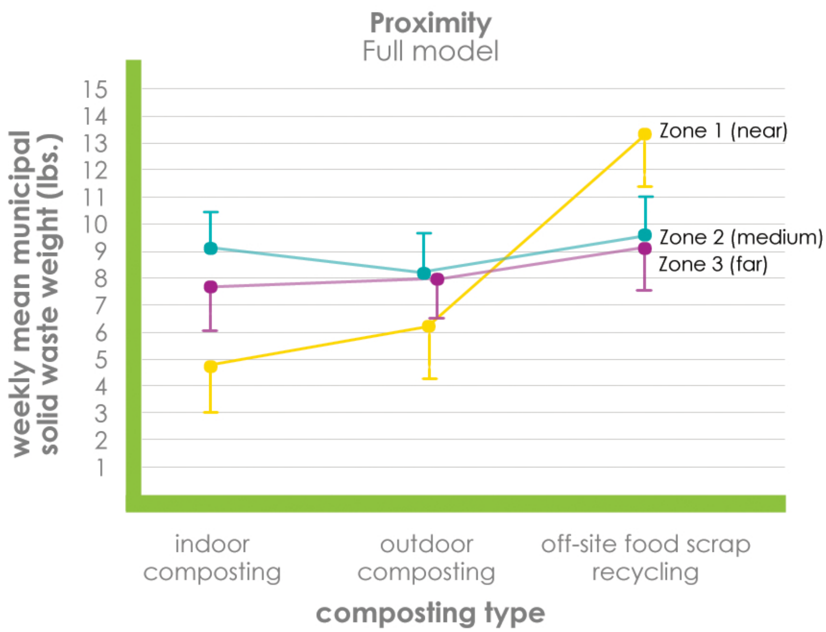


Figure 16. Full model of mean MSW production (lbs.) outcome for composting type by proximity zone interaction ($p \leq .000$) one three levels with control of stage in family lifecycle and composting experience

Table 5. Summary of mean MSW production (lbs.) for each moderating variable

Variable	Composting type					
	Indoor		Outdoor		Off-Site	
	M	*Std. Error*	*M*	*Std. Error*	*M*	*Std. Error*
Stage in family lifecycle						
Child(ren)	8.266	(1.242)	9.986	(1.243)	14.114	(1.254)
No children	6.775	(1.255)	6.262	(1.270)	7.480	(1.255)
Composting experience						
None	8.442	(1.022)	9.729	(1.035)	10.095	(1.032)
Low / Medium	7.051	(1.055)	8.023	(1.060)	12.036	(1.059)
High	6.388	(1.535)	4.576	(1.573)	9.823	(1.535)
Ecological behavior						
Low	8.638	(0.990)	9.883	(1.003)	10.673	(1.008)
High	6.298	(1.038)	6.289	(1.051)	10.573	(1.029)
Environmental concern						
Low	7.425	(0.907)	8.738	(0.924)	10.306	(0.913)
High	7.819	(1.182)	7.025	(1.212)	11.640	(1.187)
Proximity						
Zone 1 (near)	4.772	(1.658)	6.611	(1.664)	12.922	(1.664)
Zone 2 (medium)	9.004	(1.239)	8.755	(1.246)	10.128	(1.253)
Zone 3 (far)	8.358	(1.527)	8.943	(1.564)	8.906	(1.521)

Research Question 3. *How does composting type affect composting attitudes?*

Quantitative results from the sub-scale derived from Edgerton et al (2009) showed a statistically significant higher positive attitude towards indoor composting than outdoor composting (p = .047) as well as a significant main effect of age (p = .007), stage in family lifecycle ($p \leq .000$), and levels of other ecological behaviors (p = .001) on composting attitude as well as significant interactions of composting type with stage in family lifecycle (p = .006), past composting experience ($p \leq .000$), levels of environmental concern ($p \leq .000$), and proximity to outdoor compost bins ($p \leq .000$). However, overall mean scores ranged only from 3.56 - 3.62 on a 5 point scale, indicating a consistently slightly positive (just above neutral) attitude towards composting for all participants throughout the duration of the study. Therefore, although statistically significant, the results may not be clinically significant for practical application, which lead to the concentration here on qualitative analysis to understand attitudes in greater depth.

Qualitative analysis results showed a higher response rate (N = 32) for indoor composting (Q1 (positive experiences) = 59%; Q2 (negative experiences) = 78%) than outdoor composting (Q1 = 38%; Q2 = 81%) or off-site food scraps recycling (Q1 = 25%; Q2 = 50%). The proportion of positive-to-unknown-to-negative responses for each composting type can be seen in the graphic summary provided in Figure 17 below. Specifically, indoor composting had the highest number of positive comments, followed by outdoor composting, and then off-site food scraps recycling. Further, indoor and outdoor composting had nearly the same number of negative comments while off-site food scraps recycling had the least number of negative comments. However, off-site food scraps recycling also had the fewest comments overall, presumably due to the low overall participation rates exemplified by the higher overall levels of MSW production during that study phase.

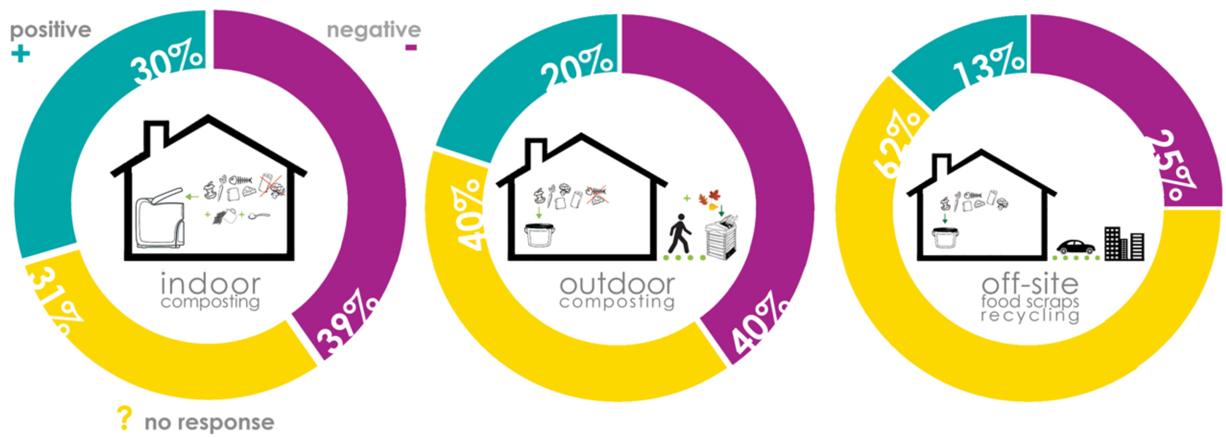


Figure 17. Summary of attitude response rates for each composting type

Indoor Composting

A graphic summary of specific response topic categories relating to the positive and negative comments for indoor composting can be found in Figure 18. The vast majority of comments were related to external rather than internal factors.

Internal factors. Positive comments consisted primarily of the personal relationship, or *bond*, participants developed with the indoor composting machine. For example, one participant explained, "*I found myself looking forward to putting in the day's food scraps into the composter after doing the dishes. Somehow, I always got a kick out of doing that each evening. We miss it already."* Other positive internal factors identified included the development of other ecological behaviors (*GEB*) as a result of using the indoor composting machine. Specifically, one participant described how the machine "*made me more likely to recycle paper and plastic"* while another participant explained, "*we found that the satisfaction of using the composter was enough for us to buy more fresh fruits and vegetables so we would have the little food scraps to compost with.*" There were no negative comments associated with internal factors for indoor composting.

External factors: Technical. Positive comments pertaining to external, technical factors (i.e. attributes inherent to the indoor composting machine and/or process of use) primarily included both *ease of use* and *efficiency.* Many participants were impressed with the quick turnaround time of the compost compared to outdoor composting as well as a variety of input options. Specifically one participant exclaimed, *"the indoor composting works wonderfully well with my family's lifestyle. I am amazed by how efficient the electronic composter is, how little space it takes up, and how easy it is to compost at home. I love that my food scraps are turned into beautiful, fresh compost by the end of the week."* Another participant said, *"We were particularly impressed with the unit's ability to handle dairy, meat, and other food products that most other forms of composting can't, due to attracting flies and vermin."* While indoor composting had the highest number of positive comments, it also had a high number of negative comments, the majority of which were in regard to *odor* and *noise*. *Noise* is a novel characteristic of indoor composting that does not exist with either outdoor or indoor composting and has therefore never before been examined in published composting research. An example of a common complaint was *"The compost bin would make noises and disturb my sleep…the smell would be unpleasant each time I opened the bin to add scraps."* A typical example of a negative comment pertaining to *ease of use* and *energy input* is *"The composting machine had a bad smell and I did not like that it had to be plugged in and working all of the time. When we opened the machine to add more scraps, the smell got everywhere. We could not add large amounts of scraps and had to either cut them or put them in the garbage."*

External factors: Environmental. As one might expect, the dominant positive external environmental aspect of indoor composting was *convenience*, predominantly due to the close proximity. Specific comments included, *"Having the NatureMill composter available right there in the kitchen is super convenient"* and *"I really like having the* *composter so close. It is not fun to walk all the way to a composting bin in the rain/wind/cold."* The majority of negative comments revolved around *space limitations*, due to the nature of the small apartments in which the study took place, For example, *"Due to space constraints in the apartment, it was inconvenient to have the composter inside the kitchen. If I had a bigger kitchen/ bigger house, I would certainly like to use the indoor composter.* Similarly, *"because an electrical outlet was not available near the other trash/recycling bins, we had to keep the machine elsewhere and it took up space (couldn't open cabinet or oven door as a result)."* A few comments included *social issues* revolving around family dynamics including, *"to be successful, both husband and wife must be willing to compost. If only one is committed, it is difficult for it to work."*

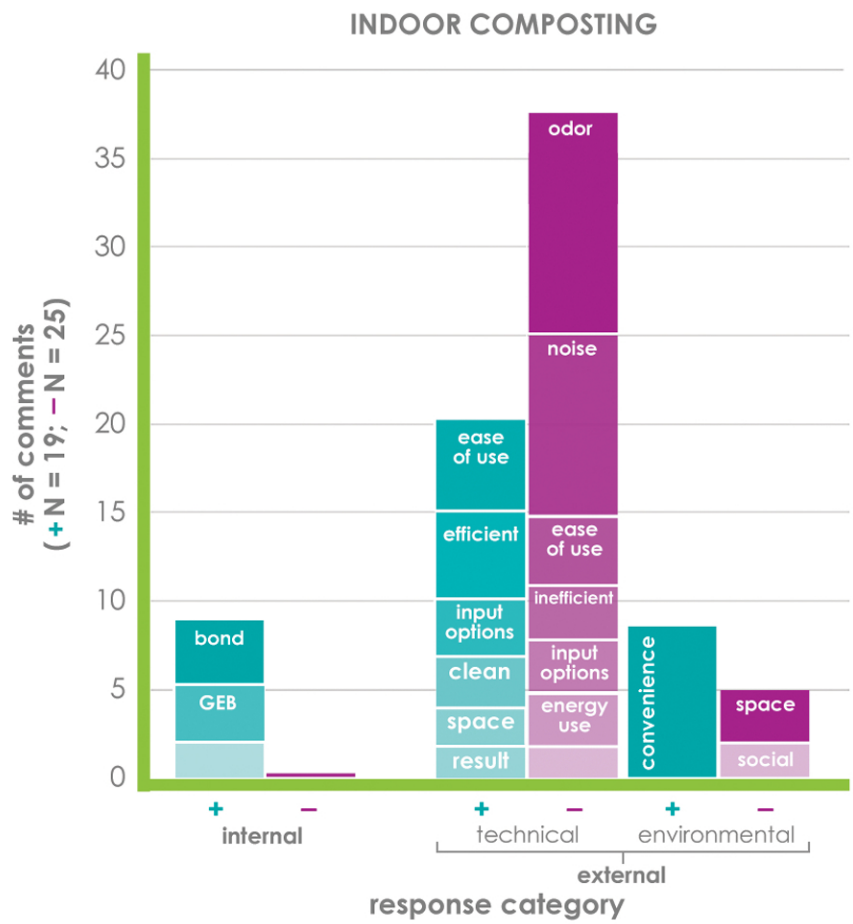


Figure 18. Summary of positive and negative comments for indoor composting

Outdoor composting

A graphic summary of specific response topic categories relating to the positive and negative comments for outdoor composting can be found in Figure 19. Similar to indoor composting, the majority of comments were related to external rather than internal factors.

Internal factors. Positive comments related to internal factors for outdoor composting consisted primarily of *care of the earth* and the personal *bond* with the composting process. For example, one participant described, *"[outdoor composting] feels a lot more natural than the indoor composting"* and another stated *"I enjoy taking the compost to the Hasbrouck garden with my daughter and teaching her about compost and soil creation…this is probably my favorite/most enjoyable phase of the study."* All negative comments regarding internal factors for outdoor composting consisted of a *lack of motivation*. For example, *"I felt ashamed that although I intended to go over to the outdoor compost bin, and I did collect scraps in the bucket, I never made it over there out of mostly laziness and lack of prioritizing it, and partly out of inconvenience and time pressures."*

External factors: Technical. Positive comments primarily pertained to the lack of *odors* associated with outdoor composting. For example, one participant explained, *"Love it, trash does not smell, compost bucket does not smell since kept in the fridge, no insects."* The increased variety of food/material *input options* and *ease of use* compared to the indoor composter was also mentioned— *"This method of composting was much more efficient for our household. I like that we could compost paper towels and napkins and that there were not restrictions on the types of veggies that can be composted."* Negative comments were highest in regard to problems with the *size/capacity* of both the outdoor bins as well as the kitchen food scrap bucket. Typical examples were *"We* *just need a bigger bucket to reduce the frequency of emptying it"* as well as *"Saving the waste to make a trip worthwhile meant putting it into the fridge and taking up space."* Problems with *odors* and pests/ messiness (i.e. *unclean*) were also mentioned when weather prohibited regular emptying of the kitchen scrap bucket— *"The compost [became] a little smelly cause I didn't take it out as often as I normally would."* One participant mentioned*, "We had a fruit fly infestation,"* while another simply said *"Raccoons."*

External factors: Environmental. There were very few positive comments regarding external environmental factors for outdoor composting. The few comments mainly compared the close proximity/ *convenience* of the outdoor bins to the far distance of off-site food scrap recycling. For example, *"Composting outside is much more convenient--at least, as long as the weather is decent"* and, *"It is closer than off-site composting."* However, negative comments also included issues with proximity/ *convenience* as well as outdoor *environmental conditions*. Specifically, *"The bin was a long way off and the rain made the composting yard extremely muddy which combined with the cold weather didn't make the trip very nice."* Another participant mentioned, *"It was sometimes difficult to motivate myself to take the compost all the way to the garden this time of year because I usually don't get home until after dark and there is not a lot of lighting over there."*

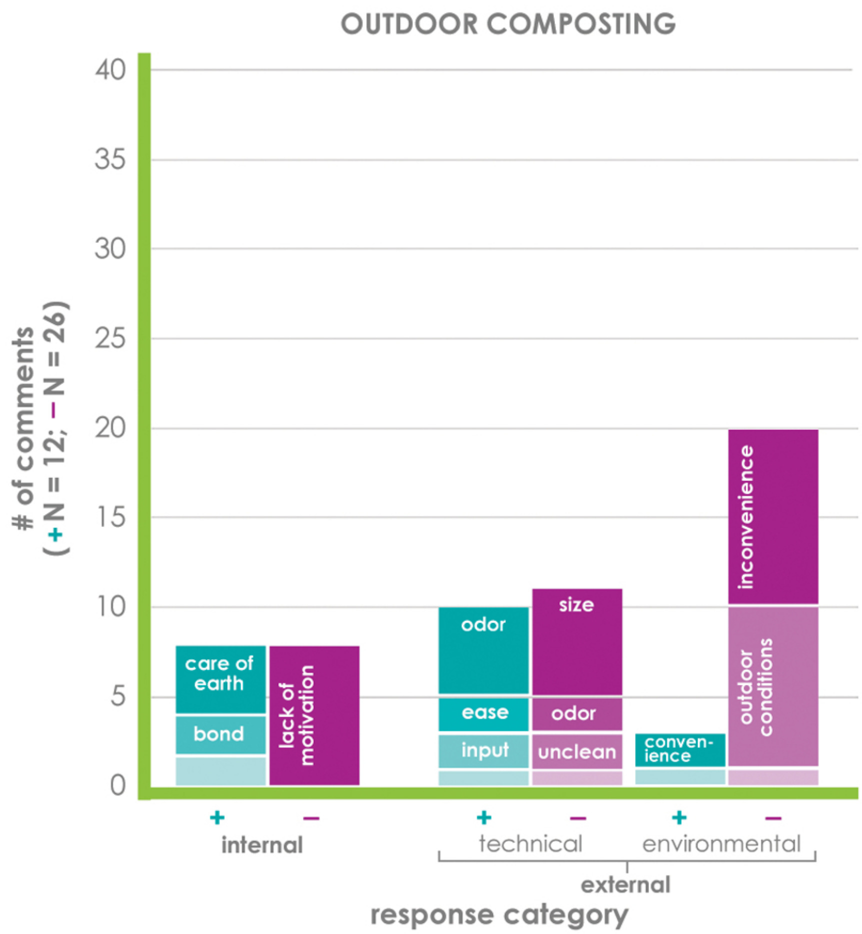


Figure 19. Summary of positive and negative comments for outdoor composting

Off-site food scraps recycling

A graphic summary of specific topics relating to the positive and negative comments for off-site food scraps recycling can be found in Figure 20. Once again, the majority of comments were related to external rather than internal factors.

