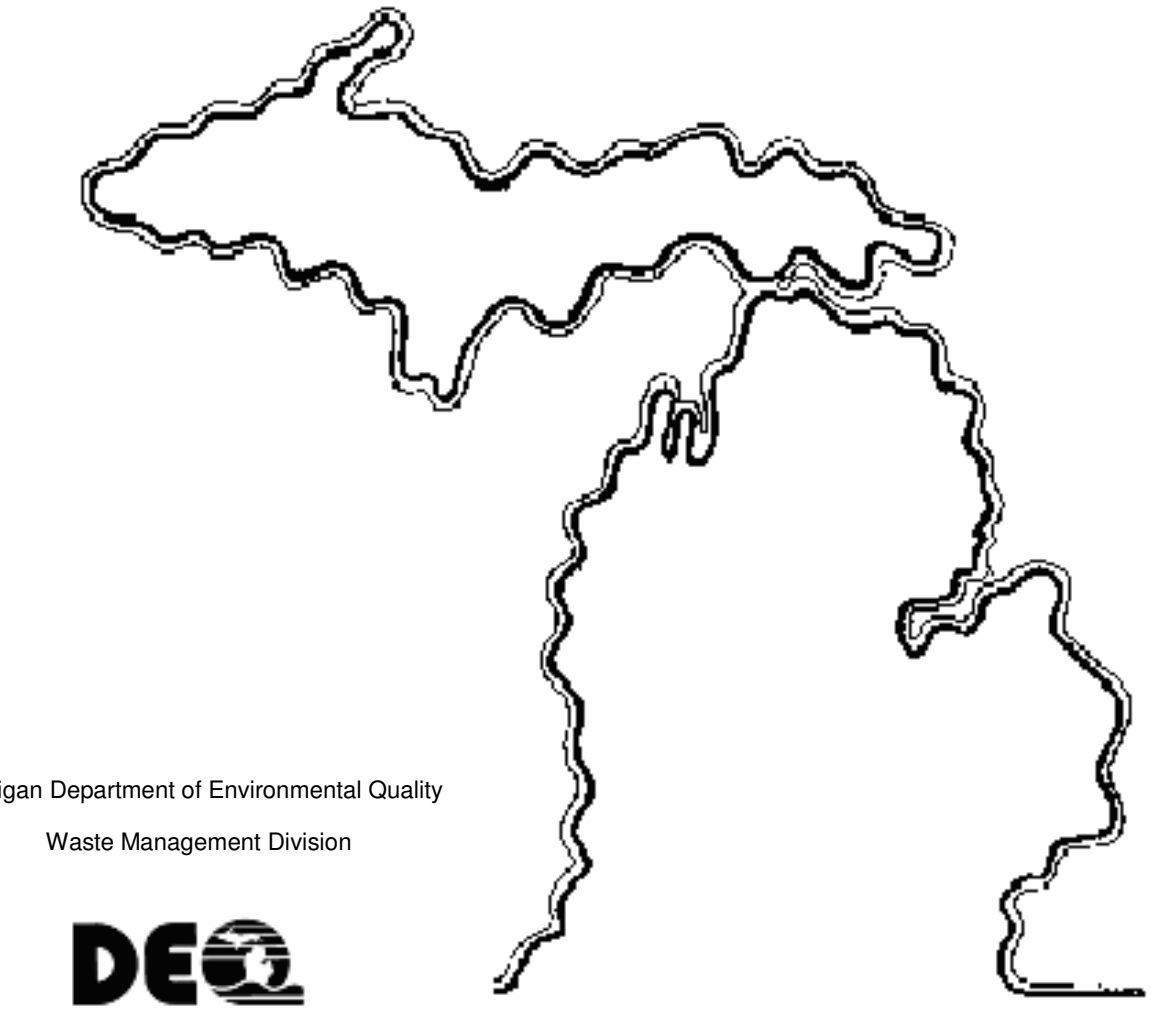
MULCHING
and
BACKYARD COMPOSTING

Guidebook



Michigan Department of Environmental Quality

Waste Management Division

DEQ

Mulching and Back Yard Composting Guide

for Michigan Residents

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Mulching and Back Yard Composting Guide

Yard waste need not find a home away from home. It is one part of the waste stream that can be managed in our own back yards. Solid waste management is everyone's responsibility. Each person should be able to find new and more effective ways to lessen their community's dependence on landfills. The State of Michigan's Solid Waste Policy focuses on the need to reduce the volume of waste generated. An important area in which we can reduce waste is in our own back yard. Yard waste can represent up to 20% of the solid waste stream and is a segment that can be reduced through education and conservation techniques such as mulching and composting.

