CHARLOTTE-MECKLENBURG'S HANDS-ON COMPOSTING WORKSHOPS AND HOME COMPOSTING METHOD: A TECHNICAL DESCRIPTION

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ABSTRACT

Mecklenburg County Solid Waste Management (Charlotte, North Carolina) offers two hour hands-on compost making workshops for residents. The workshop's objective is to enable participants to compost successfully at home. Charlotte's method of home composting using an inexpensive wire bin is easy to learn and tailored to local conditions. Autumn leaf drop is the main feedstock; supplemental nitrogen is added to bring the C:N ratio to 30:1. Bins have a capacity of 1 m^3, and produce about 0.3 m^3 of compost per batch. This paper includes a description of workshop activities, and discussion of technical issues in home composting such as layering, turning, managing grassclippings, adding kitchen scraps, 'organic' versus 'budget' nitrogen sources, tools, materials and costs.

INTRODUCTION

The modern history of composting dates from Sir Albert Howard's development of the Indore composting method in India during the early 1900s. J.I. Rodale, who brought Howard's ideas to America, popularized home composting through *Organic Gardening and Farming* magazine, launched in 1942 (Haug, 1993; Rodale, 1960). Home composting today remains a fundamental garden activity, indispensable for organic gardeners who avoid synthetic fertilizers, and highly beneficial for those who rely on 10-10-10 or '*Miracle-Gro*'.

Cooperative Extension 'how-to' pamphlets on home composting date back at least to the late-1940s, and composting books by Rodale and others have long been a familiar sight on gardening bookshelves. Home gardeners today can access home composting information on the World Wide Web (Cornell, 1998). An ever-increasing number of companies offer home compost bins, composting tools, compost inoculants and chipper-shredders for sale.

Home composting is also an effective way to transform organic 'wastes' such as yard trimmings and kitchen scraps into an environmentally beneficial resource, without the need for collection, centralized processing and distribution. For more than a decade, municipalities interested in boosting home composting have sponsored education programs, free or subsidized bin distributions, home compost demonstration gardens and composting workshops. Initiatives in Seattle, Washington, and Alameda County, California, have been especially successful (Alameda, 1997).

Since 1994, Charlotte-Mecklenburg, North Carolina, Solid Waste Management Waste Reduction has sponsored a home composting program. Over 1000 residents have attended hands-on home composting workshops, where they learn an easy-to-master and inexpensive method of home composting tailored to the Piedmont region of the southeastern USA. (For more information on the historical and organizational aspects of Charlotte's home composting program, please see the accompanying paper, *Encouraging Home Composting the Hands-On Way: Lessons From Charlotte-Mecklenburg* (Boekelheide and Barger, 1998).)

Defining composting and compost: Classic definitions of *composting* such as Golueke's (1977) and Haug's (1993) apply in a general sense to home composting, although home composting refers not to a single composting method but to a variety of techniques (Johnson, 1995). Home composting transforms organic wastes produced in the house and yard into compost or mulch on site. Typically, such systems are small, often with a capacity of 1m^3 or less. Ideally, backyard composting systems are low cost, easy to use, free from problems such as offensive odors, and able to generate a useful amount of compost for the home garden.

Similarly, a macro definition of *compost*, emphasizing factors like stability, homogeneity and absence of pathogens and weed seeds, provides a list of worthy goals for home compost rather than a workable definition.

CHARLOTTE'S HAND'S-ON HOME COMPOSTING WORKSHOPS	
OBJECTIVE	• Participants will be able to make compost at home successfully
ACTIVITIES	• Examine good quality finished home compost (made by a class the previous season)
	• Build a 1 m^3 compost pile using a wire bin, with leaves as the primary feedstock and supplemental N (either a 'budget' source or an 'organic' source), paying attention to moisture level and good aeration
	• Turn (remix) a compost pile built by a previous class
	• Add kitchen scraps to a working pile, cover 30 cm deep
	• Discuss grasscycling, mulching and 'eco-landscaping' as ways to reduce and manage grass clippings. Discuss vermiculture.
	• Distribute bin and guidebook to participants
	• Questions, discussion and evaluation
WORKSHOP ORGANIZATION	• 2 hours • 16 participants • Offered spring and fall • Active outdoor activities (old clothes and gloves recommended) • Information presented during activity rather than lecture format

Table 1: *Charlotte's home composting workshop - objective, activities and organization*

Home composting takes place largely under mesophilic conditions (~10° - 43° C), and is not confined to the compost pile, but also occurs 'in situ' as the gardener uses partly decomposed compost in various ways around the yard. Home composters and gardeners often define the quality of backyard compost using something closer to aesthetic criteria than precisely measurable factors: 'Finished' home compost is typically dark colored, easy to move with a shovel or fork, and easily mixed with soil using hand tools. The composted feedstock has transformed into a black crumbly material with a sweet earthy smell.