Internal factors. Similar to outdoor composting, the majority of positive comments related to *care of the earth—"[I] felt that my efforts (as small as they might be) would make a difference in our environment."* Similar to indoor composting, one participant also mentioned a change in other ecological behaviors (*GEB*) —*"[I] recycled more to reduce waste that went in the rubbish dump."* The few negative comments pertained to a perceived *lack of time*. For example *“It takes time to travel to the recycling place to dump the food scraps.”*

External factors: Technical. The few positive comments regarding external technical factors mainly revolved around *ease of use*. Specifically, it appeared that participants considered only having to deal with a kitchen food scraps bucket, as opposed to a machine or outdoor bins, to make the process of ‘composting’ easier— *“It is easy and convenient to collect food scraps in a jar.”* The negative comments were highly varied, consisting of *messiness*, *odor* and *heaviness* of the food scraps during travel, low *capacity* of the kitchen bucket and *energy use* (gas, car wear and tear) during travel to the off-site recycling locations. One participant’s comment summed up the issues well with the comment, *“We have a LOT of compost because we mainly eat vegetarian. So, we collected it in a large bin outside, then transferred it to the car and took it to the farmers’ market to drop off. This made the car smell and was very heavy to transport…we ended up putting some scraps in the rubbish because the compost bin got too full.”*

External factors: Environmental. The few positive comments relating to external environmental aspects of off-site food scraps recycling pertained to proximity/ *convenience* as well as space in regards to *family dynamics*. For example, *“Taking the compost off-site was not as bad as I thought it was going to be…we dropped it at the Ithaca farmers’ market on Saturdays, which we have to go anyway to pick up our CSA share.”* One participant also mentioned, *“It was easier because I didn’t have to negotiate the space indoors with my wife.”* Lastly, negative comments associated with environmental factors were the most common complaints for off-site food scraps recycling, consisting of issues with the far proximity/ lack of *convenience* of drop off sites and a lack of *resources* including lack of car, and both limited hours of operation and location options for drop off sites. For example, *"I relied on the food composting station at [a restaurant] on campus. I had to abide by their hours of operation which did not always jive with my schedule, so food scraps would pile up over the weekend…it was inconvenient to carry food scraps to central campus for composting,"* and, *"I could not do the off-site recycling— the place was too far away and I do not have a car."*

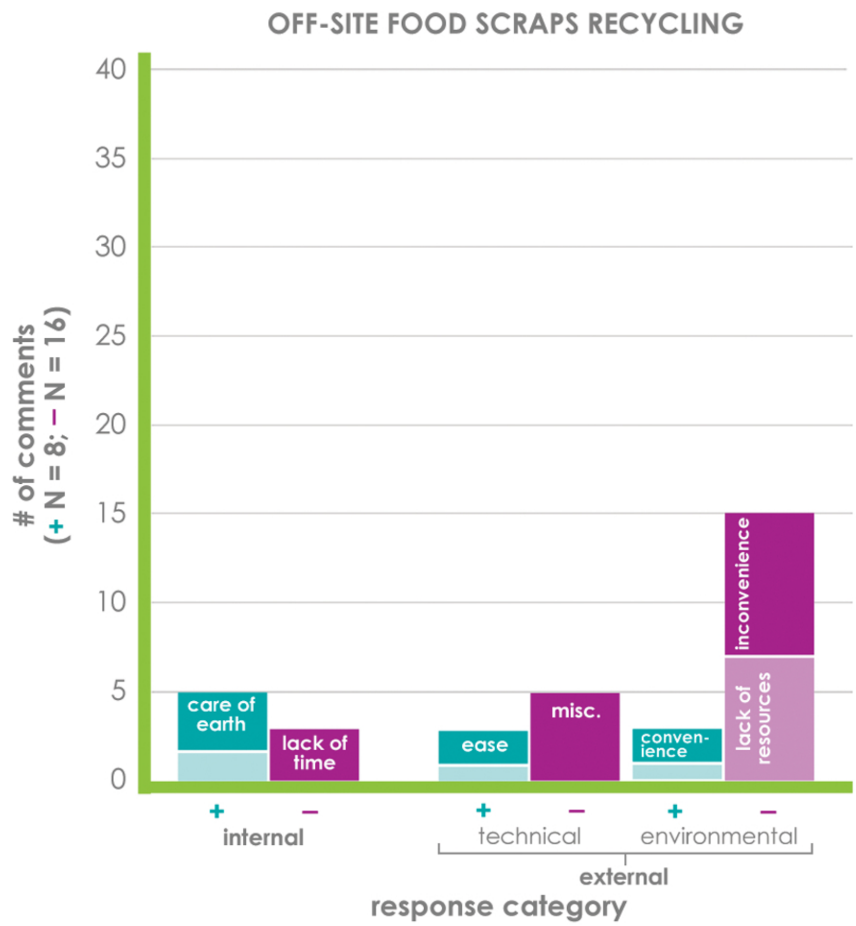


Figure 20. Summary of positive and negative comments for off-site food scraps recycling

Summary

A graphic combination summary of specific topics relating to the positive and negative comments for each composting type, with internal and external related topics combined to emphasize the proportion of positive-to-negative attitudes, can be found in Figure 21.

Overall, there were more negative than positive comments for each composting type; however, indoor composting had the most desirable ratio with a -6% rating, (i.e. 6% more negative than positive comments), followed by outdoor composting with a -28% rating, and finally, off-site food scraps recycling with a -38% rating.

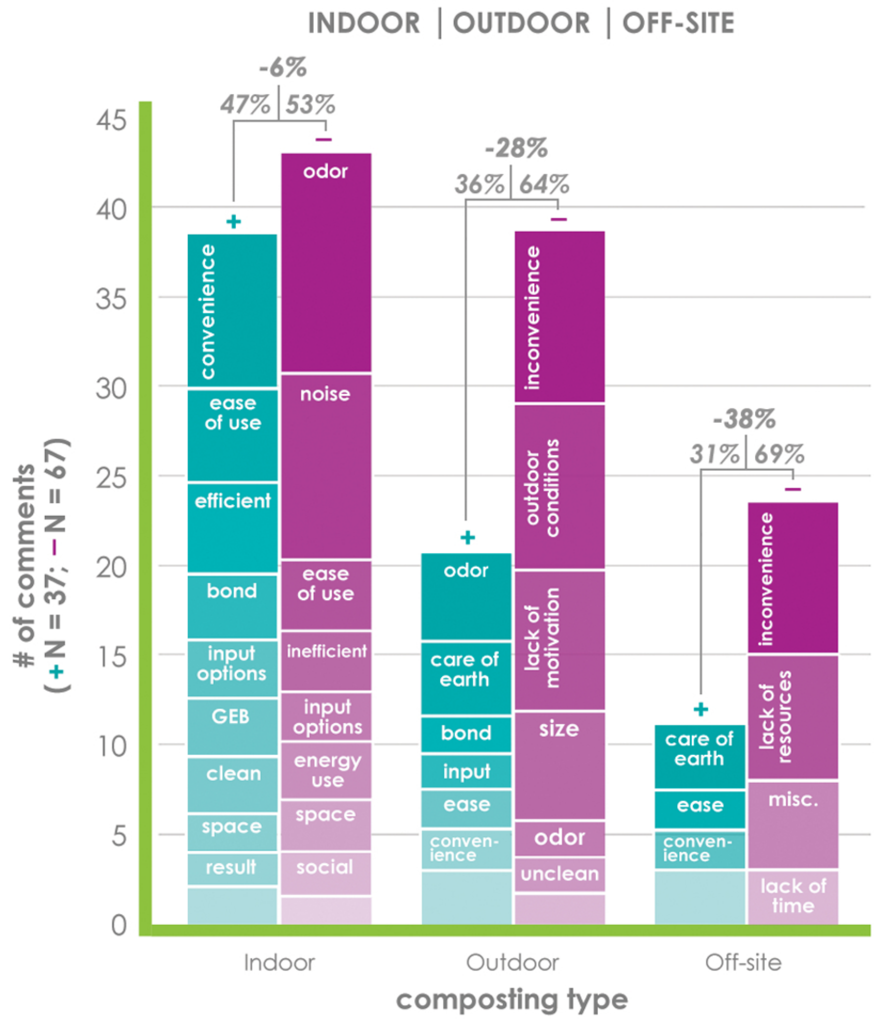


Figure 21. Summary of positive and negative comments for each composting type

DISCUSSION

The growing environmental problem of waste management can be addressed in part through widespread household waste management, specifically source reduction and soil conservation through composting. However, the solution to the problem is complex and shaped by factors beyond a general desire to care for the natural environment. The present study aimed to investigate the effects of composting type on waste production and attitudes towards composting in apartment households. The study used three major research questions, which will each be discussed separately, and this is followed by study strengths, study limitations, and future research recommendations including a practical application-based intervention aimed at increasing participation in household composting.

Research Question 1. *How does composting type affect municipal solid waste (MSW) production?*

Quick answer: Any type of composting will reduce waste, *if* you participate.

Participation in indoor or outdoor composting reduced waste more than off-site food scraps recycling; however, participation in any of the three types of composting has the potential to significantly reduce the level of municipal solid waste produced by apartment households. As the average household in this study reduced their waste by nearly 5 lbs. per week, which equates to around 250 lbs. per year, the results suggest that if each of the 338 households in the Hasbrouck apartment complex participated in composting, waste would be reduced by 845,000 lbs., or 423 U.S. tons, per year. Further, due to household composting alone, a small city of approximately 10,400 households such as Ithaca NY (U.S. Census, 2010) has the potential to reduce waste by over 250 million lbs. each year— a substantial contribution to sustainability!

Although it may seem that the variation in waste reduction by composting type was associated with variation in the efficiency or technical design of each type of composting, waste reduction was instead most affected by variations in the level of participation. If waste reduction potential for each composting type was considered outside the context of user lifestyle a reversal of the findings would have occurred and participation in off-site food scraps recycling would have resulted in the most waste reduction because food scraps recycling accepts the widest range of compostable materials (see Appendix for complete charts of accepted materials by composting type). Thus, the study results indicated off-site food scrap recycling, compared to indoor and outdoor composting, was the composting type that residents participated in the least. The qualitative results of composting attitudes support the interpretation as food scraps recycling had the lowest attitude score and least number of comments overall. Although there was no significant difference in MSW production found between indoor and outdoor composting overall, significant differences were found between all three types of composting when various moderating variables were also analyzed. In short, participation—not technical efficiency of each composting type-- mediates the relationship between composting type and MSW production (see Figure 22).

Figure 22. Conceptual model of results for research question 1

Research Question 2. *Do the factors of stage in family lifecycle, composting experience, ecological behaviors, environmental concern, and proximity moderate the relationship between composting type and MSW production?*

Quick answer: Mostly, yes. One 'type' of composting does not fit all households!

The relationship between composting type and amount of waste reduction depended primarily upon whether or not a household has children (*stage in family lifecycle*) and the distance (*proximity*) of a household to a compost site; secondarily upon a household's level of past *composting experience*; and less upon the household's participation in other *ecological behaviors*. A household's level of *environmental concern* did not moderate the relationship between composing type and waste production. In addition, of the three most significant factors that shaped the level of waste reduction for each type of composting-- *stage in family lifecycle, composting experience,* and *proximity*-- each can be categorized as a demographic, internal, and external factor, respectively. Thus, 'one type' of composting does not fit all households! Instead, participation in household composting was highly influenced by a combination of Kollmuss and Agyeman's (2002) three 'factor' categories of pro-environmental behavior, from which the organization of this study is based. A conceptual model of research question 2 is presented in Figure 23 and the influence of each moderating variable is elaborated upon in the subsequent paragraphs.

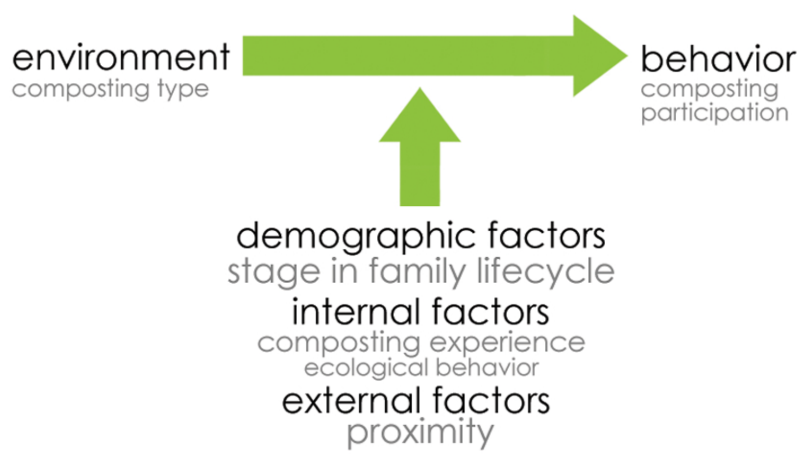


Figure 23. Conceptual model of results for research question 2

Stage in family lifecycle. While study findings generally support the results of the Swedish survey study by Edgerton and colleagues (2009) that *stage in family lifecycle* and *composting knowledge* are associated with household composting participation and that *level of environmental concern* is not, the present study was primarily concerned with the significance of interactions, not main effects. In addition, the results cannot quite be compared to Edgerton and colleagues (2009) as they found that families with children were equally likely to participate as young adults without children yet nearly five times less likely to participate in outdoor composting than retired individuals, yet no retired individuals participated in the present study. Instead, study results suggest families with children not only produce more food waste overall, and therefore have a higher potential for waste reduction through composting, but are also significantly less likely to travel off-site to recycle food scraps than households without children. In addition, composting type makes less of a difference in waste reduction for households without children as they produce less food waste overall. The reason for the strong preference against off-site food scraps recycling for families with children may stem from issues with what Åberg and colleagues (1996) term *internal household dynamics*--for example, chore allocation can be a significant barrier to composting within families. However, the majority of children in participating households were of a young age. Therefore, issues with chore allocation would fall between the adults—a situation that is no different than a household of adults without children. A more likely interpretation is that families with children consider *inconvenience*, the most negative attribute expressed for off-site food scraps recycling, to be a more substantial composting participation barrier than odor or noise, which were the most negative attributes expressed for indoor composting. Indeed, the level of waste reduction associated with indoor composting (considered to be the most convenient of all three composting types) was substantially higher for families with children than that of outdoor composting or off-site food scraps recycling. Overall, the results suggest families with children not only have the highest potential for waste reduction through composting but also that indoor composting may be their preferred composting type, followed by outdoor composting.

Further, although composting type matters less for individuals and families with out children, they may prefer outdoor composting (see Figure 11 in the Results section).

Composting experience. Both the survey study by Edgerton and colleagues (2009) and the 6-week New Zealand home composting intervention by Gillan and colleagues (2003) strongly suggest *composting-specific knowledge* is essential to composting participation. For that reason, composting knowledge was controlled (held constant) in the present study through considerable effort to educate all participants on each type of composting. Thus, past *composting experience* was measured instead. Households with higher levels of composting experience showed significantly higher levels of participation in outdoor composting than indoor or outdoor composting and higher levels of participation than other participants with no or low-to medium experience with composting. The findings were not surprising as participants' past experience, and therefore composting-specific knowledge, was presumably with outdoor composting. Thus, the findings of the two aforementioned studies are supported. In addition, the results suggest that participation can increase over time with increased experience, regardless of the amount of initial composting-specific education obtained, because again, all households were extensively educated about outdoor composting immediately following the baseline data collection phase. The implications for practical composting education programs are to encourage hands-on experience in addition to traditional lecture or handout methods of teaching.

Ecological behaviors. The findings suggest that people who participate in a high number of other ecological behaviors (*water and power conservation, nature protection activities* etc.) also participate more in indoor and outdoor composting than those who participate in a low number of other ecological behaviors, who show little-to no variation in waste reduction between composting types. The results are not consistent with the findings of Edgerton and colleagues (2009) who suggest there is no association between pro-environmental behavior and participation in outdoor composting. However, Sterner and Bartelings (1999) mention that *existing participation in garden waste composting* was a significant predictor in the take up of outdoor composting once a municipal weight-based waste billing system was initiated. Thus, it seems reasonable that the *type* of ecological behavior, namely whether or not the behavior relates to composting, is associated with composting participation even though general ecological behaviors are not. Alternatively, the conflicting results could be the result of measurement discrepancies or cultural differences between the current study and that of Edgerton and colleagues (2009). Specifically, the 49-item General Ecological Behavior (GEB) Scale (Kaiser & Wilson, 2000), which is a validated measure designed specifically for cross-cultural use in the United States, was used in the present study whereas an 8-item ‘Pro-environmental Behavior’ scale was used by Edgerton and colleagues (2009); a measure designed by the authors for use in Scotland. A second alternative explanation is that those with a lower level of other ecological behaviors simply do not produce as many food scraps to compost (e.g. do not eat as high of a fresh foods diet), which would explain the higher levels of waste overall and little variation in waste reduction between composting types. In addition, an explanation for the those with a high level of other ecological behaviors to participate significantly less in off-site food scraps recycling than indoor or outdoor composting may be associated with a lack of resources, namely personal transportation, as ‘ecological automobile use’ is one of the sub scales of the GEB scale. Indeed, *lack of resources,* in addition to *inconvenience*, was expressed by participants as a primary barrier to participation in off-site food scraps recycling. However, none of the scale items explicitly measure the availability of personal transportation so the interpretation is speculative. Implications of the findings that residents with higher levels of other ecological behaviors also participate more in composting may be that interventions that aim to increase general ecological behaviors may also increase composting participation.

Environmental Concern. An individual's level of environmental concern (i.e. care for the state of the natural environment) has no relation to composting participation. The findings support but also extend the findings of Edgerton and colleagues (2009) on outdoor composting to include indoor composting and off-site food scraps recycling. The results are not surprising and suggest the attitude-action gap extends to all types of composting.