This guidebook is an introduction to the principles of organic material resource recovery for residential use. For those interested in learning more about municipal composting, the Michigan Department of Natural Resources publishes a "Yard Waste Composting Guidebook for Michigan Communities"

Yard Waste Does not Just Disappear

Many communities have discovered that yard waste does not simply disappear by a vote of the City Council. Mulching, back yard composting, separate collection, and municipal composting are programs that do not spring up overnight. Most Americans have become accustomed to the convenience of regular yard waste collection services and often take trash disposal, like other utilities, for granted. Public outcry has caused many a mayor to regret signing a "sudden" yard waste ban without winning over community support well in advance. Citizens have shown themselves ready to change their yard management habits, but they typically want information and time to make a gradual transition over to the new regulations. Mulching is a concept that needs to be "sold" to the public before it will become a more widespread practice.

Mulching

The technique of mulching is the easiest way to avoid generating organic waste in the first place. Leaving grass clippings on the lawn is the simplest type of mulching. Mulching, however, is not practical for all residents and every home and not all yard wastes are easy to use as mulches. Brush must be chipped before it can be used as mulch, and few residents own brush chippers. Many communities operate municipal wood waste chipping programs using the wood mulch in public areas such as parks and roadways.

Composting

Some yards have simply too many leaves to use on site as mulch. Composting is the recommended technique of organic waste reduction for yard waste that can not be mulched. Back yard compost bins should be used when mulching is not practical. Municipal yard waste composting programs are the solution for waste that is not mulched or composted at home. Municipal composting facilities can be kept to a manageable size if residents pitch in to keep yard waste off the curbside by learning proper organic waste management practices. Mulching and composting can keep yard waste out of the landfill.

A Composting Story

An operator of a municipal composting program describes his industry like this: "In my business, I have thousands of "farmers" who grow a crop for me. This is a special crop that generates no revenue for the farmer, feeds no animals or people, but they fertilize and water it just the same. These farmers harvest the crop weekly and purchase expensive plastic bags to contain the harvest. Then they pay either the government or a private trucker to collect the containers and bring them to me where they pay again to have me dispose of the packages and do something to make their crop disappear! What I do with it is turn it into a soil enhancer, screen it, put it into even more expensive plastic bags, and sell it back to these same farmers so they can produce more of the crop that they are so willing to pay to get rid of. What a country!"

Of course he was talking about the process whereby grass clippings are bagged, collected, and converted into compost in a municipal composting operation to be sold back to residents as organic soil amendments. Paying for collection and composting, however, is far better for the environment than sending grass clippings to the landfill. Before the municipal option is implemented, a public education program on the benefits of mulching can go a long way toward reducing the quantity of waste generated, possibly reducing the cost and scope of any centralized program.

Yard Waste Disposal

Municipal yard waste disposal causes a number of problems. Grass clippings in the landfill take up valuable space, generate explosive methane gas, and contribute to leachate that can contaminate ground water. Plastic bags use fossil fuels and are difficult to recycle. Separate yard waste collection is expensive and can cause taxes to rise. Municipal composting operations can be as difficult to site as landfills. The cost of operating a yard waste composting site is many times greater than the resale value of the finished compost. Dealing with plastic bags at the compost site often adds ten to twenty dollars per ton to the cost of processing.

These problems can be avoided by practicing proper mulching techniques and using back yard compost bins. Twenty percent or more of the solid waste volume can be eliminated through mulching and home composting of yard waste. Solid waste cost is one area where residents can do something to reduce government spending.

The Economics of Mulching

Mulching should be seen as an economic issue. Leaving yard waste at home is a means whereby the homeowner can stop paying for the plastic bags, the trash hauler, and the waste disposal operation. Mulching means lower taxes. While the savings vary from community to community, costs ranging from $50 to $100 dollars per ton are typical for many communities for the collection and disposal of solid waste. If each householder could divert one ton of yard waste per year from the curb, the community might realize a savings of up to one hundred dollars per household.

Mulching and composting are ways homeowners can manufacture their own black dirt topsoil and soil amendments. At three dollars per cubic foot bag at the garden center, one cubic yard of mulched yard waste represents a savings of over eighty dollars. If one cubic yard of compost can be blended to make ten cubic yards of topsoil, then a yard of compost can equal one truckload of black dirt worth at least one hundred dollars.

Once cost benefits can be shown, the citizen can further enjoy knowing that they have done their share in reducing our dependence on landfills while experiencing first hand the satisfaction of conserving natural resources. Like those who enjoy feeding wild birds, mulching is a means of feeding the soil ecosystem and the associated plants, trees, and landscape that give us pleasure while also appreciating the value of the home.

Pitch-In for Resource Recovery

With new legislation banning yard waste from landfills and other waste disposal facilities, mulching is increasingly becoming a civic responsibility. In terms of tons diverted from the waste stream, yard waste recycling in many suburban environments can exceed the weight of aluminum, tin, glass, and newspaper combined. Some communities are instituting user fees and new household trash rate increases for those individuals who choose to continue to put yard waste out with the trash. Yard waste management is becoming less a public necessity and more a luxury that suggests a "pay for service" program.

As you read this guidebook, you will find some practical ideas and suggestions that could modify your household landscape management practices so that the volume of organic waste at the curb can be decreased. There are other sources of information listed in the bibliography. Your local county extension agent, garden center, hardware, and library should be able to provide additional information regarding a more natural and ecologically responsible lifestyle.