HANDS-ON COMPOSTING WORKSHOPS

The objective of Charlotte's home composting workshops is to enable participants to compost successfully at home. Workshops are 'hands-on' active learning activities, where participants build a compost pile similar to the one they will make in their own yard. The composting method is based on familiar home composting techniques, adapted to conditions in Charlotte and the Piedmont.

Workshops: Home composting workshops are open to all county residents, and charge a $5 registration fee. Participants receive a wire compost bin and a compost guidebook (Boekelheide, 1994). A second bin is available for an additional $5. Over 1000 people have taken a workshop since the program started in April 1994. (In addition to the workshops, approximately 500 residents have taken advantage of one of the free compost bin give-aways sponsored by Mecklenburg County five times since 1996. At each give-away, the workshop instructor demonstrated the composting method taught at workshops, using a lecture-demonstration format.)

Workshop activities: The organization of Charlotte's compost workshops owes much to Peace Corps training philosophy and practice (Peace Corps, 1984). Lecturing is kept to an absolute minimum; instead, information is presented 'just in time' as needed in class, or in response to participant questions as they come up.

Before beginning the bin building activity, the instructor welcomes the group and invites participants to 'put on their gloves, roll up their sleeves and join in'. Since the guidebook includes all information presented in class, there is no need to take notes. The first stop for each group is a pile of finished compost made by a class during the previous season. Viewing the black rich compost invariably raises group interest and motivation.

Each group then selects a location and forms the bin. Participants learn the 'campsite method' for siting a pile: Water readily available, a level spot, a convenient site (and, preferably, out of sight of the neighbors). The class then fills the bin in layers. The instructor builds the first layer as a demonstration; the class builds the second with a good deal of instructor input, then completes the third relying on themselves.

After completing a new pile, participants 'turn' a pile built by an earlier class. Feeling the heat of the decomposing compost and measuring the temperature is another activity that generates intense participant interest. The instructor then demonstrates how to add kitchen scraps, using the class's newly built pile.

At the close of class, the group holds a brief question and answer period and the instructor distributes bins and a 17 page guidebook on composting and grasscycling.

Workshop scheduling: Charlotte offers workshops in the fall and in the spring. The fall series runs from the time of leaf drop in mid-to-late October through late November. The spring series is offered from late March through early May, a period when gardeners clean up yards after the winter and countless bags of leaves are set out for curbside collection.

Workshops are held on Saturdays, with one class in the morning from 10 AM - noon and a second from 1-3 PM, at the Compost Garden at Compost Central, Charlotte's large yard waste composting facility. Workshop enrollment is limited in theory to 16 people, an ideal number for a hands-on class. However, no one is turned away, and classes have been larger than 20 at times. If fewer than five people pre-register for a class, that class is generally canceled the preceding Friday and the registrants informed by phone. The Compost Central location has a great advantage in providing plenty of leaves for hands-on classes (> 24 m^3 per year).

CHARLOTTE'S HOME COMPOSTING METHOD

Background, climate and ecology: Charlotte is located in the central part of the American Piedmont (Godfrey, 1997). Soil organic matter in the Piedmont is naturally maintained through autumn leaf drop. Mecklenburg is an urbanized and rapidly growing county, with few if any undisturbed natural areas. Charlotte is nicknamed 'The City of Trees' - majestic oaks line major streets, and autumn leaf drop is a major waste management problem.

Mecklenburg County is on the border between USDA zones 7B and 8A. The climate is temperate, with four distinct seasons, though winters are mild, rarely falling below 0° for more than a few days at a time. Charlotte has a long, warm and humid growing season between April and October, with average summer temperatures in the upper 20s C. Between 100-120 cm rain falls annually, distributed more-or-less evenly throughout the year.

In Charlotte, composting follows seasonal variations. Home compost piles built in the spring are ready within three months, for fall or even late summer use. Those built in the autumn are usually not ready for six to eight months, for late spring or (more usually) summer use.

Bin materials: The compost bin used in Charlotte's classes is made of welded wire fencing. Several other public home composting programs around the US have used wire bins successfully (Composting Council, 1996). The relatively low cost of wire bins ($4.50 per unit) keeps workshops and free bin distributions affordable. The fencing is medium gage steel wire welded in rectangles 5 cm by 10 cm (2 in x 4 in). The fencing is 90 cm (3 ft) high (taller fencing (120 cm (4 ft) and higher) is very inconvenient to work with for people of average height).