Proximity. Proximity is not addressed in previous research yet findings suggest is has a highly significant association with composting participation. The expected association was that households with a closer proximity (i.e. shorter walking distance) to the outdoor compost bins (and therefore the garden) would have a higher level of waste reduction than household who lived further away. Instead, the results only suggest households who lived the very closest to the outdoor garden compost bins participated significantly more in *indoor* composting yet only slightly (and non-significantly) more in outdoor composting. The results are perplexing. One explanation considered was that a relationship exists between households who live closest to the garden and households who also have children (*stage in family lifecycle)* as the associations for each are similar—specifically, higher levels of participation in indoor composting, followed by outdoor composting and in a distant third, off-site food scraps recycling (see Figures 11 & 13 in the Results section). However, no relationship between the two variables exists. An alternative explanation is that those who live closest to outdoor garden compost bins also use the garden as a 'dump site' for the compost produced by the indoor composting machine and that those who live further away participate less in indoor composting because they do not perceive having an adequate nearby location to dispose of finished compost. The higher level of indoor composting participation and therefore dumping of compost, for those who live nearby the outdoor garden compost bins may have been reinforced by the existing pile of finished compost existing in the garden or a sense of intrinsic satisfaction (DeYoung, 2000) from providing finished compost in a vegetable garden for others to use. However, the interpretation does not explain why none of other households displayed any variation between the three composting types. It seems the most plausible explanation is that the five households within 500 feet of the gardens were largely outliers who had the highest food-to-other waste ratio of the 27 households in the study. In other words, either by chance or by influence of the garden, those who live closest to the garden may also consume more fresh foods. No information was collected that could verify the interpretation of the garden influence, therefore it is merely speculation. However, housing assignments at the Hasbrouck apartment complex are largely out of resident control as assignments are made in the order in which applications are received, according to a ranking of housing type preference (studio, 1 bedroom, 2 bedroom apartment, or 2-bedroom townhouse) and space availability. Still, further research studies with a larger sample size are needed to accurately interpret the effects, and therefore implications, of proximity of composting participation.

Additional variables. The cross-sectional survey study conducted by Edgerton and colleagues (2009) found that poor *aesthetics* and the excessive *physical space requirements* of outdoor compost bins reduced composting participation. In addition, the field intervention by Åberg and colleagues (1996) found that problems associated with *pests* and *emptying* the outdoor composting units also limited participation. Although none of the issues were explicitly measured in the current study, none of the issues were expressed by participants in the qualitative findings, which may suggest a lack of support for the effects of aesthetics, spatial requirements and emptying procedures for outdoor composting. However, although the outdoor compost bins in the present study were larger than would typically be found in a backyard, they were located in the community garden and therefore did not take up private space of any single household. Further, the current study primarily took place in the late-fall to winter months (when fewer insects and animals are present) and the responsibility of emptying the composting units was delegated to one of the on-site graduate community advisors and the researcher. Thus, generalizations of outdoor composting participation barriers cannot necessarily be made from a single family household to an apartment complex due to variations such as larger space availability and centralized maintenance.

In summary, different composing types are suited to different household types. The greatest contribution to sustainability may be found by providing composting options and allowing households to select the option best suited to their circumstances.

Research Question 3. *How does composting type affect attitudes about composting?*
Quick answer: Different people favor different types of composting.

According to the qualitative data gathered, indoor composting was by far the most well-liked, primarily for its in-kitchen convenience, ease of use and efficiency in compost production; however, it was also the most disliked, overwhelmingly due to the bad odor and loud noise. On the contrary, outdoor composting was generally well-liked for its lack of odor and feelings of 'earth care,' yet strongly disliked for its inconvenience, exposure to outdoor conditions (weather, mud, darkness etc.), the general lack of motivation to participate, and the small size of the provided food scrap buckets. Off-site food scraps recycling was the most disliked also due to its inconvenience but also for a general lack of resources (namely transportation and location options), which corresponds to a lower participation rate. Overall, there were more negative than positive comments and a positive attitude towards a particular type of composting also corresponds to higher participation, and therefore higher waste reduction.

The results may support findings of Edgerton and colleagues (2009) that a favorable *composting attitude* is a significant predictor of household outdoor composting participation as well as earlier findings by some authors (Tucker et al, 2003) that *negative experiences* with are a primary reason for dropping out of an outdoor home composting scheme. Although households completed the same ‘composting attitude’ scale used by Edgerton and colleagues (2009) after each composting phase, there was little-to-no variation in attitudes. Thus, all of the interpretations of the present study are based upon qualitative user comments regarding attitudes as compared to quantitative waste reduction levels, which is admittedly not an entirely valid comparison. In addition, indoor composting has what would appear to be a significantly higher positive attitude associated with it than outdoor composting, yet differences in actual waste reduction are minimal. The results may suggest a threshold effect for attitudes; however, the interpretation is merely speculative as there is no evidence of such an effect in previous composting literature.

Indoor composting. More participants commented on using the indoor composting machine than on either outdoor composting or off-site food scraps recycling which resulted a in the higher number of both positive and negative comments for indoor composting overall. Although indoor composting received by far the most favorable ‘rating,’ of positive to negative comments, participation in indoor composting did not result in significantly lower levels of waste than outdoor composting. The results are surprising considering the potential of the indoor composting technology to not only supply direct feedback through witnessing the decomposition process, but to provide immediate access for disposal at the source of food waste—in the kitchen. However, indoor composting also accepts the narrowest range of compostable materials. Although 'input options' was not found to be as major of a barrier to participation as odor, noise, ease of use or inefficiency, it is a limitation which has direct consequences for land-fill bound waste production. It is important to note that in order to control for variations in materials accepted by each type of composting, each household was given the option to participate in off-site food scraps recycling during both the indoor and outdoor composting phases. The decision is not really considered a limitation of the study design nor a significant contributing factor to the interpretation of the results for indoor composting because if each household had participated in off-site food scraps recycling during each phase of composting, the variation in waste reduction between composting types would not have occurred as it did.

Participation in indoor composting largely eliminates the external environmental barriers of inconvenience and problematic outdoor conditions found with outdoor composting, but it is instead primarily limited by external technical factors such as odor and noise. As past composting literature has only investigated outdoor composting, 'noise' is a novel factor to associate with composting. However, both noise and odor could be considered analogous to 'technical misfits,' identified as a primary barrier towards outdoor composting participation by Åberg and colleagues (1996). As such, the present study suggests an extension of the findings to include indoor composting. The issue of odor may have been a result of a study timeframe limitation. Specifically, manufacturer instructions suggest the indoor machines require about four weeks to build enough beneficial bacteria to compost food scraps effectively. Yet each time a machine was transferred to another household to use, it was generally emptied, resulting in a 'restart' of the process. The issue of noise may have been more salient in the context of the small apartments than it might be in a larger apartment or home. Several participants complained of the machine waking them during the night although the maximum sound level for the machine is only 51db—about 10db lower than a normal conversation. In addition, ‘indoor’ composting units can be placed outside, which can reduce or eliminate the issues of noise and odor yet largely keep the convenience factor intact. In fact, two of the households moved their indoor composting machine to just outside their front door, while others mentioned they would enjoy using the machine more if they had a garage or larger home.

Although both noise and odor were expressed as major sources of negative attitudes towards indoor composting, neither significantly limited overall waste reduction or composting participation. Acknowledging that the electronic indoor composting machine was novel to all participants, some of whom volunteered for the study just to ‘try out’ the technology, and that each household only used an indoor composting machine for three or four weeks, it is not clear to what extent participation in indoor composting would remain stable over an extended period of time. In fact, only one of the 27 households decided to purchase an indoor compost bin at the end of the study, which many suggest the novelty is short lived. On the other hand, participants still had access to the outdoor compost bins once the study ended, which may make paying the high cost for the machines less justified. Although offered to households at a discounted rate, the machines were indeed still very expensive. Considering that Tucker and colleagues (2003) suggest composting participation increases dramatically when compost bins are free or subsidized, it would not be unreasonable to assume participation would decrease when compost bins are perceived as costly. Alternatively, the residents may have considered the transport of the indoor compost bin a limitation, as all households contained a student and would be required to move upon graduation.

Lastly, an interesting finding is that indoor composting may have the potential to increase other ecological behaviors. Specifically, a few of the participants mentioned that use of the indoor composting machine encouraged both recycling behavior and the purchase of fresh foods. The mechanism may be direct feedback and/ or intrinsic satisfaction, which is an internal factor regarding personal satisfaction from performing a specific behavior (DeYoung, 2000). Although internal factors largely did not shape the attitudes expressed by participants for indoor composting, the potential for indoor composting to affect other ecological behaviors is worthy of future study.

In summary, attitudes for indoor composting were largely shaped by external technical factors from which the barriers of odor and noise appear to overshadow the benefits of convenience-- an external environmental factor. In addition, while the longevity of indoor composting participation in unknown, it is relatively effective at initialing participation and has the potential to increase other ecological behaviors as well the potential to be favored by those who consider convenience to be a high priority. Lastly, indoor composting may be more appropriate for those in a larger home or those with an outdoor area just off the kitchen than those in small or upper-story apartments due to the barriers of odor and noise.

Outdoor composting. Outdoor composting had the same number of negative comments as indoor composting; however, also had fewer positive comments. In contrast to indoor composting, outdoor composting had a fairly even proportion of positive and negative attitudes for both internal and external technical factors; however, it was severely limited by external environmental factors. When considering all of the major limitations expressed for outdoor composting--a general lack of motivation to participate, the small size of the provided food scrap buckets, exposure to outdoor conditions, and inconvenience— all of the limitations seem to stem from the external environmental limitation of 'inconvenience.' Specifically, if the larger environment supported more convenient emptying of the compost bucket, it would reduce the impact of the other issues (e.g., motivation, bucket size, weather). For example, the process of outdoor composting-- collecting kitchen food scraps and then subsequently walking even a relatively short distance outdoors to empty the food scraps-- may be perceived as less inconvenient if: 1) outdoor conditions were controlled, such as providing protection from the elements, walking paths, and adequate lighting for security and vision after dark, and 2) the location of the compost bins was more salient, such as along a route or at a destination often traveled by residents. By moving the outdoor bins to a centralized location, which for this study could be near the Community Center where users already travel to do laundry and collect mail, the food scrap bucket could be easily emptied more often thereby making issues with the size of the buckets, motivation, and possibly outdoor conditions may be less salient. The implications for future interventions surrounding outdoor composting are to consider lifestyle research, such as that surrounding the importance of understanding internal household dynamics for composting participation (Åberg et al, 1996), within the context of a larger external environment which can inhibit or support those existing lifestyles.

While the interpretation of results and solutions provided is somewhat speculative, it is supported not only by the qualitative findings on composting attitudes but also the two surprising findings that neither participation in indoor composting (compared to outdoor composting) nor a close proximity to the outdoor compost bins results in significantly higher waste reduction. Thus, the findings suggest that proximity alone is not the primary facet of participant's definition of 'convenience.' Indeed, McKenzie-Mohr and colleagues (1995) suggest 'inconvenience' actually includes a lack of resources, which ultimately results in a lack of participation. In the present study, the 'lack of resources' extends beyond composting supplies to environmental support systems. Lastly, although Edgerton and colleagues (2009) did not find *social norms* or *social diffusion* to be associated with household composting participation, there may be merit in future studies surrounding the influence of social networks of individuals on composting participation as information may be more easily shared among individuals and families who compost with the same apartment complex, particularly if outdoor compost bins are place in a centralized or other salient location.

Overall, outdoor composting attitudes are somewhere ‘in the middle’ of the stronger attitudes towards indoor composting and off site food scraps recycling. In regard to internal factors, participants feel a personal ‘bond’ with both outdoor composting and indoor composting, but not off-site food scraps recycling, as well as a feeling that they are taking care of the earth for both outdoor composting and off-site food scraps recycling yet not necessarily with indoor composting. The reason may be due to the lack of technology associated with outdoor composting—it feels more ‘natural,’ as one participant mentioned. Indoor composting uses electricity and off-site food scraps recycling required some mode of transportation yet outdoor composting exposes participants to the outdoors and the process is more ‘hands-on.’ While exposure to nature may have benefits, *outdoor conditions* were also considered one of the major limitations of outdoor composting. The results suggest outdoor composting has the potential to compliment indoor composting as a strategy for apartment composting success. Specifically, issues with odor and noise found with the indoor composter do not exist for outdoor composting. Yet, indoor composting is convenient where as outdoor composting is not. That being said, outdoor composting requires less resources, including overall economic and environmental impact cost, than either indoor composting or off-site food scraps recycling yet results in relatively high positive attitudes as well waste reduction that is significantly higher than off site food scraps recycling and comparably to indoor composting. Thus, encouraging participation in outdoor composting over other types of composting may be warranted.

In summary, while attitudes for outdoor composting were the most balanced of the three composting types in regard to overall favorability as well as being shaped by both internal and external factors; however, it was limited by external environmental factors. By considering the environmental context in which outdoor composting takes place, as well as lifestyle factors such as internal household dynamics, strategies that aim to increase outdoor composting participation may be more successful. Lastly, outdoor composting may be used in conjunction with other types of composting in order to balance the internal and external factors that shape attitudes about outdoor composting.

Off-Site Food Scraps Recycling. Off-site food scraps recycling is the least favored of all composting types and as a result has the lowest levels of participation and overall comments. Participants indicated their participation was severely limited by both of the external environmental factors of inconvenience and lack of resources; however, 'lack of resources' may be the fundamental limitation. Off-site food scraps recycling had a comparably high number of negative attitudes associated with 'inconvenience' as outdoor composting yet significantly lower levels of participation. In addition, 'lack of resources' was not indicated as a limitation for outdoor composting yet was the other primary limitation expressed for off-site food scraps recycling. Although it is difficult to decipher what a participant defines as 'inconvenient,' it seems the perceived 'inconvenience' of off-site food scraps recycling limited participation more than the 'inconvenience' of outdoor composting because off-site food scraps recycling includes a lack of resources. As mentioned earlier, McKenzie-Mohr and colleagues (1995) suggest inconvenience includes a lack of resources, which inhibits participation in composting. Further, qualitative comments suggest the 'lack of resources' that accompany off-site food scraps recycling are multi-faceted and extend beyond supplies to transportation availability and the hours of operation for drop-off sites. In addition, the most limiting internal factor was 'perceived lack of time,' which was not mentioned for either of the other two composting types. Thus, off-site food scraps recycling is perceived as more 'inconvenient' than outdoor composting despite a comparable number of negative comments that directly refer to the issue of convenience.

Further, although a personal vehicle is not required for participation in off-site food scraps recycling, participants believe carrying food scraps while walking or taking public transportation to one of many drop-off sites is unacceptable and therefore did not participate. Interestingly, some participants who did have personal transportation available indicated off-site food scraps recycling as convenient, especially if a drop off site was at an existing destination. The broader implications of the findings may be that off-site food scraps recycling is less practical than indoor or outdoor composting in areas where residents may not have access to personal transportation, such as the college campus in which the study took place, and yet the strategic placement of drop-off sites may encourage participation for those with personal transportation. Similarly, while no prior research exists on off-site food scraps recycling, it is important to note the findings, which stem from the attitudes of apartment households, are not necessarily generalizeable to either other apartment complexes or to single-family dwellings. For example, off-site food scraps recycling may a viable option for apartment complexes that do not have outdoor garden or outdoor space in which to place outdoor compost bins or a large amount of finished compost because off-site food scraps recycling requires the least amount of technical equipment resources of all composting types Yet, most single-family households have adequate outdoor space and therefore outdoor composting may be more appropriate.

The highest favorable attitudes for off-site food scraps recycling stem from an internal factor. Specifically, the positive feeling participants have from caring for the earth, which may be akin to feelings of intrinsic satisfaction. However, a number of the comments were actually speculative as many did not actually participate in off-site food scraps recycling. Thus, a valid comparison between each of the three composting types for positive attitudes surrounding ‘earth care’ cannot be made.

In summary, off-site food scraps recycling is the least favored method of composting for residents and thus has the lowest rates of participation. Despite accepting the widest range of compostable materials, requiring the lowest amount of technical knowledge and resources, off-site food scraps recycling was more limited by external environmental factors than any of the three composting types—specifically, a lack of environmental resources. Lastly, food scraps recycling has the potential to be favored by apartment complexes or households who do not have personal spatial resources yet have personal transportation resources.

Strengths of Study

The present study is one of only two longitudinal intervention designs identified in previous household composting literature. The experimental intervention design has strong internal validity and is first to use a within-subjects methodology, to compare types of composting beyond traditional outdoor composting, and to take place in the United States. The study is also the first to use apartment rather than single-family households as the unit of analysis. Lastly, the study design not only uses principles of behavioral economics and environmental psychology but also uses a combination of quantitative and qualitative analysis to examine the underlying reasons for the behavioral outcomes and organize them into categories of demographic, internal, and external factors based suggestions of Kollmuss and Agyeman (2002). That being said, the primary strength of the study is the environmental psychology approach. Specifically, the problem of food waste is approached with the aim of identifying external factors that affect behavior in order to provide recommendations for future designs that may be 'designed-in' to environments as well as technologies and educational programs to support composting.

Limitations of Study

The primary limitations of this study stem from threats to external validity and include: 1) the restricted timeframe, 2) the small sample size, 3) the restricted setting and sample population, and 4) the nature of the intervention design. First, due to the restricted timeframe, namely the lack of adequate time to develop a persistent composting routine, it is not clear if the participants are still composting or will continue to compost in the future. It is clear that one of the 27 households plans to continue with indoor composting, but not clear if other households plan to continue with outdoor composting or off-site food scraps recycling. The importance of this limitation cannot be overstated as persistence, not initiation, is the true indicator of pro-environmental program success (Vining & Ebreo, 1992) and essential for the sustainability of our planet. Thus, the results are only indicative of short term household composting participation and cannot necessarily be generalized to long-term participation. Second, the sample of 27 households, while largely sufficient for qualitative analysis, may have sufficient statistical power to have affected the results of the moderating variables in the quantitative analysis by over or under-estimating effects. Third, the study results may not generalize to contexts beyond the setting and participants of the present study. Specifically, the study took place in an apartment complex with a garden and adequate outdoor space in which to place compost bins, has relatively small apartment sizes, restricts the number of occupants and presents of pets, and all of the participants are highly educated and part of a larger college campus community. Additionally, results may not generalize to households with older children. Lastly, all of the interpretations are based on composting behaviors that were influenced by the study intervention and would not have occurred naturally such as the provided maintenance of the outdoor compost bins, supply of composting materials such as leaves and wood pellets, education and direct help support as well as the direct feedback resulting from the recording of waste weights, weekly reminders to log trash weights and monthly composting-related surveys. While the ultimate goal of the research is to inform broader design applications and educational programs, the limitations of the study may largely restrict a broad application of the findings.