Part 1 Mulching

Mulching - Nature's Composting Secret

Mulching simply refers to any technique whereby organic matter is spread in thin layers on the surface of the ground and left to decompose naturally so that soil organisms can convert it to humus - decomposed organic matter in the soil. Decorative bark layered around shrubbery is popular mulch. Wood chips are often spread around trees and landscaping to hold moisture. Grass clippings, leaves, and compost can be placed around garden vegetables, flowers, and in soil beds to keep down weeds. Leaving blades of grass on the lawn is the most common residential mulching technique. All mulches help retain water in the soil. Mulch keeps the soil cool in the summer and warm in the winter. Mulch is a form of drought insurance.

Mulching is Nature's waste recycling system. Nature spreads thin layers of organic waste evenly over the surface of the soil. Year after year, season upon season, leaves and blades of grass mature, die, and fall to the ground. Soil organisms begin the process of decomposition. First molds, then bacteria, later earthworms and beetles come to return organic matter back to the soil from which it came. In this process of natural mulching, topsoil is gradually created over time, as rich layers of humus are formed that give the soil its dark color and its good "rich earth" smell. (See Figure 1)

Do you have an answer to the question, "Why do I bag my grass?" Certainly no one is forcing you to spend the extra time and effort. There are numerous models of mulching mowers available. The landscape experts say there is no scientific reason to collect grass clippings. Grass clippings are not collected at golf courses, the home of the master turf professionals. Extension agents are recommending leaving grass on the lawn. Many municipalities are ceasing yard waste collection entirely. It seems that if residents were taught how to mulch, mulching could take the place of bagging.

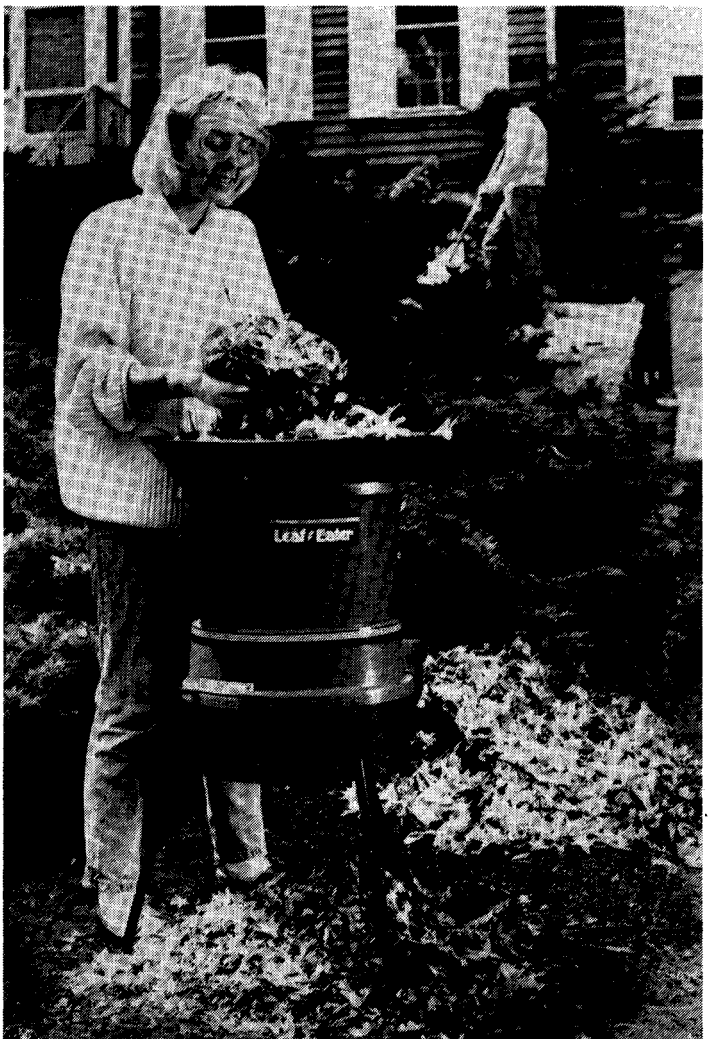
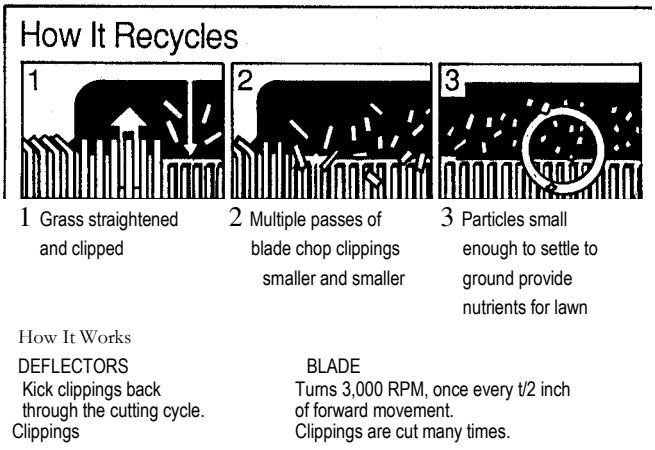


Figure 1

How to Mulch Grass Clippings

The easiest way to start mulching is to take the grass catcher off the lawn mower. Your mower service agent should be able to put a trap door over the discharge end if your mower does not already have one. For conventional side discharge mowers without a trap door, mulching may require a bit of raking following mowing to break up the little rows of clippings. To avoid raking the entire lawn, mow from the outer edge in ever smaller circles toward the center, making sure that the side discharge mower is "walking" or blowing the grass clippings ever closer to the central point. In this manner, clippings are chopped several times and most fall between the blades as mulch. The few that are left near the center can easily be raked and placed into the compost bin or spread in the garden.