Composters make a bin by cutting a 3.75 m (12 ft 6 in) length of wire and forming it into a cylinder. The ends of cut wire are bent back to keep the cylinder from unrolling. Each cylinder bin holds ~1 m^3 (~1.4 yd^3) of material.

The ample capacity of the bin is ideal for leaf composting. Rolls of wire 15 m (50 foot) long retail for $18 each; each roll makes four bins.

Location and land preparation: The workshop suggests leveling soil under the bin and removing grass and weeds. Leveling is important, since wire bins have the disadvantage of 'slumping' when placed on a slope. In Charlotte's climate, bins work in either sun or shade. Roots sometimes invade bins under trees. Building piles on a layer of black plastic mulch covered with 7-15 cm (3-6 in) of inexpensive organic mulch or dry leaves solves this problem.

Composting method: Composters learn to build a 'batch' of compost (filling the bin to capacity) using a layering technique. Each layer contains 30 cm of leaves, a nitrogen source, and a shovelful or two of working compost or topsoil. Classes select a 'budget' N source (cow manure plus 30-2-2 fertilizer or equivalent) or an 'organic' N source (inexpensive rabbit food) (Tables 2 and 3). Using a manure fork, composters mix the ingredients of each layer while adding water to 50% by volume (the moisture of a squeezed-out sponge). After finishing the bottom layer, the composter uses the same process to make the middle layer, and then the top layer.

Workshops do not recommend the traditional technique putting a layer of coarse materials such as sticks or brush at the bottom of piles, since that interferes with easy turning using a manure fork.

Turning: Workshops recommend four turns for the compost, the first and most important turning within the first week. Subsequent turns are at roughly three week intervals.

Tools: Recommended tools include a five pronged manure fork or a D-handled garden fork; a container for gathering leaves, such as an old plastic garbage can; a wheelbarrow and shovel for moving finished compost to sites in the yard; and a garden hose or watering can to water the pile. I strongly recommend a piece of 'rebar' ~1.2 m (48 in) long. For people wishing to compost kitchen scraps, I suggest a 2-4 quart plastic container for the kitchen counter, and a simple 'poking' device made from a 5 cm x 10 cm (2x4) board 1.2 m long cut at a 45° angle on one end. This composting method requires no mechanized equipment, such as a shredder.

Compost production: Each bin, filled according to instructions to capacity (1 m^3), produces about 0.3 m^3 of finished compost (~10.6 ft^3). This is enough to amend 3 m^2 (32 ft^2) of garden bed (at 7.5 cm (~3 in) coverage), or topdress an area of 9 m^2 (97 ft^2) (at 2.5 cm (1 in) coverage). Purchased commercially in bags, 0.3 m^3 of Charlotte's municipal yard waste compost sells for about $26.50.

Materials not recommended for composting: The instructor warns participants against adding dog or cat droppings; large amounts of meat, fish or dairy wastes; oils and fats; pesticides, herbicides or other household chemicals; or sick plants and weeds that have set seed to their home compost. These materials can become a danger or a nuisance, and their safe composting requires more carefully controlled conditions than those in most backyard compost bins.

DISCUSSION

Charlotte's workshops teach a managed biological process approach (Golueke 1977) to building and maintaining the bin. By Golueke's taxonomy of composting methods, the Charlotte composting technique is an aerobic mesophilic non-mechanized system. Although a wire bin holds materials in place, the design is best described as a self-insulating 'contained' windrow. To design the system, I drew on personal experience, composting techniques used by Peace Corps and other well-established garden and horticultural programs, a literature review, experimentation at Compost Central and in Charlotte backyards, and suggestions from experienced composters.

Passive piles: Workshop participants learn that 'passive' leaf piles, without additional N, are a viable option for those who do not want a faster composting method. A 'passive' leaf pile gives 'leaf mold compost' in 12-24 months, and a passive pile is far preferable to dragging bags of leaves to the curb for collection (Table 2).

TECHNIQUES

Layering: Layering is an easy way to arrive at the right approximate proportions of C:N. Some excellent home composting instructors, however, do not recommend layering and strongly prefer to pre-mix ingredients before