Future Research

While the current study provides insight into the effects of different apartment household lifestyles on participation in different composting types, future research is needed to address the limitations of the intervention design with a basis in practical application. For example, the study design originated from the idea that indoor compost bins could be 'designed-in' to apartment kitchens, as are appliances such as microwaves, stoves and dishwashers to encourage composting participation through environmental psychology and behavioral economic principles of salience, proximity and convenience. However, the bins are prohibitively expensive for many apartment complexes to purchase on a large scale and no evidence existed to suggest the cost would be justified. As a result, the study was conducted and results suggest the cost is not justified as use of indoor compost bins do not result in greater waste reduction than the use of outdoor compost bins for the majority of households. That being said, at Hasbrouck apartments the outdoor compost bins have existed for many years yet only one household in 338 was known to be using the bins on a regular basis to compost food scraps as the majority of households indicated they were not aware of the existence of either the bins or even the garden. The anecdote suggests a practical application-based study would be justified that, for example, installed outdoor compost bins at various locations in one or more apartment complexes and covertly tracked and compared the bins for use. In addition, food scrap buckets and educational information should be accessible to residents, who are not aware research is being conducted. After a sufficient amount of time, qualitative interviews could be conducted with residents to decipher the demographic and internal and external influences driving the decisions of those who took up composting and those who did not. The additional research would also ideally provide insight into the perplexing findings of the current study regarding proximity. Lastly, additional data which was overlooked in this study could be collected such as the number of participants with personal transportation, how each household disposed of or used any compost produced, in which type of composting was any previous experience, and the age of the children within each household.

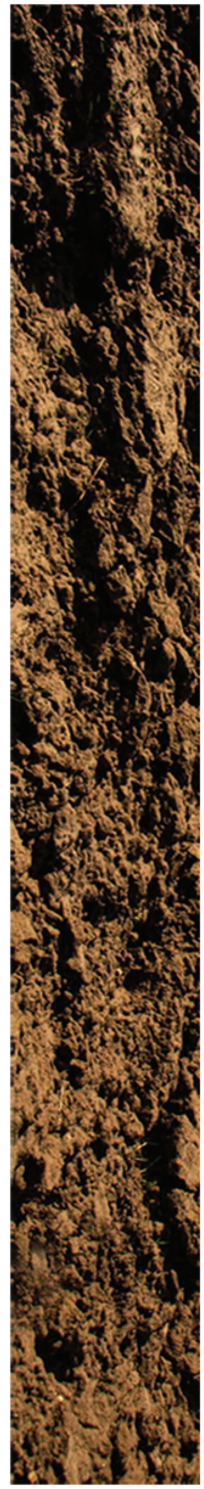
Conclusion

The growing environmental problem of waste management can be addressed in part through widespread household waste management, specifically source reduction and soil conservation through composting. However, the solution to the problem is complex and driven by factors beyond a general desire to care for the natural environment. The results of this study offer insights into understanding some of the factors that drive participation in composting, which can then be used by designers, authorities, and educators to inform targeted environmental, technical, and educational interventions aimed at shifting food waste from an environmental problem to an environmental solution.

APPENDIX I
RECRUITMENT
Wave 1

INTERESTED IN COMPOSTING?

JOIN A RESEARCH STUDY!



WHY?

LEARN to compost! receive education & materials

get FREE stuff! composting supplies, digital hanging scale and cash drawing entry

make a DIFFERENCE! add to a knowledge base used to promote sustainable household initiatives

WHAT?

Compare the use of an indoor electronic to outdoor bin

WHO?

Hasbrouck residents over 18 with good written & spoken English skills & not currently composting at home

WHEN?

September - mid December 2012

HOW?

1. rotate use of compost bins
2. weigh your trash bags
3. complete web surveys

OR

1. complete web surveys only

SIGN UP!

AUGUST 21: Hasbrouck welcome event

AUGUST 30, 6-7PM: Hasbrouck community center

QUESTIONS? contact Jen at jim55@cornell.edu

Recruitment flyer

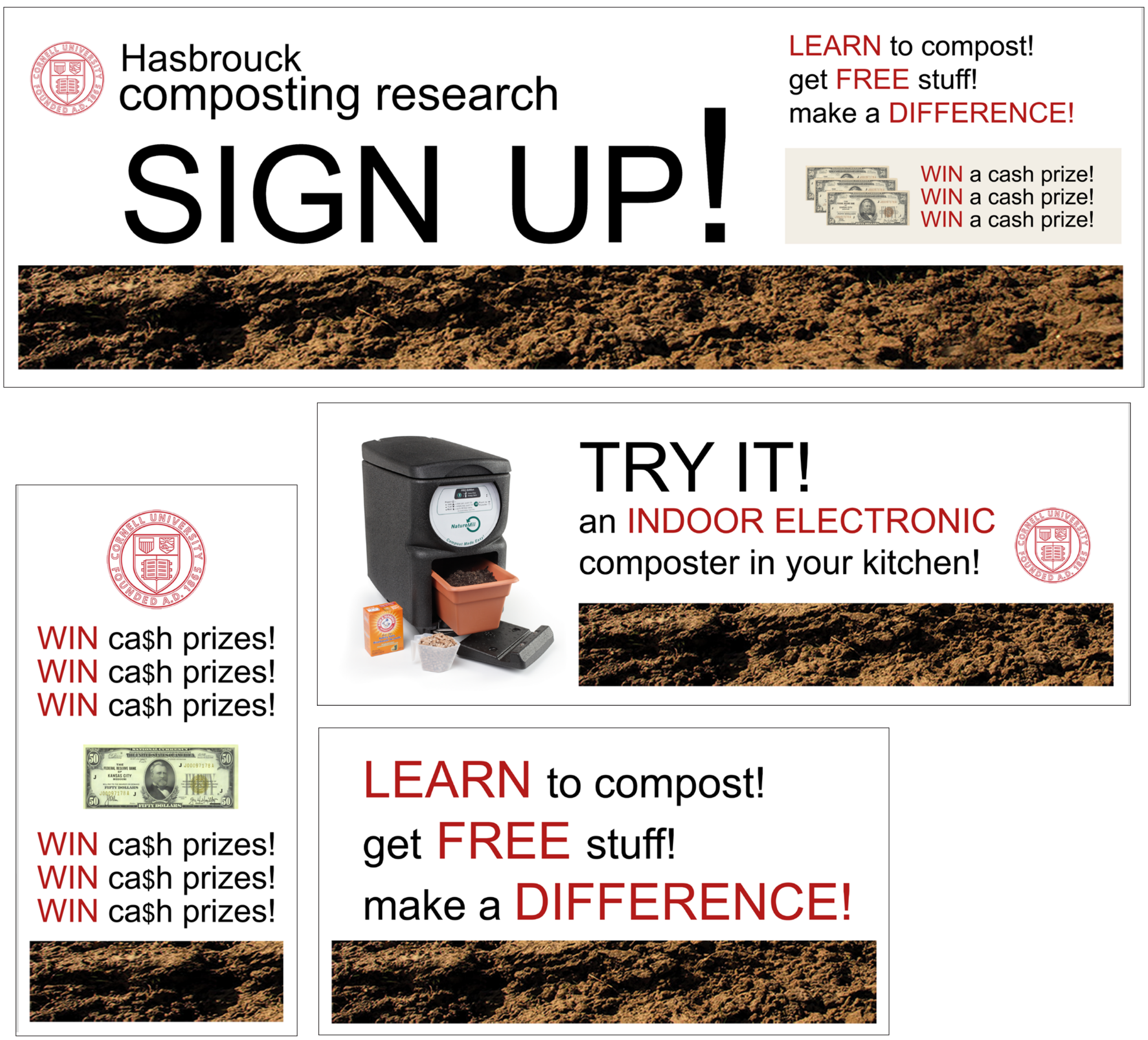
Subject line: Interested in composting?

Hello Hasbrouck resident,
My name is Jen Mackall and I am a Cornell graduate student conducting research on composting activities at Hasbrouck. I invite you to join my study, detailed in the attached flyer. The information gained from this research may be used to inform future sustainability initiatives.

I will be demonstrating the study activities and materials, including an indoor electronic composter, at the upcoming Hasbrouck Welcome Event on August 21. I look forward to meeting you there!

Jen

Recruitment email sample



Recruitment posters, Hasbrouck Welcome Event

Recruitment photos, Hasbrouck Welcome Event

Recruitment child's activity, Hasbrouck Welcome Event

Recruitment child’s activity, Hasbrouck Community Center
photos adapted from Elffert & Freymann (2007)

INFORMED CONSENT
Hasbrouck Composting Study

Researcher Information:
The information gained from this study will be used for the master's thesis research of:

Jen Mackall
Dept. of Design & Environmental Analysis
MVR Hall, Cornell University
jim55@cornell.edu, 937.206.6701

Background:
The purpose of this research is to compare two methods of composting, indoor and outdoor.

Study Procedure:
You will be randomly assigned to participate in one of two group options. Your total estimated time commitment if placed in Group A is 3.5 hours, in addition to composting time, and 30 minutes if placed in Group B. The study length is 14 weeks and is divided into five phases. A summary of tasks for each phase and group are listed below.

Group A:

1. Introduction Phase (Aug. 30):
    a. Complete online Environmental Survey: 15 minutes
2. Baseline Phase (Sept. 2-Sept. 15): You will not yet be composting in this phase.
    a. Weigh and record each bag of trash your household produces: 1-2 minutes/ bag
    b. Transfer measurements weekly to an online form: 5 minutes/ week
    c. Attend Composting Learning Session on Sept 13: 30 minutes
    d. Indoor composter training and installation, if applicable: 15 minutes
3. Composting Phase 1 (Sept. 16-Oct 13): You will do one of the following a-c:
    a. Indoor Composting:
        i. Use the provided indoor electronic composter
        ii. Continue to weigh & record your trash weight
    b. Outdoor Composting:
        i. Gather food scraps and empty in outdoor garden compost bins
        ii. Continue to weigh & record your trash weight
    c. No Composting:
        i. Continue to weigh & record your trash weight
    d. Complete online Composting Survey: 5 minutes
4. Composting Phase 2 (Oct. 14-Nov. 10):
    a. Same as Composting Phase 1
    b. Composter exchange/training/installation, if applicable: 5-15 minutes
5. Composting Phase 3 (Nov. 11-Dec. 8):
    a. Same as Composting Phase 1
    b. Complete online Environmental Survey: 15 minutes
    c. Composter collection, if applicable: 5 minutes

Group B:

1. Introduction Phase (Aug. 30):
    a. Complete online Environmental Survey: 15 minutes
2. Composting Phase 3 (Dec. 8):
    a. Complete online Environmental Survey: 15 minutes

Costs: None.

Informed consent form, Wave 1

Benefits & Compensation:
For your participation in group A of this study you will receive:

1. Education and training materials about composting
2. A kitchen food scrap jar for use with outdoor composting
3. An SR-Series Digital Hanging Scale by American Weigh Scales, Inc.
4. The opportunity to purchase one of the used indoor composters for a discounted cost

For your participation in group A or B of this study you will receive:

1. Entry in a drawing to win one of four $50 Visa Cash cards

Risks:
The risks of this study are no greater than those faced by everyday life. You will be asked to disclose household activity, ecological and waste management-related behavior information and may be asked to use an electronic composter and scale. Contact the researcher with questions or concerns.

Confidentiality:
For the purposes of this research your responses and information will be confidential but not anonymous unless you request that they be which you can do at any time. Efforts to preserve confidentiality include:

1. Assignment of an identification (ID) number for use on all surveys and materials.
2. Identifying information will be kept in a pass-code protected digital file and/or locked file cabinet, to be destroyed upon study completion.
3. Only the researcher and her committee members will review the collected data, which will be used solely for the purpose of this study and any publications that may result from this study. Any final publication will not contain identifying information.
4. You may request a copy of your completed surveys.
5. Participant data will be kept confidential except in cases where the researcher is legally obligated to report specific incidents (e.g. abuse, suicide risk).

Institutional Review Board:
All surveys and informational materials were reviewed and approved by Cornell's Institutional Review Board (IRB). If you have questions or concerns regarding your rights as a participant in this study, or if problems arise that you feel you cannot discuss with the researcher, you may contact the Cornell IRB at 607.222.5128 or access their website at http://www.irb.cornell.edu. You may also report concerns or complaints anonymously through EthicsPoint or toll free at 1.866.293.3077.

Voluntary Participation:
Your participation in this study is voluntary. If you decide to participate, you will be asked to sign this consent form but can withdraw from the study at any time and without giving a reason. You are free to not answer any or all questions or participate in any or all activities if you choose.

Consent:
By signing this consent form, I confirm that I have read and understood the information and have had the opportunity to ask questions. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving a reason and without cost. I understand that I will be given a copy of this consent form. I voluntarily agree to take part in this study.

Signature ____ Date __________________

Informed consent form, Wave 1

Please answer the following questions.

1. Are you over 18 years of age? Y / N
2. Are you currently composting at home? Y / N
3. How would you rate your current level of <u>spoken</u> English fluency?

   Very good   Good   Fair   Poor   Very Poor

4. How would you rate your current level of <u>written</u> English fluency?

   Very good   Good   Fair   Poor   Very Poor

Please fill in the following information.

Name: ________________________________

Email: ________________________________

Phone #: ______________________________

Hasbrouck apartment #: _________________

ID#: ______

Contact / eligibility form

RECRUITMENT
Wave 2

GO GREEN Hasbrouck!

take part in a fall semester pilot study to reduce waste!

WHY JOIN?

GO GREEN! **did you know?** food doesn't break down in landfills but instead rots, producing methane, a gas *21x the global warming potential of carbon dioxide!*

Get FREE stuff! get a free kitchen food scrap jar, measurement scale, education & temporary use of a fancy electronic composter! Check it out: www.naturemill.com

Win CASH! get entry to **win up to $200** in cash cards *plus 2 more entries* for each friend you get to sign up!

NO smell! food in the trash smells because it rots but composting turns it to soil instead. compost = less trash!

Plants ❤ compost! use to grow your plants strong!

WHEN: fall 2012 semester
sign up deadline is **September 12**

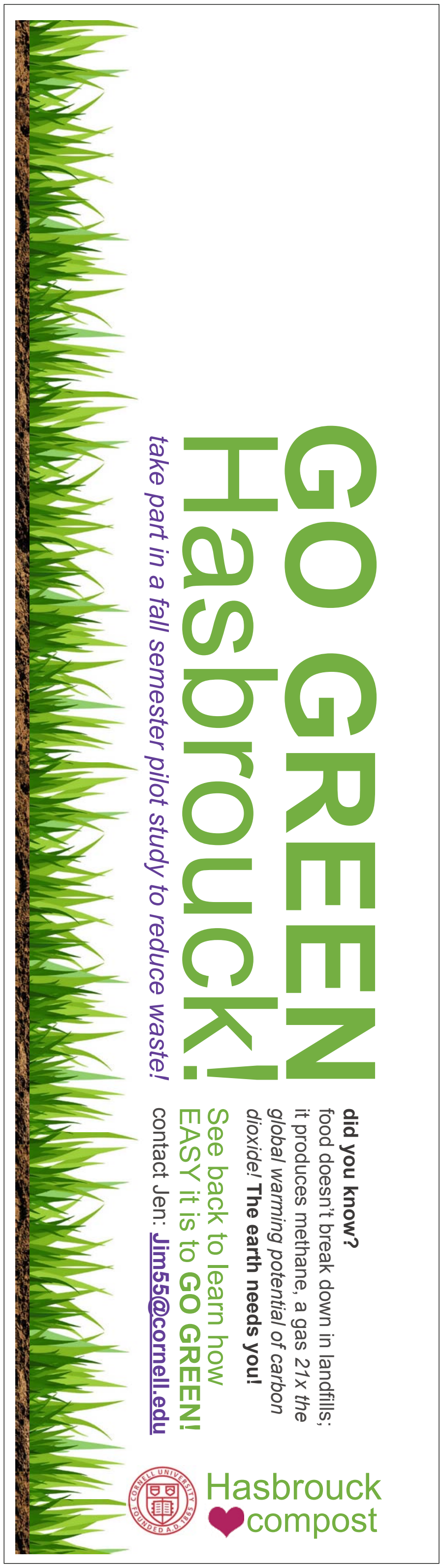
check it out!
materials display in the community center lobby!

HOW: it's EASY!
we provide everything!

1. try 2 different compost bins
2. weigh your trash bags
3. complete online surveys

INTERESTED?
contact Jen at **Jim55@cornell.edu**
MS in Human-Environment Relations
Dept. of Design & Environmental Analysis, Cornell University

Recruitment flyer



front

back

Recruitment door hanger

Recruitment display materials, Hasbrouck Community Center

Recruitment display photos, Hasbrouck Community Center

Subject line: Help Hasbrouck GO GREEN!

Help your Hasbrouck community GO GREEN this semester by reducing waste (not to mention help out a fellow graduate student with her thesis!). Check it out:

WHY JOIN?

SAVE the environment! Help ensure the planet is a healthy place to live now, for your children & future generations by reducing landfill waste. **Did you know?** Food doesn't break down in landfills but instead rots and produces methane, a gas with **21x the global warming potential of carbon dioxide!!**

Get FREE supplies & win CASH! You will get a free food scrap jar, measurement scale & informational materials as well as entry to win up to $200 in cash cards. You get to try out a fancy electronic gizmo in your kitchen for one month, see if you like it & have the option of purchasing it for LESS THAN HALF the cost at the end of the study. Check it out: http://www.naturemill.com

It's EASY (really)! Composting in your kitchen takes no more time than throwing food in the trash. And, you already take your bags of trash out to the dumpster often right? It only takes a few extra seconds to weigh that bag & record the weight. You can complete all surveys online at your convenience and I deliver all supplies right to your door!

No smell! When you throw food in your trash can it smells bad because it starts to rot. When you compost it correctly, it turns to soil instead. You will learn how to compost correctly so may be able to take your trash out less often because it won't smell!

Plants LOVE compost! Compost is mineral-rich soil you can sprinkle on your plants to help them grow (also called "black gold" for gardeners)! The indoor composter can produce compost in as little as *2 weeks*!