Mulching mowers have become quite popular in recent years and their new features are proudly displayed by dealers. Advertising campaigns are helping convert homeowners over to these new "zero discharge" mowers. Mulching mowers are designed differently from conventional mowers with closed trap doors. The first difference is, of course, the lack of a discharge point and a catcher. The second is the horsepower rating, since mulching mowers require more horsepower to cut and re-cut the grass. The special blade not only cuts, it also acts as a vacuum and fan that circulates the clippings back to the blade for additional pulverizing. The air pressure then forces the chopped clippings downward into the lawn. (See Figure 2)



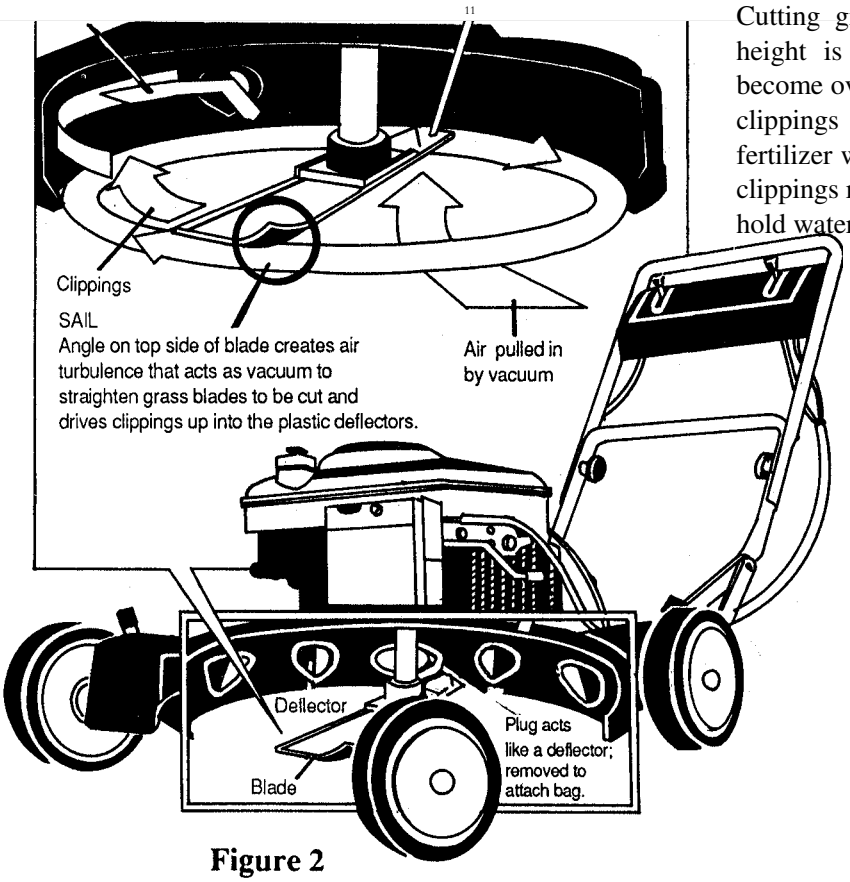


Figure 2

Mulching mowers require a lawn that is not overly wet and has not been left too long between cuttings. The height of the grass should be somewhat higher than typical settings for bagging mowers and the lawn is best cut when the grass is one third higher than the height of the blade. For the average lawn, if the grass is left at two inches following mowing, (See Figure 3) the grass would be cut when it reaches three inches. While the new system takes some getting used to, user satisfaction is running near 100% for those who have made the switch. The lawn must be mowed more often than with conventional mowers, but the time actually spent in the yard is less because there is no need to continually stop and empty the catcher. Mulching mowers should be used every five to six days instead of every week.

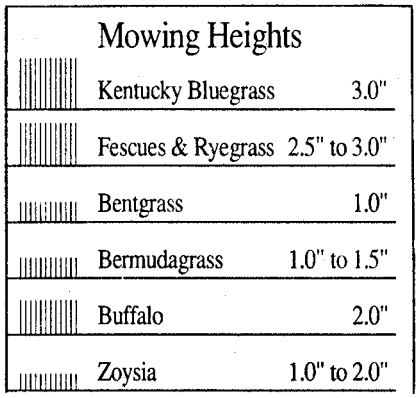


Figure 3

Cutting grass higher and with only one third the blade height is easier and faster than cutting grass that has become overgrown. Fertilizing can be decreased since grass clippings contain 4% nitrogen and act like a time release fertilizer when they are returned regularly to the soil. Grass clippings return to the soil to form organic humus that helps hold water while keeping the soil loose and aerated.