CHARLOTTE HOME COMPOST MATERIALS, CHARACTERISTICS AND YIELD

Feedstock	Mass (kg)	Moisture %	N %	C:N	Yield (kg)	Soil application area (m^2/ft^2) bed prep (7.5cm)	top dress (2.5 cm)	Cost $	Retail value $
Home leaf compost without N ('passive pile')									
leaves	150	35	0.625	80					
water	46	100	0	0					
total	*196*	*50*	*0.6*	*80*	*98*	*2.2/24*	*6.6/71*	*$0*	*$20*
Home leaf compost with 'budget' N supplement									
leaves	150	35	0.625	80					
manure	54.6	50	0.5	50					
30-2-2	3.5	0	30	0					
compost	12	50	2	25					
water	47	100	0	0					
total	*267*	*50*	*1.5*	*32*	*134*	*3/32*	*9/97*	*$4*	*$28*
Home leaf compost with 'organic' N supplement									
leaves	150	35	0.625	80					
rabbit food	22.5	15	2.56	16.6					
compost	12	50	2	25					
water	60	100	0	0					
total	*244*	*50*	*1.1*	*47*	*122*	*2.8/30*	*8.3/89*	*$10*	*$25***
Home leaf compost with 'budget' N supplement plus kitchen scraps									
leaves	150	35	0.625	80					
manure	54.6	50	0.5	50					
30-2-2	3	0.5	30	0					
compost	12	50	2	25					
scraps	91.3	80	3	16.7					
water*	0	100	0	0					
total	*311*	*51*	*1.6*	*31*	*155*	*3.5/38*	*10.5/113*	*$4*	*$32*
Home leaf compost with 'organic' N supplement plus kitchen scraps									
leaves	150	35	0.625	80					
rabbit food	22.5	15	2.56	16.6					
compost	12	50	2	25					
scraps	91.3	80	3	16.7					
water*	5	100	0	0					
total	*281*	*50*	*1.3*	*38*	*140.4*	*3.2/34*	*9.5/102*	*$10*	*$29***

Table 2: *Charlotte home compost materials, characteristics and yield.*

Reference: Cornell University Compost Website [T.Richard, N. Trautmann, M. Krasny, S. Fredenburg and C. Stuart] (Cornell, 1998). Notes: *Water: Although kitchen scraps contribute ample moisture, they are added in relatively small amounts on an on-going basis. In a practical sense, the amount of water added when a pile is first made is more accurately reflected in the calculations without kitchen scraps (above). **Value of 'organic' compost: Certified 'organic' compost is not available in Charlotte. Using the price of the closest locally-available product, an 'organic vermicompost' sold at Talley's Market natural food store for ~$5/kg, the value of one batch of organic home compost might be on the order of $500! Justifiably or not, the designation 'organic' can clearly have a powerful influence on the public.)

adding them to the bin. After trying both pre-mixing and layering at different workshops, I found layering was more popular and readily understood by workshop participants. In trials, layering also has (unexpectedly) given higher quality finished compost than pre-mixing, given that layered piles are turned and thoroughly remixed within the first week. However, I did not shred materials before or during pre-mixing, a technique often used by composters who prefer pre-mixing.

Turning: The wire bin makes turning a very simple operation, a fact much easier to demonstrate than to explain in words. The composter unhooks the wire to open the cylinder; removes it from the pile; sets it up (now empty) next to the pile and refastens it; then tosses the working compost back into the wire cylinder, breaking up and mixing the materials and adding water as needed.

The first turn, ideally within a week of when the pile is built, is a remixing process that allows the composter to blend and break up materials that are packed together and to water dry spots. Three additional turns at roughly three week intervals thereafter (at four weeks, seven weeks, and ten weeks) gave the best results in trials, perhaps in part because the pause between turnings allows actinomycetes and fungi populations to become well established. Additional or more frequent turnings made no difference in either speed of composting or quality of end-product.

Unturned piles take longer to break down and have large areas within the pile with minimum decomposition. The first turn yields the greatest benefits.

Shredding: I do not suggest that composters shred material. The cost of a shredder might discourage many home composters, especially low-income families, and inexpensive shredders can be noisy and inconvenient to use.

In Charlotte, a home composter can produce nicely finished compost from leaves in a reasonable time without shredding. Surprisingly, trials have shown no clear evidence that shredding Charlotte's autumn leaves speeds up or improves the composting process. Instead, shredded leaves tend to mat together in hydrophobic clumps, similar to peat moss, which remain dry and resist breakdown.

Experienced home composters report excellent results composting with leaves and grassclippings shredded and mixed using a lawn mower (Webster, personal communication; Alameda, 1997). Although this mix has not worked well in trials without shredding, using a 'lawnmower as shredder/mixer' as an inexpensive and convenient way to mix leaves and grassclippings for home composting merits further testing.

FEEDSTOCKS: LEAVES AND KITCHEN SCRAPS

Leaves: The basic compost feedstock: The most important feedstock for home composting in Charlotte is autumn leaf drop from hardwoods such as pin oak (*Quercus palustris*), willow oak (*Q. phellos*), sweet gum (*Liquidambar styraciflua*), hickories (*Carya spp.*) and maples (*Acer spp.*). The home compost bin used in Charlotte's system holds approximately 150 kg (~330 lbs) of leaves per batch (equivalent to approximately 15 average sized plastic 'lawn waste' bags of leaves, at 10 kg each (~22 lbs).