The sign-up deadline is Thursday, September 12. If you are interested just shoot me an email at jim55@cornell.edu or sign up at the Community Center lobby table display. I will stop by your apartment sometime next week to deliver your supplies.

Enjoy your day!
Jen Mackall
Candidate for MS in Human-Environment Relations
Department of Design & Environmental Analysis
Cornell University

Recruitment email sample

INFORMED CONSENT
Hasbrouck Composting Study

Researcher Information:
The information gained from this study will be used for the master's thesis research of:
Jen Mackall
Dept. of Design & Environmental Analysis
MVR Hall, Cornell University
jim55@cornell.edu, 937.206.6701

Background:
The purpose of this research is to compare two methods of composting, indoor and outdoor.

Study Procedure:
Your total estimated time commitment is 3.5 hours in addition to composting time. The study length is 11 weeks and is divided into four phases. A summary of tasks for each phase are listed below.

1. Baseline Phase (Sept. 23-Oct 6): You will not yet be composting in this phase.
    a. Complete online Environmental Survey: 15 minutes
    b. Weigh and record each bag of trash your household produces: 1-2 minutes/ bag
    c. Transfer weights weekly to an online form: 5 minutes/ week
    d. Attend Composting Learning Session: 30 minutes
    e. Indoor composter training and installation, if applicable: 15 minutes
2. Composting Phase 1 (Oct 7-Oct 27): You will do one of the following a-c:
    a. Indoor Composting:
        i. Use the provided indoor electronic composter
        ii. Continue to weigh & record your trash weight
    b. Outdoor Composting:
        i. Gather food scraps and empty in outdoor garden compost bins
        ii. Continue to weigh & record your trash weight
    c. Off-site Composting:
        i. Option of not composting or taking food scraps off-site to a recycling center
        ii. Continue to weigh & record your trash weight
    d. Complete online Composting Survey: 5 minutes
3. Composting Phase 2 (Oct. 28-Nov. 17):
    a. Same as Composting Phase 1
    b. Composter exchange/training/installation, if applicable: 5-15 minutes
4. Composting Phase 3 (Nov. 18-Dec. 8):
    a. Same as Composting Phase 1
    b. Complete online Environmental Survey: 15 minutes
    c. Composter collection, if applicable: 5 minutes

Costs: None.

Benefits & Compensation:
For your participation in this study you will receive:
1. Education and training materials about composting
2. A kitchen food scrap jar for use with outdoor composting
3. An SR-Series Digital Hanging Scale by American Weigh Scales, Inc.
4. The opportunity to purchase one of the used indoor composters for a discounted cost
5. Entry in a drawing to win one of four $50 Visa Cash cards

Informed consent form, Wave 2

INFORMED CONSENT
Hasbrouck Composting Study

Risks:
The risks of this study are no greater than those faced by everyday life. You will be asked to disclose household activity, ecological and waste management-related behavior information and may be asked to use an electronic composter and scale. Contact the researcher with questions or concerns.

Confidentiality:
For the purposes of this research your responses and information will be confidential but not anonymous unless you request that they be which you can do at any time. Efforts to preserve confidentiality include:

1. Assignment of an identification (ID) number for use on all surveys and materials.
2. Identifying information will be kept in a pass-code protected digital file and/or locked file cabinet, to be destroyed upon study completion.
3. Only the researcher and her committee members will review the collected data, which will be used solely for the purpose of this study and any publications that may result from this study. Any final publication will not contain identifying information.
4. You may request a copy of your completed surveys.
5. Participant data will be kept confidential except in cases where the researcher is legally obligated to report specific incidents (e.g. abuse, suicide risk).

Institutional Review Board:
All surveys and informational materials were reviewed and approved by Cornell's Institutional Review Board (IRB). If you have questions or concerns regarding your rights as a participant in this study, or if problems arise that you feel you cannot discuss with the researcher, you may contact the Cornell IRB at 607.222.5128 or access their website at http://www.irb.cornell.edu. You may also report concerns or complaints anonymously through EthicsPoint or toll free at 1.866.293.3077.

Voluntary Participation:
Your participation in this study is voluntary. If you decide to participate, you will be asked to sign this consent form but can withdraw from the study at any time and without giving a reason. You are free to not answer any or all questions or participate in any or all activities if you choose.

Consent:
By signing this consent form, I confirm that I have read and understood the information and have had the opportunity to ask questions. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving a reason and without cost. I understand that I will be given a copy of this consent form. I voluntarily agree to take part in this study.

Signature ____ Date __________________

Informed consent form, Wave 2

APPENDIX II
DATA COLLECTION

Q1.1 Each participant in the Hasbrouck Composting Study should complete this survey. The survey includes multiple choice and fill-in-the-blank questions and should take less than 15 minutes to complete. The survey is being conducted by Jen Mackall of Cornell University. Thank you for volunteering to participate in this survey!

Q2.1 Please enter your unique ID number assigned for the Composting Study.

Q3.1 How often have you composted kitchen food scraps in the past?
- ❍ Never
- ❍ Rarely
- ❍ Sometimes
- ❍ Quite Often
- ❍ Very Often

Q3.2 Please state how much you agree or disagree with the following statements regarding kitchen food scrap composting.

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
I am knowledgeable about composting	❍	❍	❍	❍	❍
I am interested in composting	❍	❍	❍	❍	❍
Composting takes up a lot of time	❍	❍	❍	❍	❍
Composting takes a lot of effort	❍	❍	❍	❍	❍
Composting requires a lot of technical knowledge	❍	❍	❍	❍	❍
Composting requires a lot of space	❍	❍	❍	❍	❍
Composting is not worthwhile unless there is a lot of waste	❍	❍	❍	❍	❍
Composting bins attract flies and vermin	❍	❍	❍	❍	❍
Compost bins are unsightly	❍	❍	❍	❍	❍

Environmental Survey

Q4.1 Please state how much you agree or disagree with the following statements.

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
We are approaching the limit of the number of people the earth can support	❍	❍	❍	❍	❍
Humans have the right to modify the natural environment to suit their needs	❍	❍	❍	❍	❍
When humans interfere with nature it often produces disastrous consequences	❍	❍	❍	❍	❍
Human ingenuity will ensure that we do NOT make the earth unlivable	❍	❍	❍	❍	❍
Humans are severely abusing the environment	❍	❍	❍	❍	❍
The earth has plenty of natural resources if we just learn how to develop them	❍	❍	❍	❍	❍
Plants and animals have as much right as humans to exist	❍	❍	❍	❍	❍
The balance of nature is strong enough to cope with the impacts of	❍	❍	❍	❍	❍

modern industrial nations					
Despite our special abilities humans are still subject to the laws of nature	❍	❍	❍	❍	❍
The so-called "ecological crisis" facing humankind has been greatly exaggerated	❍	❍	❍	❍	❍
The earth is like a spaceship with very limited room and resources	❍	❍	❍	❍	❍
Humans were never meant to rule over the rest of nature	❍	❍	❍	❍	❍
The balance of nature is very delicate and easily upset	❍	❍	❍	❍	❍
Humans will eventually learn enough about how nature works to be able to control it	❍	❍	❍	❍	❍
If things continue on their present course, we will soon experience a major ecological catastrophe	❍	❍	❍	❍	❍

Q5.1 Please answer yes or no to the following questions.

	Yes	No
Sometimes I give change to panhandlers	❍	❍
From time to time I contribute money to charity	❍	❍
If an elderly or disabled person enters a crowded bus or subway, I offer him or her my seat	❍	❍
If I were an employer, I would consider hiring a person previously convicted of a crime	❍	❍
In fast-food restaurants, I usually leave the tray on the table	❍	❍
If a friend or relative had to stay in the hospital for a week or two for minor surgery (e.g., appendix, broken leg), I would visit him or her	❍	❍
Sometimes I ride public transportation without paying a fare	❍	❍
I would feel uncomfortable if people of a different ethnicity lived in the apartment next door	❍	❍
I put dead batteries in the garbage	❍	❍
After meals, I dispose of leftovers in the toilet	❍	❍
I bring unused medicine back to the pharmacy	❍	❍
I collect and recycle used paper	❍	❍
I bring empty bottles to a recycling bin	❍	❍
I prefer to shower rather than take a bath	❍	❍
In the winter, I keep the heat on so that I do not have to wear a sweater	❍	❍
I wait until I have a full load before I do laundry	❍	❍
In the winter, I leave the windows open for long periods	❍	❍

of time to let in fresh air		
I wash dirty clothes without prewashing	❍	❍
I use fabric softener in my laundry	❍	❍
I use an oven-cleaning spray to clean my oven	❍	❍
If there are insects in my apartment, I kill them with a chemical insecticide	❍	❍
I use a chemical air freshener in my bathroom	❍	❍
I use chemical toilet cleaners	❍	❍
I use a cleaner especially made for bathrooms, rather than an all-purpose cleaner	❍	❍
I use phosphate-free laundry detergent	❍	❍
Sometimes I buy beverages in cans	❍	❍
In supermarkets, I usually buy fruits and vegetables from the open bins	❍	❍
If I am offered a plastic bag in a store, I will always take it	❍	❍
For shopping, I prefer paper bags to plastic ones	❍	❍
I usually buy milk in returnable bottles	❍	❍
I often talk with friends about problems with the environment	❍	❍
I am a member of an environmental organization	❍	❍
In the past, I have pointed out to someone his or her unecological behavior	❍	❍
I sometimes contribute financially to environmental organizations	❍	❍
I do not know whether I can use leaded gas in my automobile	❍	❍
Usually, I do not drive my automobile in the city	❍	❍
I usually drive on freeways at speeds under 60 mph	❍	❍

Environmental Survey

When possible in nearby areas (around 20 miles) I use public transportation or ride a bike	❍	❍
I let the water run for a time to reach the right temperature	❍	❍
I take my own coffee cup to work or school	❍	❍
I reuse my shopping bags	❍	❍
I walk, ride a bicycle, or take public transportation to work or school	❍	❍
I give way to others, rather than cutting them off	❍	❍
I like ordering take-out from restaurants	❍	❍
I use rechargeable batteries	❍	❍
The heater for my house is shut off late at night	❍	❍
I buy organic vegetables	❍	❍
If possible, I do not insist on my right of way and make the traffic stop before entering a crosswalk	❍	❍
I use a compost bin	❍	❍

Q6.1 How long have you lived in Hasbrouck apartments?
❍ Less than 1 month
❍ Less than 1 year
❍ 1 year
❍ 2 - 5 years
❍ More than 5 years

Q6.2 Which best describes your current household?
❍ Young adult(s), no kids
❍ Family with young child/ children
❍ Family with older child/ children
❍ Family with child/ children who left home
❍ Retired

Q6.3 How many people live in your household?
- ❍ I live alone
- ❍ 2
- ❍ 3
- ❍ 4
- ❍ 5

Answer If How many people live in your household? I live alone Is Not Selected

Q6.4 Who else lives with you? Check all that apply.
- ❑ Significant other
- ❑ Family member (for example: parent, sibling)
- ❑ Child
- ❑ Roommate

Q7.1 Are you a current Cornell student?
- ❍ Yes
- ❍ No

Answer If Are you a current Cornell student? Yes Is Selected

Q7.2 In which unit at Cornell are you currently enrolled?
- ❍ College of Agriculture and Life Sciences
- ❍ College of Architecture, Art, and Planning
- ❍ College of Arts and Sciences
- ❍ Faculty of Computing and Information Science
- ❍ College of Engineering
- ❍ Cornell Institute for Public Affairs
- ❍ School of Hotel Administration
- ❍ College of Human Ecology
- ❍ New York State School of Industrial and Labor Relations
- ❍ Johnson Graduate School of Management
- ❍ Law School
- ❍ Department of Military Science
- ❍ College of Veterinary Medicine
- ❍ Other

Answer If Are you a current Cornell student? No Is Selected

Q7.3 What is your current occupation?

Q7.4 What is the highest degree or level of school you have completed?
- ❍ 8th grade or less
- ❍ High school
- ❍ Associate degree
- ❍ Bachelor's degree
- ❍ Master's degree
- ❍ Professional degree (for example: MD, DDS, DVM, LLB, JD)
- ❍ Doctorate degree

Q8.1 Please specify your gender.
- ❍ Male
- ❍ Female

Q8.2 Please specify your age, in years.

Q8.3 Please specify your race.
- ❍ Caucasian
- ❍ African American
- ❍ Native American
- ❍ Asian
- ❍ Hispanic
- ❍ Middle Eastern
- ❍ Indian
- ❍ Pacific Islander
- ❍ Mediterranean
- ❍ Other
- ❍ Prefer not to answer

Q8.4 What is your total household income?
- ❍ Less than $10,000
- ❍ $10,000 to $29,999
- ❍ $30,000 to $49,999
- ❍ $50,000 to $69,999
- ❍ $70,000 to $89,999
- ❍ $90,000 to $109,999
- ❍ $110,000 to $149,999
- ❍ $150,000 or more
- ❍ Prefer not to answer

Q9.1 If you have any questions or concerns regarding this survey, please contact Jen at jim55@cornell.edu. Please click the arrow to record your answers.

Q1.1 Each participant in the Hasbrouck Composting Study should complete this survey. The survey includes multiple choice and fill-in-the-blank questions and should take 5 minutes or less to complete. The survey is being conducted by Jen Mackall of Cornell University. Thank you for volunteering to participate in this survey!

Q2.1 Please enter your unique ID number assigned for the Composting Study.

Q3.1 Over the past month, approximately how many days per week did you compost your kitchen food scraps?
- ❍ 0
- ❍ 1
- ❍ 2
- ❍ 3
- ❍ 4
- ❍ 5
- ❍ 6
- ❍ 7

Q3.2 Over the past month, approximately how many times per day did you compost your kitchen food scraps?
- ❍ 0
- ❍ 1
- ❍ 2
- ❍ 3
- ❍ 4
- ❍ 5 or more

Q3.3 Please describe any positive experiences with composting over the past month. If you did not compost over the past month, leave blank.

Q3.4 Please describe any negative experiences with composting over the past month. If you did not compost over the past month, leave blank.

Composting Survey

Q4.1 Please state how much you agree or disagree with the following statements regarding kitchen food scrap composting.

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
I am knowledgeable about composting	❍	❍	❍	❍	❍
I am interested in composting	❍	❍	❍	❍	❍
Composting takes up a lot of time	❍	❍	❍	❍	❍
Composting takes a lot of effort	❍	❍	❍	❍	❍
Composting requires a lot of technical knowledge	❍	❍	❍	❍	❍
Composting requires a lot of space	❍	❍	❍	❍	❍
Composting is not worthwhile unless there is a lot of waste	❍	❍	❍	❍	❍
Composting bins attract flies and vermin	❍	❍	❍	❍	❍
Compost bins are unsightly	❍	❍	❍	❍	❍

Q5.1 If you have any questions or concerns regarding this survey, please contact Jen at jim55@cornell.edu. Please click the arrow to record your answers.

Q1.1 One member of each household participating in the Hasbrouck Composting Study should complete this survey weekly. This survey includes a multiple choice and fill-in-the-blank questions and should take less than 5 minutes to complete. The survey is being conducted by Jen Mackall of Cornell University. Thank you for volunteering to participate in this survey!

Q2.1 Please enter your unique ID number assigned for the Composting Study.

Q3.1 Please select the week for which you will record trash weight.
- ❍ Week 1: Sept 2-Sept 8
- ❍ Week 2: Sept 9-Sept 15
- ❍ Week 3: Sept 16-Sept 22
- ❍ Week 4: Sept 23-Sept 29
- ❍ Week 5: Sept 30-Oct 6
- ❍ Week 6: Oct 7-Oct 13
- ❍ Week 7: Oct 14-Oct 20
- ❍ Week 8: Oct 21-Oct 27
- ❍ Week 9: Oct 28-Nov 3
- ❍ Week 10: Nov 4-Nov 10
- ❍ Week 11: Nov 11-Nov 17
- ❍ Week 12: Nov 18-Nov 24
- ❍ Week 13: Nov 25-Dec 1
- ❍ Week 14: Dec 2-Dec 8

Q3.2 Please record the weight of each trash bag in pounds (00.00 lbs) for each day this week you disposed of it in the dumpster. Weight measurements should be recorded exactly as shown on your Composting Study Schedule & Trash Log. For each day no trash was taken to the dumpster, a '0' will be recorded.

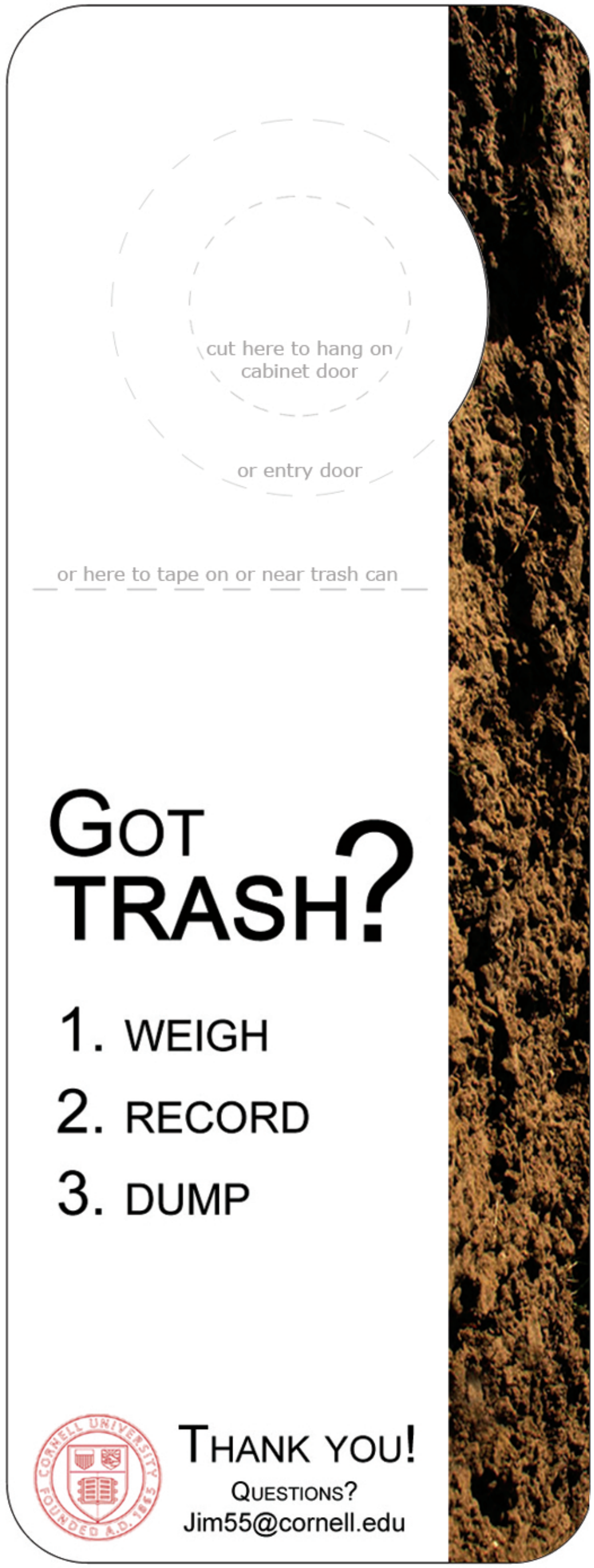
	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Current week:							

Q3.3 How typical was your household trash volume this week?
- ❍ Above typical volume
- ❍ Typical volume
- ❍ Below typical volume

Q3.4 If your trash volume this week was not typical, please explain why it was above or below typical volume.