When asked in a recent survey in Texas, many householders stated that the main reason they bag their grass is to avoid generating thatch. While thatch is a problem in many lawns, turfgrass specialists have numerous studies that show that GRASS CLIPPINGS DO NOT CAUSE THATCH to build up. Thatch is caused by high-lignin stubble at the plant base derived from roots, rhizomes, crowns, and stolons that decompose slowly. The green clippings contain little, if any, lignin and decompose quickly. If anything, mulching green grass clippings

can actually help decompose thatch by supporting a healthy soil ecosystem. With grass mulching, some lawns may need additional aeration and watering to help soil organisms decompose the grass clippings properly, especially during dry periods.

"Don't Bag It"

In the summer of 1989, in Fort Worth, Texas, a revolutionary lawn care project was initiated. As a part of the "Don't Bag It Lawn Care Plan," nearly 200 volunteers signed up for a program to end the bagging of grass clippings. A joint effort of the City and the County Agricultural Extension Service asked civic groups to help publicize the program and solicit volunteers. Press releases and conferences were held two weeks before the kick off date. Flyers were sent to residents explaining the "Don't Bag It" program. Meetings were scheduled in neighborhoods, especially those where bagging was popular. Demonstrations were held and volunteers recruited.

Those selected for participation were given signs for their lawns indicating participation in the "Don't Bag It" program. (See Figure 4) They were counseled individually by a member of the Master Gardener program on mulching and mowing techniques. Each was provided with free lawn fertilizer and specific instructions on the rate of application. Toro Industries provided mulching mowers to each of the applicants for use during the demonstration.

Figure 4

Over 98% of the participants stayed with the program. There were follow up sessions to encourage "backsliders" from giving up before the end of the season. Surveys were distributed and the results tallied. The final survey results showed that the average time to mow the lawn before the "Don't Bag It" program was 93 minutes. The average time after the program was 58 minutes. It took 38% less time to mow without bagging clippings. The lawn was cut an average of 4.1 times per month before the program and 5.4 times after. The homeowners rated their lawns at 2.4 on a scale of 1 to 4 (with 4 being excellent) prior to the program. Following the experiment, they rated their lawn at 3.4, a 30% improvement. 92% expressed satisfaction with their lawns; many noted that their lawn looked better than it had in years.

With its vast open areas, Texas is not facing the same landfill space crisis as the Great Lakes area. If Texans can be encouraged to mulch, certainly Michiganians can rise to the occasion. Mulching grass clippings improved lawn quality, saved time and money, and helped foster community pride. Objections faded once residents had encouragement, education, and practical experience. Mulching is proving to be the lawn management program of the future.

Leaves

Leaves can also be mulched. Leaves left on the ground over the winter will not harm the grass which goes dormant in the Michigan climate. Winter puts leaves through a "freeze thaw" cycle that helps soften them for decomposition. Winter snow and spring rains provide needed moisture for the subsequent breakdown.

Leaves can be gathered and placed into wooded areas for mulching. They should be spread evenly, never more than six or eight inches deep. Random and unattended piles several feet in height are neither mulch nor compost. Take the time to spread your leaves evenly so that they can decompose properly. If you have no natural undergrowth areas on your property, be sure to ask permission of any adjacent landowners to spread leaves in their woodlands before using it as your disposal site. At no time should you use vacant lots, ditches, rural areas or piles over the fence as dump sites. Mulching is the beneficial use of organic

matter that also happens to solve a disposal problem. Dumping leaves is a public nuisance and is often punishable by fines.

Leaf mulching can be assisted by chopping, shredding, or mowing the leaves before using them as mulch. Care must be exercised when handling dangerous chopping equipment. Make sure that your machine or mower is rated to handle leaves and that all necessary safety precautions are used. Safety glasses, gloves, and heavy clothing are wise items to wear around all pulverizing equipment.

Leaves that are placed in large piles in the fall tend to insulate themselves and shed water, looking much like they did months before. If leaves are gathered in the fall, they should be moistened several times, layer by layer, to aid decomposition. If possible, spread leaves over the garden, in flowering beds and wherever there is open soil.

Earthworms – The Mulching Assistant

Earthworms are the ultimate mulch specialists. The common night crawler, *lumbricus terrestris*, is a seasoned mulch hunter. Following every rain, or in the cool, moist mornings, hundreds of earthworms come to the surface to feed. These "mulch munchers" grab leaves, blades of grass, and other bits of organic matter and tow them back to their burrows. Deep under the soil, these worms store organic matter, excrete digestive juices to help them decompose, and feast upon the resultant compost at a later date.

The worm devours the decomposed mulch and deposits the waste in the burrow and on the surface as earthworm castings. Since the worms continually excavate and turn the soil, the humus layer remains near the root zone while the surface is continually cleared of debris. Earthworms will maintain a population level equal to the available feed, or mulch. They keep the soil loose, aerated, and well drained. Working in harmony with other organisms, earthworms turn under the seasonal mulch layers, "vermicompost" it and convert it to available plant nutrients.