I encourage incorporation of other yard wastes in home compost, the exception being grassclippings. Workshops advocate grasscycling as the preferred way to deal with grassclippings. Kitchen scraps,with certain precautions, are an optional ingredient.

Kitchen scraps: Kitchen scraps increase chances for odor and insect problems in home compost piles, and some well established programs (Seattle, 1996) offer bins especially designed for kitchen scraps at discount prices, and discourage residents from composting yard waste and kitchen scraps together. Kitchen scraps are typically high in moisture (>70%) and food wastes that attract flies. On the other hand, kitchen scraps are a traditional ingredient in home compost piles which contribute valuable nutrients and divert a troublesome source of organics from garbage destined for the landfill.

Charlotte workshops take a 'middle of the road' approach. Experienced composters are encouraged to add kitchen scraps in small quantities (~ 4 liters) to their working compost, and to bury them at least 30 cm deep. Scraps can be added for no more than 12-14 weeks to a single pile. This approach treats the compost pile as simple backyard 'microbial digester' for the easily decomposed kitchen wastes, and can be easily managed without odor or pest problems. Vermicomposting offers another option for kitchen scraps for dedicated home composters

At the same time, workshops stress that kitchen scraps are not necessary for composting. I encourage beginners to try a simple leaf pile enriched with N first, especially if they live in densely populated urban areas, or if they have had problems in the past with rodents, dogs, raccoons or opossums.

GRASS CLIPPINGS:

Grass clippings can be a major headache for both waste managers and backyard composters in Charlotte. Grass clippings are difficult to work with even for large- scale composting operations (Steve Elliot [Compost Central manager], personal communication). Haug (1993) gets it 100% right when he observes that 'Grass and leaves are sometimes collected and composted together, but the two substrates could not be more different. Leaves...make a good structural mix, (while) ...grass is often anaerobic and malodorous....' As Tom Richard demonstrates, the high moisture content of grass clippings makes using them as a nitrogen source a very tricky process, since the added water can turn a pile into an anaerobic 'mess' (Cornell, 1998). Grass clippings have been the source of the majority of public complaints and questions about backyard compost piles in the past in this area.

The backyard composting method taught in workshop is excellent for fallen leaves and workable for kitchen scraps, but does not work especially well with grass clippings from the tall fescue (*Festuca elatior*) lawns predominant in the area. Grass clippings mixed manually with leaves did not compost well in trials at Compost Central. The grass clippings tended to mat together and desiccate or putrefy (creating strong odors and fly problems) without contributing much N to the decomposing leaf mass, which decayed as slowly as piles without any supplemental N.

In view of these observations, Charlotte's composting workshops stress the importance and desirability of grasscycling and use of grass trimmings as mulch, rather than composting grass clippings. The best home composting option for grass clippings may well be passive leaf piles in shady areas on the edges of yards large enough to place the compost well away from areas where people gather. When grass clippings are stirred into these piles on an on-going basis during the growing season, the piles over time attract very healthy worm populations. After approximately two years, the home gardeners can harvest 'finished' compost from the middle of the pile.

The most promising way to cut down the amount of grass clippings, however, may be to encourage a new approach to landscaping using native plants, perennials, shrubs and trees to create beds and natural areas in place of vast lawns. Workshops encourage re-landscaping huge lawns, customary here, with a mix of grass and garden beds planted with the many desirable perennials that thrive in the Carolina Piedmont.

In spite of problems and lack of success thus far, trials of grass clippings in home compost continue, seeking ways to harness the N in the clippings. Shredding leaves and grass clippings with a lawnmower may be the best option for this (see shredding).

NITROGEN SUPPLEMENT-'BUDGET' AND 'ORGANIC'

Local trials confirm the axiom that leaf piles do not heat significantly above ambient and compost slowly without supplemental N. Since the objective of workshops is to teach a composting method that works reliably under local conditions (heats readily to thermophylic temperatures, causes no odor problems, gives a nicely finished compost in a reasonable amount of time), participants learn how to make home compost using an N supplement.

The main feedstock, autumn leaves, has a C:N ratio of approximately 80:1. A full bin of leaves contains approximately 40 kg of actual C. The Charlotte method adds supplemental nitrogen to bring the C:N ratio of each batch to approximately 30:1. Approximately 1.3 kg actual N is needed per pile to reach a 30:1 C:N ratio. The leaves contain about 0.5 kg N; thus, approximately 0.8-1 kg. N is needed to reach a 30:1 ratio.