Q4.1 If you have any questions or concerns regarding this trash record, contact Jen at Jim55@Cornell.edu. Please click the arrow to record your answers.

Trash Record



Trash log reminder door tag

Composting Study Schedule & Trash Log

Post/tape this chart to your kitchen refrigerator to log trash weight and guide you through the study process

Questions? Contact Jen at jim55@cornell.edu

Step 1. Saturday, Sept 1, 1) empty all trash in your household before recording any data for week 1
2) complete the *Environmental Survey* at https://cornell.qualtrics.com/SE/?SID=SV_4YkP0xMi5s445Fi

Step 2. Every day, for the next 14 weeks, record the weight of each trash bag in **00.00 lbs format**, just prior to dumpster disposal.

Step 3. Every Saturday, record weekly measurements on the *Trash Record* at https://cornell.qualtrics.com/SE/?SID=SV_4IoCv2icfSLOTE8
When finished, check the 'yes' box under the right-hand column labeled 'Recorded Online?' for that week.

Tear off sheet after completing each study phase

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	TOTAL	Recorded Online?
Week 11: Nov 11-Nov 17	11	12	13	14	15	16	17	. lbs	☐ yes
Week 12: Nov 18-Nov 24	18	19	20	21	22	23	24	. lbs	☐ yes
Week 13: Nov 25-Dec 1	25	26	27	28	29	30	1	. lbs	☐ yes
Week 14: Dec 2-Dec 8	2	3	4	5	6	7	*8	. lbs	☐ yes

***Step 9. Dec 8 evening**, 1) empty & record all trash in your household
2) complete the *Environmental Survey* at https://cornell.qualtrics.com/SE/?SID=SV_4YkP0xMi5s445Fi

Step 11. Finished! You will receive an email regarding prize drawing winners and pick-up/purchase of the indoor composters

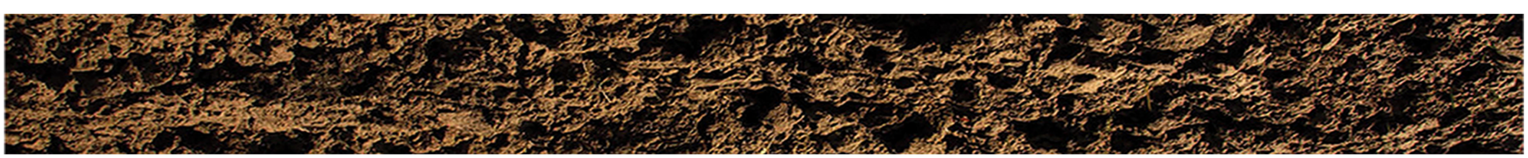
Notes:

unique ID#(s):

How to measure trash weight:

1. Tie the trash bag into a knot at the top
2. Push the 'on' button at the center of the scale
3. Insert scale hook into bag knot
4. Lift scale with attached bag with two hands so the bag is not touching the ground*
5. Continue to holding until scale screen reads "HOLD"
6. Record weight on Trash Log exactly as shown on screen, in 00.00lbs format
7. Remove scale from trash bag and re-place scale on fridge
8. Dispose of trash bag in dumpster

*Find help if bag is too heavy. If weight exceeds 44lbs, weigh in two separate bags then record total



Trash log, Wave 1

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	**TOTAL**	Recorded Online?
Week 1: Sept 2-Sept 8	2	3	4	5	6	7	8	. lbs	☐ yes
Week 2: Sept 9-Sept 15	9	10	11	12	**13	14	*15	. lbs	☐ yes

****Step 4. Sept 13 from 6pm-7pm**, attend the learning session in the Hasbrouck Garden & receive your composter
***Step 5. Sept 15 evening**, empty & record all trash in your household before moving on to week 3
Step 6. Sept 16 morning, begin using your new composter, if applicable
Note! Even if you do not receive a composter to use over the next 4 weeks, continue to log your trash weight

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	**TOTAL**	Recorded Online?
Week 3: Sept 16-Sept 22	16	17	18	19	20	21	22	. lbs	☐ yes
Week 4: Sept 23-Sept 29	23	24	25	26	27	28	29	. lbs	☐ yes
Week 5: Sept 30-Oct 6	30	1	2	3	4	5	6	. lbs	☐ yes
Week 6: Oct 7-Oct 13	7	8	9	10	11	12	*13	. lbs	☐ yes

***Step 7. Oct 13 evening,** 1) empty & record all trash in your household before moving on to week 7
2) complete the *Composting Survey* at https://cornell.qualtrics.com/SE/?SID=SV_7ZIwpRD52YWcSi0
Step 8. Oct 14, Jen will visit to exchange your composter. A time that works for you should be set up by Oct 11.

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	**TOTAL**	Recorded Online?
Week 7: Oct 14-Oct 20	14	15	16	17	18	19	20	. lbs	☐ yes
Week 8: Oct 21-Oct 27	21	22	23	24	25	26	27	. lbs	☐ yes
Week 9: Oct 28-Nov 3	28	29	30	31	1	2	3	. lbs	☐ yes
Week 10: Nov 4-Nov 10	4	5	6	7	8	9	*10	. lbs	☐ yes

***Step 9. Nov 10 evening**, 1) empty & record all trash in your household before moving on to week 11
2) complete the *Composting Survey* at https://cornell.qualtrics.com/SE/?SID=SV_7ZIwpRD52YWcSi0
Step 10. Nov 11, Jen will visit to exchange your composter. A time that works for you should be set up by Nov 8.

Trash log tear off pages, Wave 1

Composting Study Schedule & Trash Log

Post/tape this chart to your kitchen refrigerator to log trash weight and guide you through the study process

Questions? Contact Jen at jim55@cornell.edu

Step 1. Saturday, Sept 23, 1) empty all trash in your household before recording any trash weight for week 1
2) complete the online Environmental Survey

Step 2. Every day, for the next 11 weeks, record the weight of each trash bag in **00.00 lbs format**, just prior to dumpster disposal

Step 3. Every Saturday, one person in your household should transfer the current week's trash weights to the online Trash Record
When finished, check the 'yes' box under the right-hand column labeled 'Recorded Online?' for that week.

Tear off sheet after completing each study phase

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	**TOTAL**	Recorded Online?
Week 9: Nov 18-Nov 24	18	19	20	21	22	23	24	. lbs	☐ yes
Week 10: Nov 25-Dec 1	25	26	27	28	29	30	1	. lbs	☐ yes
Week 11: Dec 2-Dec 8	2	3	4	5	6	7	*8	. lbs	☐ yes

***Step 11. Dec 8 evening**, 1) empty & record all trash in your household
2) complete the online Environmental Survey

Step 12. Finished! You will receive an email regarding prize drawing winners and pick-up/purchase of the indoor composters

Notes:

____

unique ID#(s): ___________________________

____

____

____

____

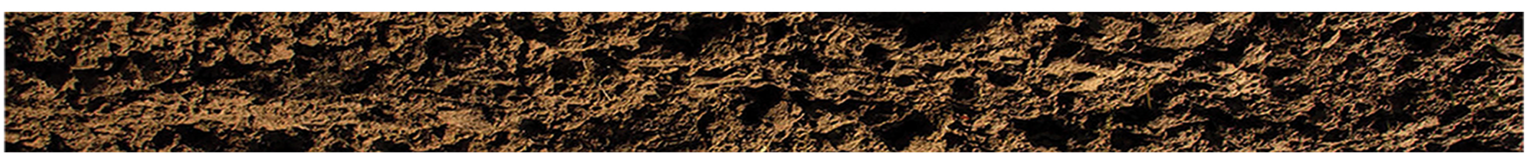
____

____

How to measure trash weight:

1. Tie the trash bag into a knot at the top
2. Push the 'on' button at the center of the scale
3. Insert scale hook into bag knot
4. Lift scale with attached bag with two hands so the bag is not touching the ground*
5. Continue to holding until scale screen reads "HOLD"
6. Record weight on Trash Log exactly as shown on screen, in 00.00lbs format
7. Remove scale from trash bag and re-place scale on fridge
8. Dispose of trash bag in dumpster

*Find help if bag is too heavy. If weight exceeds 44lbs, weigh in two separate bags then record total



Trash log, Wave 2

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	TOTAL	Recorded Online?
Week 1: Sept 23-Sept 29	23	24	25	26	27	28	29	. lbs	☐ yes
Week 2: Sept 30-Oct 6	30	1	2	3	4	5	*6	. lbs	☐ yes

Step 4. Oct 4 or 5 (date/time TBA), attend the learning session in the Hasbrouck Garden & receive your composter
***Step 5.Oct 6 evening**, empty & record all trash in your household before moving on to week 3
Step 6. Oct 7 morning, begin using your new composter, if applicable
Note! Even if you do not receive a composter to use over the next 3 weeks, continue to log your trash weight

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	TOTAL	Recorded Online?
Week 3: Oct 7- Oct 13	7	8	9	10	11	12	13	. lbs	☐ yes
Week 4: Oct 14- Oct 20	14	15	16	17	18	19	20	. lbs	☐ yes
Week 5: Oct 21-Oct 27	21	22	23	24	25	26	*27	. lbs	☐ yes

***Step 7. Oct 27 evening,** 1) empty & record all trash in your household before moving on to week 6
2) complete the online Composting Survey
Step 8. By Oct 28, Jen will visit to exchange your composter. A time that works for you should be set up by Oct 25

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	TOTAL	Recorded Online?
Week 6: Oct 28-Nov 3	28	29	30	31	1	2	3	. lbs	☐ yes
Week 7: Nov 4-Nov 10	4	5	6	7	8	9	10	. lbs	☐ yes
Week 8: Nov 11-Nov 17	11	12	13	14	15	16	*17	. lbs	☐ yes

***Step 9. Nov 17 evening**, 1) empty & record all trash in your household before moving on to week 9
2) complete the online Composting Survey
Step 10. By Nov 18, Jen will visit to exchange your composter. A time that works for you should be set up by Nov 15

Trash log tear off pages, Wave 2

APPENDIX III
EDUCATIONAL MATERIALS

Cornell Dining facilities:

- Trillium
- Ivy Room
- Martha’s Café
- Mattin’s Café
- Moosewood at Anabel Taylor
- Risley Dining
- Synapsis Café
- 104West!

In addition to these locations, Cornell collects post-consumer compostable waste at the following locations:

- Big Red Barn
- Okenshields
- Robert Purcell Marketplace Eatery
- North Star
- Cook House Dining Room
- Becker House Dining Room
- Jansen’s Dining Room in Hans Bethe House
- Keeton House Dining Room
- Rose House Dining Room

http://www.campuslife.cornell.edu/campuslife/dining/composting-at-cornell-faqs.cfm

Off-Campus drop-off sites:

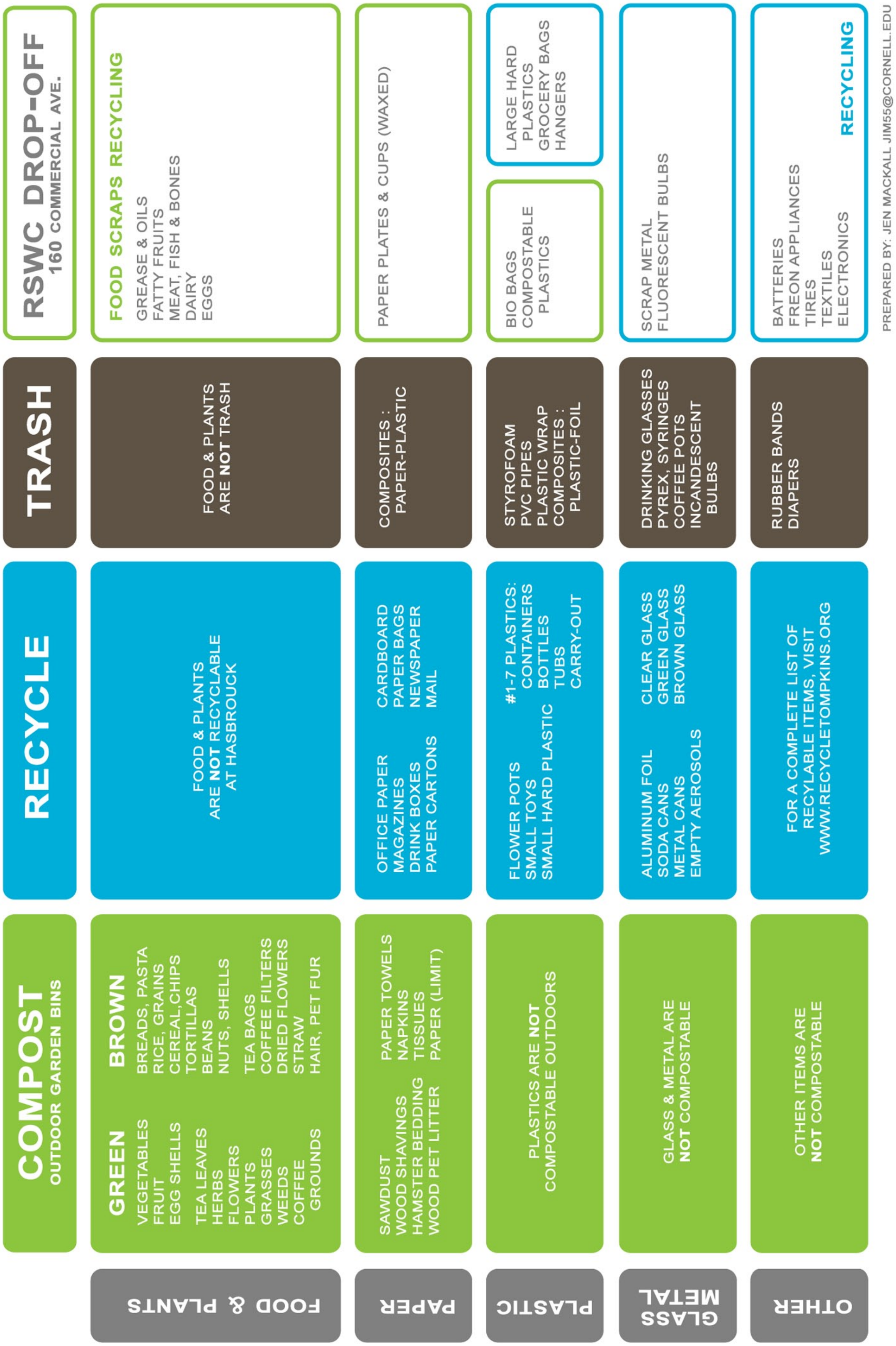
- Farmers’ Market: Steamboat Landing 545 3rd Street
- Tompkins County Recycling Center: 160 Commercial Ave