Many gardeners have had success introducing any of several species of redworms to their lawns and gardens. Redworms devour the humus layer of the soil voraciously, quickly turning mulch into castings. Native to temperate river deltas, redworms require moist, well drained, rich topsoil with plenty of mulch. They can not make a poor soil good, only a good soil better. The aeration and mulching benefits provided by redworms is hundreds of times that of the less active night crawler. A few dozen redworms purchased at the bait store or a few thousand ordered through the mail are often sufficient to get started. A good book on using redworms is Mary Applehof's Worms Eat My Garbage which is listed in the bibliography.

Part 2 Composting

The Biology of Composting

While "germs" and bacteria have earned a negative reputation for causing disease, micro-organisms are essential to the natural process of decay and perform the healthful and beneficial service of decomposing dead organic matter and converting it into plant nutrients. The earth would be cluttered with the bodies of dead plants and animals were it not for natural organisms that convert nature's waste into humus. Compost is a method of harnessing these organisms to rapidly accelerate the rate of organic waste decomposition.

Nature does not build piles of organic matter, mix in water and nutrients, turn the pile, and spread finished compost over the countryside. Nature mulches using thin layers and lets low temperature or "mesophilic" organisms do the decomposition at temperatures up to 120°F. Composting uses a different group of "thermophilic" organisms that operate at a higher temperature range from 120°F up to 160°F. It is the organisms themselves that generate this heat from the organic matter.

Like the coal, oil, or natural gas that living material could eventually become if it were left to accumulate over time, organic matter contains energy. It is the biology and structure of the compost pile that releases this energy in the form of heat. To compost means to utilize these high temperature organisms of rapid decomposition to convert organic waste into humus in a matter of months rather than years. To maintain the thermophilic temperatures, a means must be provided to keep this heat from radiating away. This is the purpose behind piles and bins.

Composting can be understood as a type of bacteria farming. Like other forms of livestock, micro-organisms need food, air, and water. Food is the organic waste. Air is provided by mixing and aerating. Water comes from rainfall and the garden hose. With the proper balance of food, air, and water coupled with sufficient volume to hold heat, micro-organisms will thrive and generate heat to initiate and sustain the composting reaction. The colonies of bacteria will reproduce of their own accord and convert the food into their own bodies and by-products. The dark appearance of compost is actually billions upon billions of decayed micro-organisms.

In this marvelous process of decomposition, there are types of organisms at work other than bacteria. An entire eco-system of molds, fungi, actinomycetes, and other organisms feed upon the waste and the byproducts of other organisms. Macro-organisms such as earthworms, nematodes, beetles, insects, and a host of invertebrates graze upon the cultures of micro-organisms. This decomposer food chain is the vital living system that connects the soil with the plant and animal life on the surface.

Nature has an arsenal of organisms ready to decompose waste whether it is mulched or composted. The relationships between food, air, and water determine the RATE of decomposition. Even without air, there are anaerobic (without air) organisms that can decompose waste. Instead of releasing heat through decomposition, these organisms release natural methane gas, (CH_4) and hydrogen sulfide (H_2S) which is characterized by a rotten egg smell. Anaerobic decomposition is the major cause of odors and should be avoided in back yard composting. It is the action of man that determines whether residential organic waste is decomposed mesophyllically by mulching, thermophilically by composting, or anaerobically.

The decomposition process can be delayed and modified, but it can never be completely halted. Nature will eventually recover organic waste whether we mulch it or compost it. It is our actions that foster or hinder the natural process. Mulching, passive, and active composting are the three means by which we promote organic waste reduction, and the rate of decomposition is determined by the success of our efforts to condition the food and provide air and water.

Passive Composting

If yard waste is left to accumulate in a pile for extended periods of time, it is no longer mulch and begins to enter into the realm of composting. The simplest compost piles are increasingly larger mounds of organic waste that are left to sit and rot over time. The householder often cares little for using the dark and crumbly material that appears after several years.

These "passive compost" piles are largely a back yard disposal system.

For many people, odd piles in the corner are hardly a clutter or a bother and these individuals avoid the effort of watering and turning an active compost pile. Rainfall, earthworms, and nature are left to do their work, and given time, decompose organic material fairly well. Passive composting piles can take many forms. Some are piles in the corner, others a means of filling in low areas. Some people take the time to dig a trench and bury their organic waste.

When considering passive composting, there is some wisdom in the practice of just letting sleeping piles lie. Passive compost piles can be quite odorous if disturbed before their time. However, if the pile is never turned, there is little need to worry about odor. It is primarily the need for space, the desire to concentrate organic waste in a controlled area, and a need to process waste quickly in a nuisance free manner that leads people to build compost piles that require regular tending. For others, the passive attitude of "let it rot" is quite serviceable.