Charlotte's home composting system uses a purchased N supplement. Charlotte, an urban area, has few readily available sources of 'scroungable' N, such as farm manure. While garden 'greens' (spent bedding plants, prunings, weeds, and so on) theoretically can provide N, locally sufficient quantities of 'greens' are not available for most urban composters (including most gardeners), particularly at the time of leaf drop in the fall. Grass clippings are difficult to home compost without problems, as discussed above.

Classes offer two choices for adding N: A 'budget' option and an 'organic gardening' option. Each workshop selects the type of N they wish to use in their model pile by majority vote (so far, the split has been about 50/50).

NITROGEN SOURCES FOR BACKYARD COMPOST			
N source	N %	$/kg N*	Amount required (kg)[1]
'Budget' N supplements			
30-2-2 (lawn fertilizer)	30	$1.29	3.3
48-0-0 (urea)	48	$0.77	2.1
Organic' N supplements			
5-2-2 (Espoma Plant-tone)	5	$15.84	20
Rabbit food ($7/bag)[2]	2.6	$11.85	38.6[2]
Rabbit food ($10/bag)[2]	2.6	$16.92	38.6[2]
Blood meal	12	$24.75	8.3
Charlotte compost[3]	2	$10.30	50
Chicken manure[4]	3	$18.33	33.3
Cottonseed meal	6	$26.40	16.7
Cow manure[5]	0.5	$11.00	200
'Recycled' N supplements[6]			
Coffee grounds	2	$0	71.4
'Greens'[7]	2.5	$0	114.3
Kitchen scraps	3.3	$0	150
Grass clippings	2.6	$0	152

TABLE 3: *Nitrogen sources for backyard compost*

Notes: * $/kg N: Since a 1m^3 leaf bin requires ~1 kg actual N to reach 30:1, the amounts shown in this column also represent the cost per pile of supplementing N using a given method. 1. Amount required: This column shows the amount of listed materail needed to bring a 1 m^3 leaf pile to 30:1 C:N. 2. Rabbit food: As explained in the text, inexpensive rabbit food in the least expensive way locally to buy alfalfa. Prices range widely, this shows a low and high cost. Though 38.6 kg is theoretically needed to reach 30:1, 22.5 kg (1 bag) appears to be ample based on trials. 3. Charlotte compost: Charlotte-Mecklenburg yard waste compost, bagged ("Eco" brand). 4. Chicken manure: 'Black Hen' brand, bagged. 5. Cow manure: Bagged. 6. 'Recycled' N supplements: These materials are available wiithout charge. Amount required reflects moisture content of the materials.

With either technique, the temperature of the interior of the composting mass reaches at least 20° C above ambient, (50° C (122° F), ± 5° C) within a week. For a summary of Charlotte's home composting 'recipes' and N sources, please see Tables 2 and 3.

Alternative N sources: Though workshops demonstrate making a pile using purchased N, the instructor discusses alternative free sources of N available locally to motivated and enterprising home composters, including horse or poultry manure, coffee grounds from coffeehouses like Starbucks and 'green' wastes from large gardens, produce sellers or juicers. If used in sufficient quantities, these all can be as effective as purchased N.

'BUDGET' NITROGEN SUPPLEMENT

For each batch of compost, 'the budget' option uses twelve cup measures (2.7 kg (6 lb)) of inexpensive lawn fertilizer (roughly 30-2-2 or the equivalent), along with three bags (54.6 kg) of inexpensive cow manure (0.5-0.5-0.5), adding four cups of fertilizer and 1 bag of manure per layer.

Rather than simply add N in the form of synthetic fertilizer, such as urea ($CO(NH_2)_2$) (48-0-0) or NH_4NO_3 (34-0-0, no longer readily available), I decided to 'enrich' bagged cow manure by adding enough synthetic fertilizer to reach the level needed for a 30:1 C:N ratio in the pile. I hoped to simulate farm manure, an ideal N source for

home composting but hard to find in Charlotte. In contrast, bagged cow manure is widely available locally for less than $1 for a 18.2 kg (40 lb) bag, with a cost of $11.00/kgN. Alternatives were to use bagged chicken manure (~3% N) or to gather manure from farms. The latter was logistically impossible; the bagged chicken manure was relatively expensive ($18.33/kgN, as 'Black Hen' brand), not readily available, and malodorous.