Off-site food scraps recycling locations

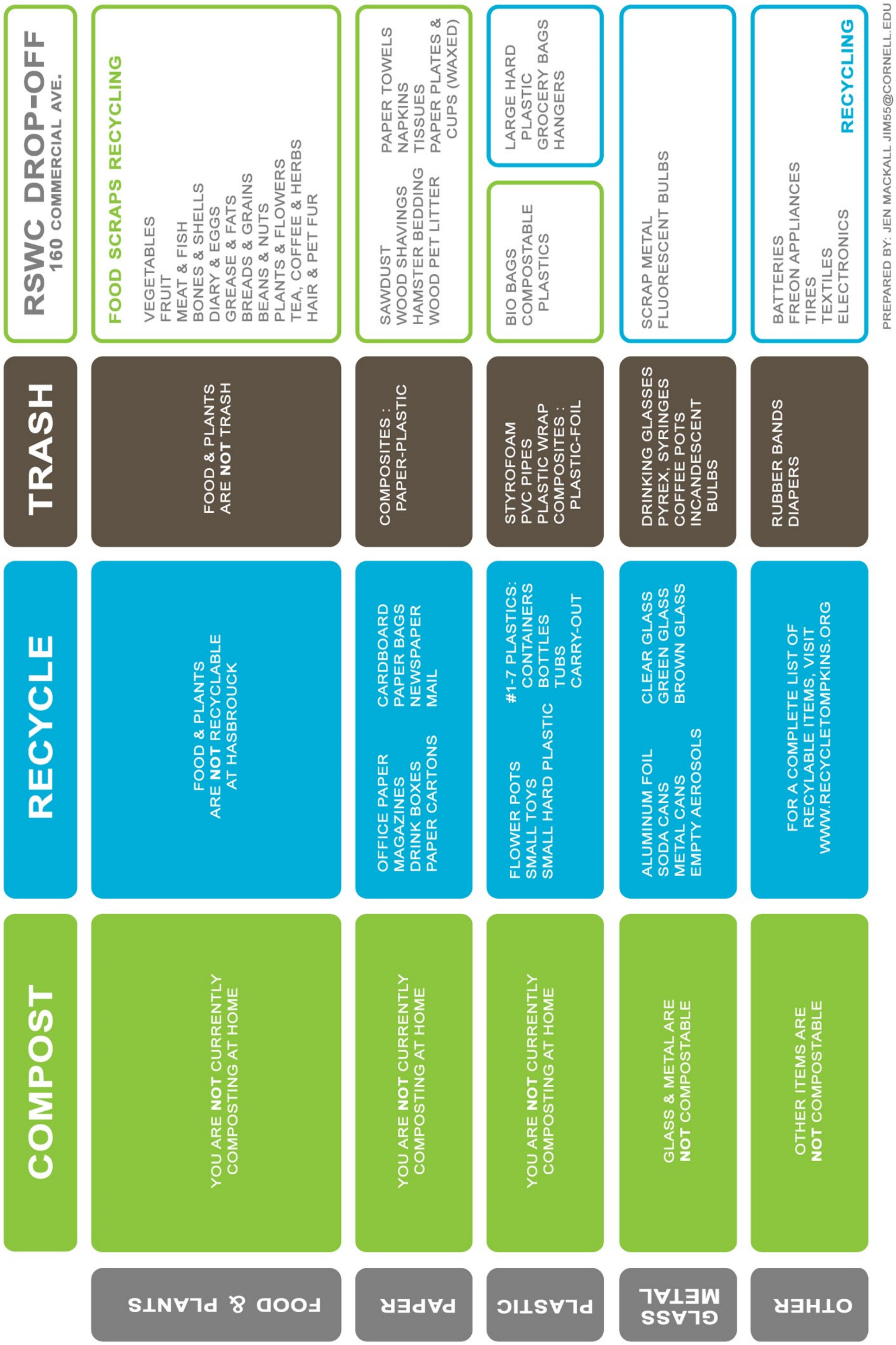
	COMPOST INDOOR KITCHEN COMPOSTER	RECYCLE	TRASH	RSWC DROP-OFF 160 COMMERCIAL AVE.
FOOD & PLANTS	**GREEN** LOW-FIBROUS VEGETABLES LOW ACID FRUIT MEAT, FISH FISH BONES DAIRY, FATS EGGS, SHELLS TEA LEAVES HERBS FLOWER TOPS GRASSES **BROWN** BREADS, PASTA RICE, GRAINS CEREAL, CHIPS TORTILLAS BEANS NUTS PEANUT SHELLS DRIED FLOWERS STRAW	FOOD & PLANTS ARE **NOT** RECYCLABLE AT HASBROUCK	FOOD & PLANTS ARE **NOT** TRASH	FOOD SCRAPS RECYCLING **FIBROUS VEGGIES :** BROCCOLI, CABBAGE, KALE, CAULIFLOWER, BRUSSEL SPROUTS **ACIDIC FRUITS :** LEMON, LIME, TOMATO, PICKLES **FIBEROUS ITEMS :** STRING, HAIR, LEMONGRASS, WOODY PLANTS & STEMS **HARD ITEMS :** PITS, WALNUT & LOBSTER SHELLS, HUSKS, WINE CORKS, MEAT BONES
PAPER	SAWDUST WOOD SHAVINGS HAMSTER BEDDING WOOD PET LITTER	OFFICE PAPER MAGAZINES DRINK BOXES PAPER CARTONS CARDBOARD PAPER BAGS NEWSPAPER MAIL	COMPOSITES : PAPER-PLASTIC	PAPER TOWELS NAPKINS TISSUES PAPER PLATES & CUPS (WAXED)
PLASTIC	PLASTICS ARE **NOT** COMPOSTABLE INDOORS	FLOWER POTS SMALL TOYS SMALL HARD PLASTIC **#1-7 PLASTICS:** CONTAINERS, BOTTLES, TUBS, CARRY-OUT	STYROFOAM PVC PIPES PLASTIC WRAP COMPOSITES : PLASTIC-FOIL	BIO BAGS COMPOSTABLE PLASTICS LARGE HARD PLASTIC GROCERY BAGS HANGERS
GLASS METAL	GLASS & METAL ARE **NOT** COMPOSTABLE	ALUMINUM FOIL SODA CANS METAL CANS EMPTY AEROSOLS CLEAR GLASS GREEN GLASS BROWN GLASS	DRINKING GLASSES PYREX, SYRINGES COFFEE POTS INCANDESCENT BULBS	SCRAP METAL FLUORESCENT BULBS
OTHER	OTHER ITEMS ARE **NOT** COMPOSTABLE	FOR A COMPLETE LIST OF RECYLABLE ITEMS, VISIT WWW.RECYCLETOMPKINS.ORG	RUBBER BANDS DIAPERS	BATTERIES FREON APPLIANCES TIRES TEXTILES ELECTRONICS RECYCLING

PREPARED BY: JEN MACKALL JIM55@CORNELL.EDU

Indoor composting chart



Outdoor composting chart

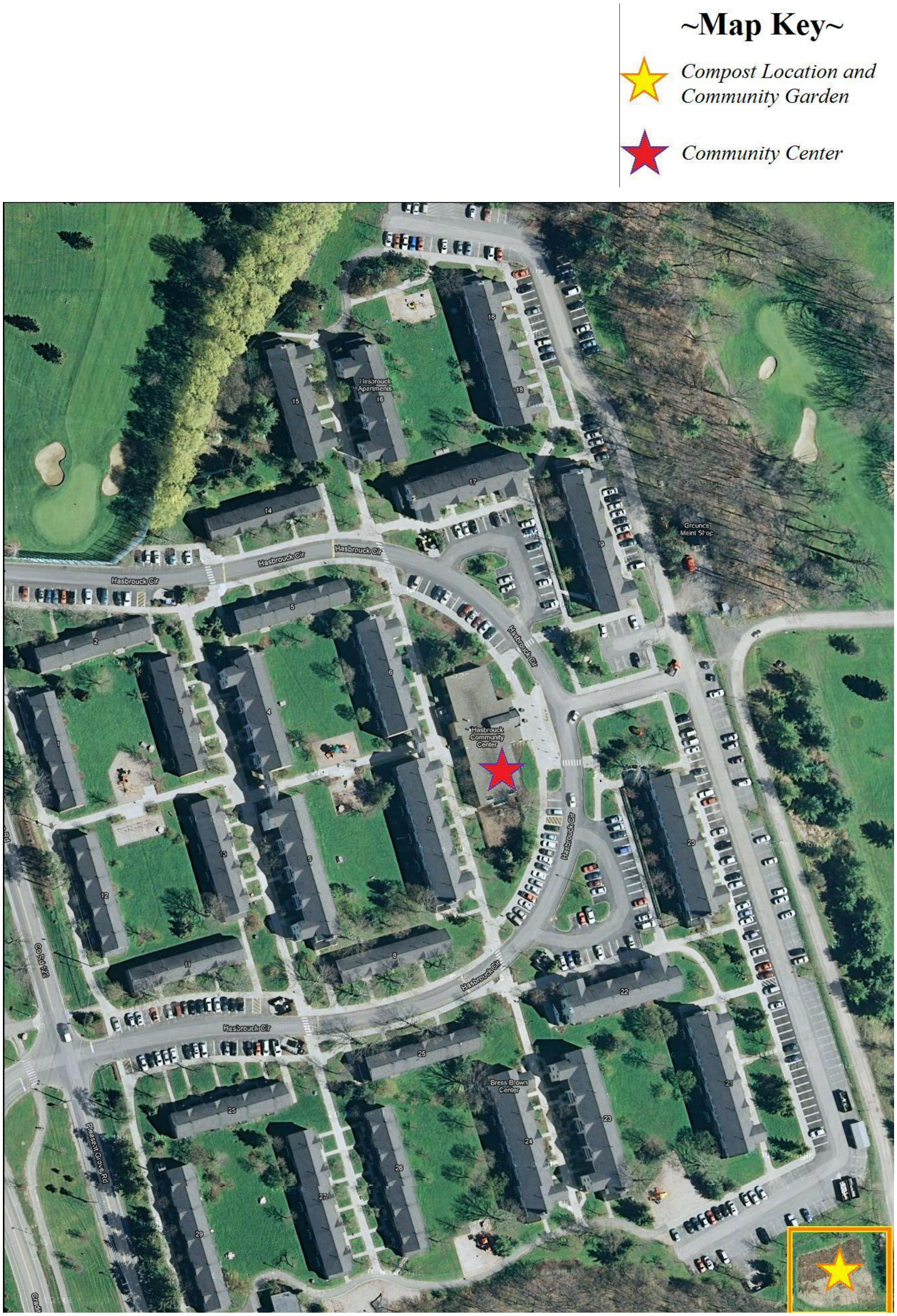


Off-site food scrap recycling chart

Outdoor compost bin directional signage

Outdoor compost bin signage

Outdoor compost bin signage



Habrouck map to outdoor compost bins
created by Erin Oliver, Cornell undergraduate research assistant

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Composting

BASICS

- ▼ "Composting" means the controlled decomposition (decay) of organic material such as yard trimmings, kitchen scraps, wood shavings, cardboard, and paper.
- ▼ "Compost" is the humus-rich material that results from composting.
- ▼ Compost contributes nutrients and beneficial life to the soil, improves soil structure, and helps prevent runoff that can pollute rivers and lakes.
- ▼ Compost helps the soil absorb and retain nutrients and moisture, and protects plants from diseases and pests. Better moisture retention means less watering, allowing you to conserve water and reduce runoff pollution.

COMPOST BENEFITS

Compost makes good mulch. It can also be mixed into garden and potting soils.

Nutrients. Compost contains the full spectrum of essential plant nutrients. However, you should test the nutrient levels in your compost and soil to determine what supplements your landscape requires. Ask your county extension agent for more information.

- ▼ Compost contains micronutrients such as iron and manganese that are often absent in synthetic fertilizers.
- ▼ Compost releases its nutrients slowly, over several months or years.
- ▼ Soil enriched with compost retains fertilizers better than lifeless soil does. Less fertilizer runs off to pollute waterways.
- ▼ Compost balances both acid and alkaline soils, bringing pH levels into the optimum range for nutrient availability.

Soil Structure. Compost helps bind clusters of soil particles (aggregates). Soil rich in aggregates is full of tiny air channels and pores that hold air, moisture, and nutrients like a sponge.

- ▼ Compost helps sandy soil retain water and nutrients that would normally wash right through the sand.
- ▼ Compost breaks up tightly bound particles in clay or silt soil, allowing roots to spread, water to drain, and air to penetrate.
- ▼ Compost alters the texture and structure of all soils, increasing their resistance to erosion.
- ▼ Compost particles attract and hold nutrients strongly enough to prevent them from washing out, but loosely enough so that plant roots can take them up as needed.
- ▼ Compost makes any soil easier to work and cultivate.

Beneficial Soil Life. Compost introduces and feeds diverse life in the soil, including bacteria, insects, worms, and more, which support vigorous plant growth.

- ▼ Compost bacteria break down mulch and plant debris into plant-available nutrients. Some soil bacteria also convert nitrogen from the air into a plant-available nutrient. Beneficial insects, worms, and other organisms are plentiful in compost-enriched soil; they burrow through the soil keeping it loose and well aerated.
- ▼ Compost suppresses diseases and harmful pests that overrun poor, lifeless soil.

Water Quality. Compost increases soil's ability to retain water and decreases runoff. Runoff pollutes water by carrying soil, fertilizers, and pesticides to nearby streams.

- ▼ A 5 percent increase in organic material quadruples the soil's ability to store water.
- ▼ Compost promotes healthy root growth, which decreases runoff.
- ▼ Compost can reduce or eliminate your use of synthetic fertilizers.
- ▼ Compost reduces the need for chemical pesticides because it contains beneficial microorganisms that protect your plants from diseases and pests.

Be sure to contain your compost pile so that it doesn't wash off your yard during a rainstorm. An excess of nutrients in water can deplete the oxygen available to fish and other aquatic life.

Factsheet information from "A Green Guide to Yard Care",
Texas Natural Resource Conservation Commission GI-28 PDF version (Rev. 8/01)

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Lasagna Composting

The “Lasagna Method” is a way of structuring a compost system so that maintenance is minimized, pests are deterred, and both large and small amounts of compostables can be handled at any time. This simple layering system can be used in any bin.

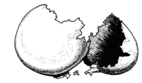
Initial Layer:

- The first layer in your bin should be a loose layer of twigs and branches – **stalky material** that will not compress as the compost bin fills up.
- The purpose of this layer is to build in a way for air to reach the center of your pile. Oxygen ensures that the decomposition will not generate unpleasant odors.

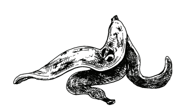
“Brown” Layers:

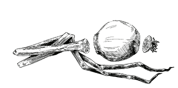
- These can be made of straw, dried leaves, wood chips, sawdust, even torn up paper. All these materials are **carbon-rich**, supplying a critical food source to the decomposer organisms.
- The brown layers help to **balance the moisture** in a pile, since the brown materials are usually much drier than the food scraps in the green layers. These materials are also usually coarser, so they create a **porous structure** that allows air into the center of the pile and allows excess water to escape. Finally, the brown layers serve as a **visual and physical barrier to pests**, by filtering food smells and putting the food scraps out of reach of insect pests.

“Green” Layers:



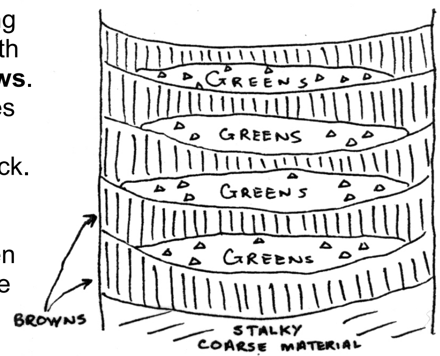
- These are **nitrogen-rich** materials, supplying another critical food source for the decomposers.
- Acceptable “greens” include food scraps from meal preparation, inedible leftovers, grass clippings that are too long to be left on the lawn, garden weeds, manure, etc.
- **DO NOT include** meat, oily materials, dairy products, or bones. These risk attracting pests to the compost area.





Layering Technique:

Cut-away view of layers within a bin

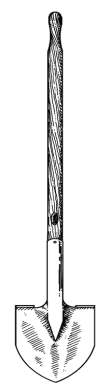


- Alternate green and brown layers, starting with a brown layer and always ending with a brown layer so that **no food ever shows**.
- Brown layers should be two to three times as thick as green layers. Green layers should be no more than 1 or 2 inches thick.
- Brown layers should be shaped like saucers – lower in the center and higher around the edges – so that the next green layer can be kept to the interior of the pile with **no food showing** on the edges.

Routine Tasks:

- Whenever your indoor collection container is ready to be emptied, take it out to the compost bin, spread the food scraps on top in thin layers – keeping them away from the edges! – and cover them with a generous layer of browns.
- Wash out the kitchen container and return it to its spot, lined with a fresh piece of newspaper to make cleaning easier.

Optional Maintenance:



With this layering technique it is not necessary to turn the compost. However if you wish to get the compost finished sooner, you may choose to turn the bin contents. Compost forks or other digging tools may be used to stir and mix ingredients right in the bin.

Alternatively, if it is possible to simply lift off or undo the existing bin, then you can get easy access to the unfinished compost. Reset the empty bin, put down an initial layer of stalky material, and turn the partially finished compost into the new bin. This will mix the ingredients, and bring the materials that were on the outside edges in to the middle where they will start to break down faster.

Harvesting Finished Compost:

The materials on the bottom layers will tend to finish first, since they started first. If there is unfinished compost on top of the bin, transfer the unfinished compost to a new bin. The finished compost may then be harvested and put to use.

The length of time it takes for compost to be ready depends on many factors, so it is difficult to give a general rule for how long it will take. Weather conditions, the size of your bin, the type of materials included, the amount of turning, and other factors all play a role in determining the speed of breakdown. Generally, a year should be sufficient. But there are ways to test whether or not the compost is "done", if you are not sure. Check with Cooperative Extension for more information on assessing and using your compost.

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Troubleshooting Compost Piles

SYMPTOM	POSSIBLE CAUSE	POSSIBLE SOLUTION/ALTERNATIVE
Compost pile is damp and warm in the middle, but nowhere else.	The pile may be too small.	Gather enough material to form a pile 3' by 3' by 3' and/or insulate the sides and cover the top.
Compost pile isn't heating up.	If it seems damp and sweet smelling, it may be a lack of nitrogen.	Mix in fresh grass clippings, manure, blood meal or other material high in nitrogen. If it is difficult to turn the pile, create holes in the pile and add the nitrogen-rich material.
	Not enough oxygen.	Turn or fluff the pile.
	Cool weather	Increase pile size and/or insulate with straw or a plastic cover.
	The pile may be too small.	Gather enough material to form a pile 3' by 3' by 3' and/or insulate the sides and cover the top.
	Pile was built over several months.	Don't worry about it. Let pile compost "cold." Check for finished compost.
Compost pile isn't heating up.	Compost may be finished.	If it looks dark and crumbly and smells earthy (not moldy or rotten), it may be done. Use it! (If unsure, call for more info.)
The pile is dry throughout.	Lack of water.	Turn the compost and add water. Moisten new materials before adding to the pile. If the pile is out in the open, consider covering with a straw or plastic cover. The pile should be as damp as a wrung-out sponge throughout.
Matted, undecomposed layers of leaves or grass clippings.	Compaction, poor aeration.	Break up layers with garden fork or shred them, then re-layer pile. Avoid adding heavy layers of leaves, grass clippings, hay or paper unless first shredded.
Large, undecomposed items.	Size and composition of materials.	Screen out undecomposed items, reduce size if necessary and use in a new pile.
Compost pile has a bad odor like a mixture of rancid butter, vinegar and rotten eggs.	Not enough oxygen, too wet.	Turn the pile and add course dry materials such as leaves, straw, or corn stalks to soak up excess moisture. Protect the pile from rain using a plastic film or other cover.
	Not enough oxygen, compacted.	Turn the pile and shake materials apart to aerate.
Compost pile has a bad odor like ammonia.	Pile may have too much nitrogen.	Add materials high in carbon such as shredded leaves, non-treated wood chips, sawdust or shredded newsprint and aerate.
Compost pile is attracting rats, raccoons, dogs, flies or other pests.	Possibly inappropriate food scraps: meat, fat, bones, or byproducts	Avoid adding such material; use a rodent-resistant bin with a top, bottom and sides. Bury non-fatty kitchen by-products 8"-12" deep in the pile.
Compost pile contains earwigs, slugs and/or other insects.	Pile is composting correctly	Insects are a good sign of a productive compost pile. Note: slugs live happily in compost piles. If the pile is next to a garden, barriers can be placed between the pile and nearby garden with traps, metal flashing, etc.