There is no "one way" or "right" method of disposing of yard waste. If our goal is to reduce the dependence on landfills, mulching and rotting are just as effective as active composting. People are encouraged to be creative and to experiment within the bounds of neighborly cooperation. Some individuals have made satisfactory, although somewhat odorous, compost just by letting grass clippings sit in sealed plastic bags for a season in the sun. One master gardener uses a three pile system that he turns only once a year, producing rich humus in the third year.

Mulching versus Composting

Active composting has an advantage over mulching in that diseases and weed seeds are destroyed when a compost pile is sustained at temperatures of at least 131°F for extended periods of time. Without active composting, tomato blight and other diseases can be spread into the next season's garden. While composting "cooks" weed seeds with high temperatures, mulches help smother weeds. Active composting has the benefit of rapidly decomposing organic waste, whereas some mulching process can take one to several years.

However, thin layers of grass left on the lawn decompose at least as rapidly as they would in the compost pile.

Mulching is an excellent example of a "keep it simple" program. Soil organisms are perfectly capable of decomposing leaves and grass clippings without the high "thermophilic" temperatures of compost piles. Nature doesn't gather thin layers of organic material into a concentrated pile, water the layers, turn and aerate the heap, and later spread the finished compost back into thin layers. Thin layers are often best left as thin layers. The roots of plants care little whether the organic matter in the soil was produced from the best hot compost piles or from years of accumulated thin layers. Organic matter is organic matter and the soil benefits regardless of the technique of application.

Active Composting

Composting need not be a mysterious ritual that conjures up visions of alchemists spinning straw into gold, nor need it be an overly technical or scientific discipline that requires rigid adherence to a set formula. Simply stated, the right way to manage yard waste is to leave it at home. If the mystery is too great or the technical information overwhelming, skip these sections and go back to mulching or letting piles rot. There is certain to be at least one technique of recycling yard waste that is suitable for every lifestyle and budget. For those interested in high rates of decomposition, volume reduction, odor control, and process efficiency, the active composting process is the recommended technique.

Active composting is a process of maximizing the natural decomposition of organic matter to produce stable humus in as short a time as possible in a minimal amount of space without generating odors or other nuisances. It is characterized by various degrees of mixing and aeration within a controlled mass of organic material and moisture. When properly managed, an active compost pile generates temperatures over 140°F and reduces the volume of the original waste down three to ten times in as little as thirty days. Active composting involves either a bin enclosure or a properly formed pile without a bin.

Active composting requires the following steps:

A. Preparing the Composting Area
B. Choosing Your Bin
C. Stockpiling
D. Inoculating
E. Mixing
R Feeding the Compost
G. Watering
H. Aerating
I. Active Composting

A. Preparing the Composting Area

Before beginning the active composting process, the composting area must be properly prepared. Start with an empty bin or space on the ground where you wish your compost pile to be located. Make certain your space is well drained and that storm water runoff from the roof or the yard will not reach the composting area. Choose a point that has a higher elevation than the rest of the yard, if possible, but make sure that it is within easy reach of the garden hose because, like house plants or garden vegetables, the compost pile needs occasional light watering.

Many gardeners establish their compost area on the edge of the garden since this is where much of the compostable material comes from and is often the place where most of the compost is used. If you don't have a garden, this may be a good time to start one. Many gardeners say that compost is the secret to tastier home grown vegetables. An area where a landscape project is contemplated is also a good location for the compost bin. The wise landscaper knows that compost enriched soil yields long term growth dividends for trees and shrubbery.

Appearance and aesthetics are usually as important as proximity to the intended use for the compost. In selecting a location, make sure that there is plenty of area adjoining the composting area for stockpiling, additional active compost piles, and wheel barrow access. The ideal composting area for most homes is a clear area, away from trees and landscaping. A 12' x 9' open area is more than sufficient, but a 6' x 6' area should service a single bin quite satisfactorily. Avoid tight and cramped corner spots. Provide plenty of room to access the working area with a pitchfork from all directions.

B. Choose Your Bin

With proper compost preparation, piles can be made to heat and decompose adequately without the need for bins. The main purpose of bins and enclosures is to help hold heat by keeping the composting mass as close as possible to the active composting center. Bins also allow air infiltration from the sides in small piles, assisting the "chimney effect" of warm air rising and aiding ventilation. Bins are an advantage since they help the pile look neat, containing unsightly waste within an enclosure.

Avoid using an existing building or wooden fence as a side wall since an active composting pile will decompose walls, discolor paint, and destroy wooden fence slats. Use galvanized metal, plastic, or cedar for rust and decay prevention in the construction of the bin. (Redwood is decay resistant but comes from "old growth" forests and is considered by some to be a non-renewable resource.) Do not use treated lumber because it contains compounds that may contain heavy metals or toxins that could leach into the compost. One recommendation is to use recycled plastic or bins made with scrap cedar. Enclosures of chicken wire, hardware cloth, and other types of wire mesh are popular. (See Figure 6)