The fertilizer N carrier workshops use is inexpensive 'lawn green' fertilizer (~30-2-2), frequently on sale locally for ~$3 for a 7.7 kg (17 lb) bag, enough for three bins using 'the Charlotte method'. This is more convenient for the typical resident than buying large (22.7 kg (50 lb)) bags of N fertilizer. The price per kg N is $1.29/kgN, compared to $0.77/kgN for urea.

To my surprise, I observed that piles made with the 'supplemented' manure decomposed more rapidly and completely than those made with mineral N alone, though the amount of N in the two treatments was the same. Perhaps mineral N leaches from the pile readily in the absence of a material like manure, or the microbes (many heterotrophic) prefer amino N or N in an organic complex (urea seems to behave like mineral N, although it is a small organic molecule containing amino N). There is no guarantee, however, that this observation would hold up under more careful experimental conditions.

'ORGANIC' NITROGEN SUPPLEMENT

Many home composters garden organically, and are reluctant to use synthetic fertilizer in composting. Our first 'organic' recipe used cow manure as described for the 'budget' method, supplemented with an 'organic' fertilizer. Espoma 'Plant Tone' (5-2-2) with N carriers including dried manure and food processing wastes. This, however, was relatively costly (a 22.7 kg (50 lb) bag of Plant Tone cost $18, and provided N for roughly three piles, at a cost per kg N of $15.84). Other 'organic' N fertilizers, such as bagged chicken manure, cottonseed meal ($26.40/kgN) and bloodmeal ($24.75/ kgN), were even more expensive per unit N, and faced numerous objections from gardeners concerned about pesticide use (in cotton), sustainability and humane treatment of livestock.

I decided to research legume-based material as an 'organic' and 'sustainable' N supplement. Ground alfalfa was not readily available locally, but inexpensive rabbit food, largely alfalfa, was. Initial experiments were very promising, and workshops now use rabbit food as the 'organic' N source. In many ways, it is ideal for backyard composting; easy to handle, no unpleasant odor, relatively easy to obtain, with N fixed by bacterial action rather than industrial processes. Subsequent inquiries have revealed that rabbit food is a popular N source for composting experimentation. The only drawback is a relatively high price per kg N (between $13.75 and $17.19).

The 'organic' recipe for compost uses 22.7 kg (50 lbs) of inexpensive rabbit food (the least expensive local source of ground or pelleted alfalfa) as an N source, per batch of compost. Cow manure is not necessary in the 'organic' recipe using rabbit food.

The 'organic' method provides about 0.6 kg actual N, which when added to the 0.5 kg of leaf N gives a total of about 1.1 kg actual N for the pile. This provides a C:N ratio of about 42:1 for the pile. Curiously, in spite of the 'higher than optimal' C:N ratio, piles made with the rabbit pellets consistently heat more rapidly and to higher temperatures than those made using the budget method, and as little as 11.3 kg (25 lb, or a half bag) of rabbit food is sufficient to heat piles made May through September. During the coming season, I plan to test to find the smallest amount of rabbit food needed to obtain pile heating.

One caution: When using straw as a feedstock and 22.7 kg of rabbit food, and an overly-heavy watering of the pile, a marked odor nuisance from ammonia can occur, a problem I have not noted in piles made with leaves. The cause is uncertain - perhaps the higher pH of the straw and high moisture level contribute to NH_3 formation.

INOCULA

Charlotte's method does not use purchased inoculum. I teach composters to introduce beneficial microbes by adding about 24 liters (3 bucketfuls or 6 shovelfuls) of old or working compost to their pile as they build it. An equal amount of 'sweet smelling dark topsoil' can replace the compost. Although this traditional practice may not be necessary given the ubiquity of microbial life on Earth, it does no harm. Large scale composting operations often remix finished or partially-finished compost with new feedstock (Haug, 1993).

Adding large amounts of soil makes the compost very heavy and inconvenient to turn. Some Coop Extension pamphlets still call for 1/3 soil in compost piles, a recommendation I cannot support.

HOME COMPOST PRODUCED AND WASTE DIVERTED

In Charlotte, home composters typically compost between 1-4 m^3 (1-4 bins, or 1.4 to 5.6 yd^3) of 'feedstock' (mostly leaves) per year, or 150 - 600 kg of yard waste. Home composters who compost kitchen scraps can divert up to an additional ~365 kg (803 lbs) per year for a family of four. An 'active' composting family of four that makes four piles per year and composts all food scraps can divert as much as 965 kg (2123 lbs) of material from 'waste' to resource per year in their backyard.

Output from a home compost pile of the type used in Charlotte is about 0.3 m^3 (Table 2). The 'active' composting family of four can generate enough compost to dramatically improve five large flower or vegetable beds (2.7 m^2 (30 ft^2) each), or topdress 42 m^2 (440 ft^2) of garden or lawn annually. '(Improvement' assumes a 7.5 cm (~3 in) application of compost; topdressing assumes a 2.5 cm (~1 in) application.)