This fact sheet was adapted with permission from The Composting Council's National Backyard Composting Program Training Manual (1996).

STOPPING TROUBLE BEFORE IT STARTS

Material	OK?	Comments
Barbecue ashes/coal	No	Contains sulfur oxides; bad for garden
Cardboard (CC)	Yes	Glue probably organic
Coffee grounds (N, P)	Yes, but	Acidic
Cooked food scraps	Yes, but	Low in nutrients and may attract animals if it contains oils or meat/dairy
Cornstalks, cobs (C, K)	Yes, but	Must be mixed with nitrogen-rich material
Dishwater	No	Most dishwashing soaps contain perfumes, greases, sodium
Dryer lint	Yes	This is a good one!
Eggshells	Yes	Crush; source of calcium
Fish scraps	No	Can attract animals; bury scraps in a trench
Grass clippings (N, P, K)	Yes, but	Not from lawns treated with pesticides; good nitrogen source when fresh, carbon source when dried
Grease	No	Does not break down well in backyard system; attracts animals & slows composting process
Kitty litter	No	Likely to contain disease organisms
Manures - horse, cow, sheep, goat, chicken, pig	Yes, but	Horse manure more likely than others to contain weed seeds; compost thoroughly
Dog, cat & bird manure	No	May contain disease organisms
Mushroom compost	Yes, but	May contain fungicides; low in nutrients, but good soil builder
Newspaper (CC)	Yes	Shred for compost, use shredded or flat for mulch; colored sheets now considered OK
Oak leaves (C)	Yes, but	Acidic
Pine cones (C)	Yes, but	Decompose slowly; acidic
Sawdust, wood shavings (CC)	Yes, but	High in carbon and must be mixed with nitrogen-rich material
Weeds	Yes, but	Only if weeds are green and seeds have not matured
Wood ashes (P,K)	Yes, but	Use small amounts; highly alkaline

N - Nitrogen, P - Phosphorus, K - Potassium, C - Carbon (All plant and animal materials contain carbon. A single C needs to be accompanied by nitrogen or it will rob nitrogen from the soil.) CC - Extra large amounts of carbon, so needs additional nitrogen.

Compost Chart adapted from National Gardening Magazine, June 1986

The Compost Education Program is funded by the Tompkins County Solid Waste Management Division.

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Preparation of Food Scraps for Faster Composting

The ***good news*** is that composting is a natural and powerful process, and if you manage it right you can get great finished compost with ***very little work*.**

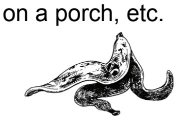
The ***even better news*** is that if you take a few minutes to cut food scraps into smaller pieces, the composting will happen even faster. The key is that the organisms that do most of the breakdown are tiny and they work *just on the surface area* of food – the smaller the pieces, the more the surface area!

What you need:

- container for collecting food scraps – milk cartons, cereal boxes, or small plastic buckets work well
- kitchen knife or scissors
- cutting board

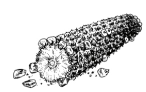
What to do:

- line your compost container with newspaper – this makes emptying and cleaning the container much easier
- place the container in a convenient spot – on the countertop, under the sink, on a porch, etc.
- do not cover the container! This just promotes odors due to fermentation.



What goes in?

- any vegetable or fruit scraps
  apple cores, orange peels, banana peels, potato skins, corn cobs, garlic tops, wilted lettuce, …
- egg shells -- crush them up a bit
- inedible leftovers of prepared foods
  pizza, last week's dinner, moldy bread, etc.
- coffee grounds and filters
- tea bags (except those made of nylon) -- tear the bag and remove the staple
- pizza boxes, newspaper, paper towels, cereal boxes, … any non-waxy paper



What doesn't go in?

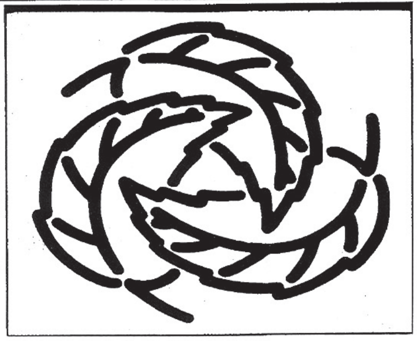
- No meat, fat, dairy products, bones, or raw eggs (these materials would break down, but they risk attracting pests)
- No plastic, metal, glass, rubber bands, twist-ties, etc.

What are the steps?

- While preparing your meal, or after eating a snack, cut the leftovers or food scraps into smaller pieces, to accelerate their breakdown in the compost bin
- Place the scraps in the compost container
- Cover food scraps with used paper towels, torn newspaper strips, or a handful of leaves or sawdust to prevent odors and fruit flies
- When container is full, take it out to the compost bin and empty it, and cover well with a layer of "browns" (dried leaves, woodchips, straw, torn paper, etc.)
- Clean the container out, line it with fresh newspaper, and return it to its spot!

The Compost Education Program is funded by the Tompkins County Solid Waste Management Division.

HOME COMPOSTING



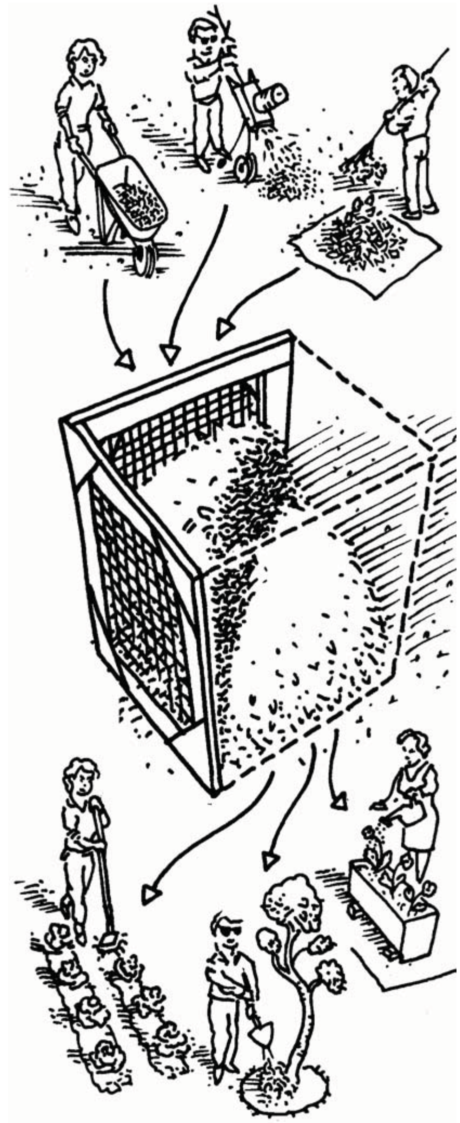
What is Compost?
Compost is a dark, crumbly, and earthysmelling form of decomposing organic matter.

Why Should I Make Compost?
Composting is the most practical and convenient way to handle your yard wastes. It can be easier and cheaper than bagging these wastes or taking them to the transfer station. Compost also improves your soil and the plants growing in it. If you have a garden, a lawn, trees, shrubs, or even planter boxes, you have a use for compost.

By using compost you return organic matter to the soil in a usable form. Organic matter in the soil improves plant growth by helping to break up heavy clay soils and improving their structure, by adding water and nutrient-holding capacity to sandy soils, and by adding essential nutrients to any soil. Improving your soil is the first step toward improving the health of your plants. Healthy plants help clean our air and conserve our soil, making our communities healthier places in which to live.

What Can I Compost?
Anything that was once alive can be composted. Yard wastes, such as fallen leaves, grass clippings, weeds and the remains of garden plants, make excellent compost. Woody yard wastes can be clipped and sawed down to a size useful for the wood stove or fireplace or they can be run through a shredder for mulching and path-making. Used as a mulch or for paths, they will eventually decompose and become compost.

Care must be taken when composting kitchen scraps. Compost them only by the methods outlined in this brochure. Meat, bones and fatty foods (such as cheese, salad dressing, and leftover cooking oil) should be put in the garbage.



COMPOST FLOW CHART

How Can I Use Compost?
Compost can be used to enrich the flower and vegetable garden, to improve the soil around trees and shrubs, as a soil amendment for houseplants and planter boxes and, when screened, as part of a seed-starting mix or lawn top-dressing. Before they decompose, chipped woody wastes make excellent mulch or path material. After they decompose, these same woody wastes will add texture to garden

The Essentials of Composting

With these principles in mind, everyone can make excellent use of their organic wastes.

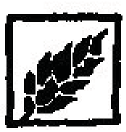
Biology

The compost pile is really a teeming microbial farm. Bacteria start the process of decaying organic matter. They are the first to break down plant tissue and also the most numerous and effective composters. Fungi and protozoans soon join the bacteria and, somewhat later in the cycle, centipedes, millipedes, beetles and earthworms do their parts.

Materials

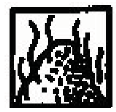
Anything growing in your yard is potential food for these tiny decomposers. Carbon and nitrogen, from the cells of dead plants and dead microbes, fuel their activity. The microorganisms use the carbon in leaves or woodier wastes as an energy source. Nitrogen provides the microbes with the raw element of proteins to build their bodies.

Everything organic has a ratio of carbon to nitrogen (C:N) in its tissues, ranging from 500:1 for sawdust, to 15:1 for table scraps. A C:N ratio of 30:1 is ideal for the activity of compost microbes. This balance can be achieved by mixing two parts grass clippings (which have a C:N ratio of 20:1) with one part fallen leaves (60:1) in your compost. Layering can be useful in arriving at these proportions, but a complete mixing of ingredients is preferable for the composting process. Other materials can also be used, such as weeds and garden wastes. Though the C:N ratio of 30:1 is ideal for a fast, hot compost, a higher ratio (i.e., 50:1) will be adequate for a slower compost. Table 1 provides an estimate for the C:N ratio of common materials.



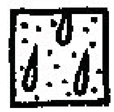
Surface Area

The more surface area the micro organisms have to work on, the faster the materials are decomposed. It's like a block of ice in the sun-slow to melt when it's large, but melting very fast when broken into smaller pieces. Chopping your garden wastes with a shovel or machete, or running them through a shredding machine or lawnmower will speed their composting.



Volume

A large compost pile will insulate itself and hold the heat of microbial activity. Its center will be warmer than its edges. Piles smaller than 3 feet cubed (27 cu.ft.) will have trouble holding this heat, while piles larger than 5 feet cubed (125 cu.ft.) don't allow enough air to reach the microbes at the center. These proportions are of importance only if your goal is a fast, hot compost.



Moisture & Aeration

All life on Earth needs a certain amount of water and air to sustain itself. The microbes in the compost pile are no different. They function best when the compost materials are about as moist as a wrung-out sponge, and are provided with many air passages. Extremes of sun or rain can adversely affect this moisture balance in your pile.

Time & Temperature

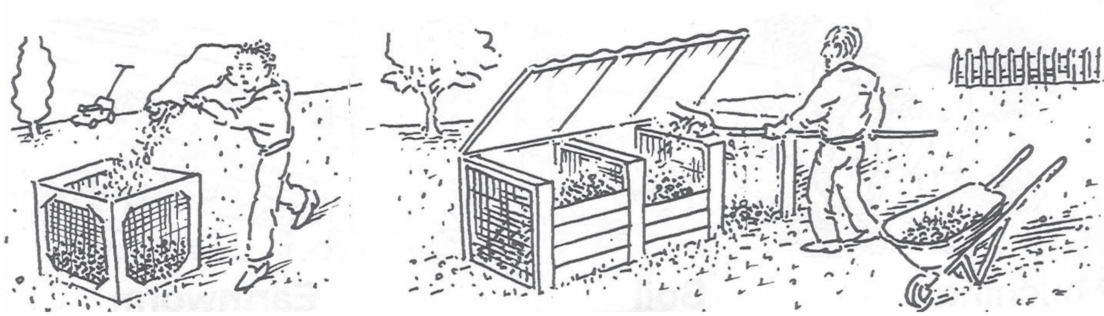
The faster the composting, the hotter the pile. If you use materials with a proper C:N ratio, provide a large amount of surface area and a big enough volume, and see that moisture and aeration are adequate, you will have a hot, fast compost (hot enough to burn your hand!) and will probably want to use the *turning unit* discussed in the next section. If you just want to deal with your yard wastes in an inexpensive, easy, non-polluting way, the *holding unit* (also discussed on the next page) will serve you well.

Material	C:N Ratio
Sawdust	200-750
Peatmoss	50
Straw	50-150
Cow manure	20
Poultry manure	3-15
Horse manure	20-50
Leaves from oak	40-80
Sun-dried grass clippings	20
Fresh grass clippings	15
Fresh garden debris	20
Vegetable wastes	~12
Garbage (food waste)	~15
Hay from legumes	15-20
Hay-general	15-32
Corrugated cardboard	~560
Newsprint	~400-850

Table 1

Some Typical C/N Ratios (based on dry weight)

Composting Yard Wastes



Holding Units

These simple containers for yard wastes are the least labor and time-consuming way to compost.

Which wastes? Non-woody yard wastes are the most appropriate.

How? Place the holding unit where it is most convenient. As weeds, grass clippings, leaves and harvest remains from garden plants are collected, they can be dropped into the unit. Chopping or shredding wastes, alternating high-carbon and high-nitrogen materials, and keeping up good moisture and aeration will all speed the process.

Advantages & disadvantages For yard wastes this is the simplest method. The units can be portable, moving to wherever needed in the garden. This method can take from 6 months to 2 years to compost organic materials, so you need to be patient. Because it does not get hot, weed seeds (and pathogens if present) may persist in the compost.

Variations Holding units can be made of circles of hardware cloth, old wooden pallets, or wood and wire. Sod can also be composted with or without a holding unit, by turning sections of it over, making sure that there is adequate moisture, and covering it with black plastic.

Turning Units

This is a series of three or more bins that allows wastes to be turned on a regular schedule. Turning units are most appropriate for gardeners with a large volume of yard waste and the desire to make a highquality compost.

Which wastes? Non-woody yard wastes are appropriate. Kitchen wastes without meat, bones or fatty foods can be added to the center of a pile if it is turned weekly and reaches high temperatures.

How? Alternate the layering of high-carbon and highnitrogen materials to approximately a 30:1 ratio. These should be moistened to the damp sponge stage. The pile temperature should be checked regularly; when the heat decreases substantially, turn the pile into the next bin. Dampen the materials if they are not moist, and add more high-nitrogen material if heating is not occurring. Then make a new pile in the original bin. Repeat the process each time the pile in the first bin cools. After two weeks in the third bin, the compost should be ready for garden use. See the *Rodale Guide to Composting* in your library for more information on hot composting.

Advantages & disadvantages This method produces a high-quality compost in a short time utilizing a substantial input of labor.

Variations The unit can be built of wood, a combination of wood and wire, or concrete block. Another type of turning unit is the barrel composter, which tumbles the wastes for aeration.

Sympton	Problem	Solution
The compost has a bad odor	Not enough air.	Turn it. Add coarser materials.
The center of the pile is dry.	Not enough water.	Moisten materials while turning the pile.
The compost is damp & warm in the middle, but nowhere else.	Too small.	Collect more material & mix the old ingredients into a new pile.
The heap is damp and sweet-smelling but still will not heat up.	Lack of nitrogen.	Mix in a nitrogen source like fresh grass clippings, fresh manure, bloodmeal or ammonium sulfate.

Composting Food Wastes

Mulching

Yard wastes can be used for weed control and water retention.

Which wastes? Woody yard wastes, leaves, and grass clippings.

How? You can simply spread leaves or grass clippings beneath plantings. For woody materials up to 1” in diameter, rent or purchase a chipper/ shredder. Tree services, if they are in your neighborhood, often will deliver wood chips free.

Advantages & disadvantages All yard wastes will work first as a mulch and then, as decomposition proceeds, as a soil enrichment. A disadvantage of mulching with woody yard wastes is that you may have to buy or rent power equipment or make arrangements with a tree service.

Variations Use chipped materials for informal garden paths.

Soil Incorporation

Burying your organic wastes is the simplest method of composting.

Which wastes? Kitchen scraps without meat, bones or fatty foods.

How? Everything should be buried at least 8 inches below the surface. Holes can be filled and covered, becoming usable garden space the following season.

Advantages & disadvantages This is a simple method, but because of the absence of air, some nutrients will be lost. Rodents and dogs can become a problem with wastes buried less than 6 inches deep.

Variations Using a posthole digger, wastes can be incorporated into the soil near the drip line of trees or shrubs and in small garden spaces.

Earthworm Compost

Feeding earthworms in wooden bins is a good way to make high-quality compost from food scraps.

Which wastes? Kitchen scraps without meat, bones, or fatty foods.

How? Fill a bin with moistened bedding such as peat moss for the worms. Rotate the burying of food wastes throughout the worm bin. Every 3-6 months the worm population should be divided and moved to fresh bedding. Refer to *Worms Eat My Garbage* by Mary Appelhof (available at some library branches) for more information.

Advantages & disadvantages This is an efficient way to convert food wastes into high-quality soil for houseplants, seedling transplants, or general garden use. The worms themselves are a useful product for fishing. However, worm composting is more expensive and complicated than soil incorporation for dealing with food wastes.

Variations A stationary outdoor bin can be used in all but the coldest months, or a portable indoor/outdoor bin can be used year-round.

This brochure is available on our “Small Scale or Backyard Composting” site:

http://cwmi.css.cornell.edu/smallscale.htm

For More Information

For more information about composting, contact your county Cooperative Extension Office.

Adapted by the Cornell Waste Management Institute, Dept of Crop and Soil Sciences, Rice Hall, Ithaca NY 14853
<http://cwmi.css.cornell.edu>
from the Seattle Tilth Association.

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