Using Charlotte's system, the start-up cost of materials and tools for the home composter is not high, from $0 (for those who already own needed tools and receive free bins) to < $50. The cost of purchased N is between $4 ('budget') and $10 ('organic') per pile. For the novice making a single bin using the 'budget' system who takes a workshop, the ~$26 retail value of 0.3 m^3 of compost (purchased by the bag) offsets the $5 class plus $4 cost of N.

WHY TEACH A SPECIFIC METHOD OF COMPOSTING HANDS-ON?

Communities face a dilemma in selecting the best strategy for encouraging home composting. One option is to demonstrate a wide variety of composting options, reflecting the myriad successful ways home gardeners make compost. The other approach, selected by Charlotte, is to focus on teaching a single composting method that works well.

Our experience is that beginning composters are hungry for clear guidelines, and are looking for a successful way to make compost, rather than 'a few simple rules' or long list of possibilities. At the same time, there are countless ways to compost successfully, and it is important not to discourage those who want to experiment or who have developed their own methods of composting. I do not present the workshop composting method as 'the only way to compost', but as simply a straightforward method that works, which individual composters can easily modify or adapt to suit their needs.

Workshops work best with minimum of technical jargon, lots of hands-on activities, and as much relaxed banter as possible. Technical aspects of composting discussed in this paper are an important part of designing and improving a composting method. Such topics may be appropriate for Master Composter training. But detailed discourses on C:N ratios and other technical questions are neither necessary nor recommended for general classes, especially with beginners.

TRIALS AND DISCARDED IDEAS

The author systematically observed compost piles made by classes and set up a number of trials using different composting techniques, though as yet no formal controlled formal experiments. These observations have been very useful in devising the composting method discussed in this paper. It is worth mentioning that some trials lead to the rejection of a number of compost-making ideas. These included covering or wrapping bins with plastic sheeting, using a 'breather pipe' of 20 cm (4 in) pvc in the center of the pile, and using clips to hold the wire in a cylinder. In sum, 'the simpler, the better' seems the best policy for home compost design.

IDEAS FOR THE FUTURE:

-- **Experimentation:** Formal experiments at the Compost Garden can yield valuable data. Ideal partners in this work would be faculty from area colleges and universities, science teachers, and Cooperative Extension agents. Diane Zablotsky of UNCC's Department of Anthropology and Sociology has already made outstanding contributions to a 'farming systems'-style ('composting systems'?) approach to gathering information on human factors and home composting behaviors.

Grass clippings: Although the bin taught in workshops is ideal for leaves, problems remain with grass clippings. Grass clippings are a major source of problems for the macro yard waste composting operation in Charlotte. This issue clearly highlights the fact that even well-designed home compost bins and workshops only address part of the need for yard waste reduction. Perhaps waste managers, Cooperative Extension Agents, and environmental groups can work together to design 'eco-landscaping' and 'eco-neighborhood' programs, where home composting is but one technique among many a resident uses to cut waste while improving soil, plant health and habitat. Reducing grass clippings may involve finding a better way to compost them at home, but programs may also want to consider teaching about grasscycling, mulching and lawn alternatives including ground covers, natural areas, and use of perennial and native plants in the landscape.

Kitchen scraps: Charlotte continues to look for an inexpensive, durable and rodent-proof kitchen waste composter for urban situations, especially for households where little dry C-rich material (such as autumn leaves) is available. Mecklenburg County is field testing the 'Green Cone' style micro-digester for this application, but Charlotte's difficult-to-dig red clay soils with poor drainage may hamper its effectiveness.

Schools and worms: The home composting system makes an ideal school science project. The author has used the method with great success with fifth graders. Developing a teaching guide and activities aligned with the North Carolina curriculum (and reflecting the current emphasis on literacy) merits a high priority because of its potentially high payoff (school children can be excellent 'motivators' for home composting and recycling). Vermiculture attracts a good deal of interest from schools and the public, and Charlotte is considering worm composting workshops for the future. Children find worms fascinating, but experience suggests that people with high enthusiasm, an active interest in worms, and sufficient time are most likely to succeed with vermiculture projects.

CONCLUSION

Charlotte-Mecklenburg's home composting workshops offer a model for other communities, especially those in the Piedmont region of the southeastern USA. By teaching residents 'hands-on' how to make compost successfully, using a simple, inexpensive and well-designed composting system, Charlotte has reduced wastes and helped gardeners enrich their soils and manage their yards in a more environmentally sound and sustainable way.

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