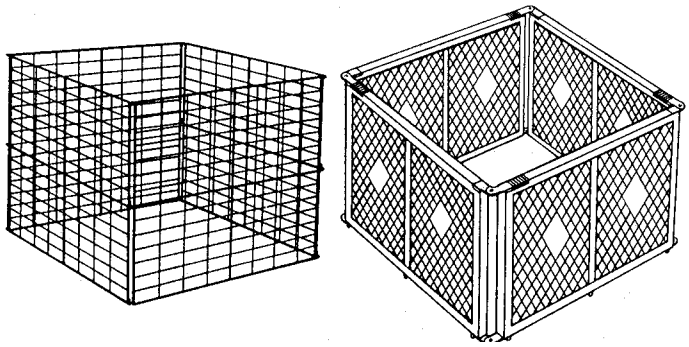


Figure 6

A wide variety of back yard compost bins are available, many of which have been proven to promote active composting when used properly. A partial list of bin manufacturers is provided in the appendix. Avoid bins with solid sides that keep out air and choke the compost. Several manufacturers sell cedar slat bins that assemble like "lincoln logs" with open sides and can have modules added to expand into three separate bins. (See Figure 7) While the three bin system

is recommended in many gardening books, their disadvantage is that the adjacent sides have no open area from which to draw air. An advantage is that less heat is lost from adjoining sides. 55 gallon drums set upon blocks with holes perforating the base and sides can be effective compost bins.

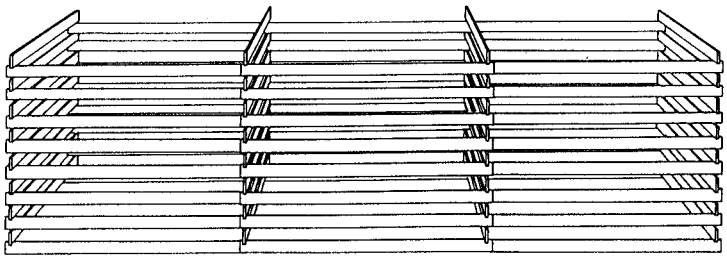


Figure 7

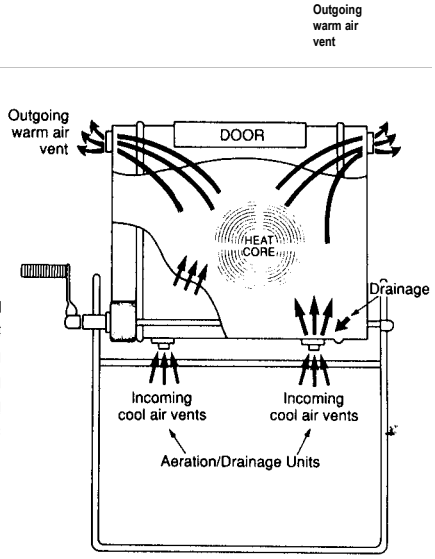


Figure 8 a

If no bin is desired, a "stand alone" pile of 5' in diameter by 5' high (1.7 cubic yards) is optimum, although a small area at the base of the pile should be cleared to allow one end of a passive air flow system to reach the open air (See Figure 9). Since the air entering the sides of the pile is as critical as air entering from the bottom, a 5+ cubic yard pile that is 4' wide by 4' high by 9' long has more surface area and better air access than a pile that is 6' by 6' by 4' high. Too large a pile has the danger of overly compacting its contents and restricting air flow.

A rotating barrel is another composting option. (See Figure 8) Barrel composters range in size from seven cubic feet up to twenty. The larger tumblers have been described by some users as difficult to turn due to their weight. Barrels are excellent mixers and condition organic material quite suitably in preparation for active bin composting. For those choosing rotating barrel composters, a bin is still necessary for higher quantities of waste, since most tumbling barrels have only a limited capacity. While barrels represent a significant added cost, many composters appreciated the material conditioning, process control, and mixing efficiency they provide.

Easily removed sides are desirable in a compost bin. Some bins have slats that are removed by pins. Others have individual panels that slide out from the top or side. Still others have removable panels or hinged gates. Wire or plastic mesh systems often have fasteners that hold the two ends together. Removable sides also make turning and aerating the compost easier, so the composter is more inclined to actually use the bin and to turn and mix material regularly. Be cautious of some bins that have doors that are too small to remove compost since compost does not flow freely like grain or other materials.

Once the bin design is chosen, a suggestion is to construct two or more free standing bins separate from, but close to each other. Sizes range between 3/4 cubic yards to 2 cubic yards in volume, such as a 3' x 3' x 3 square, 4' x 4' x 3' square, 4' x 4' round, or a 3' x 3' or 2' x 2' five or six sided bin.* Three foot widths are considered the minimum if the pile is to hold sufficient mass to heat properly.

*Cubic yardage equals the length in feet times the width times the height divided by 27. (L x W x H ÷ 27) The area of a round bin is calculated by multiplying pi *(n)* (3.141) times the radius squared times the number of feet in height. (RI x *n* x H) A bin, three feet round and three feet high, contains 1.13 cubic yards. (1.5 x 1.5 x 3.141 x 3) A four foot diameter round bin four feet high contains 1.86 cubic yards.

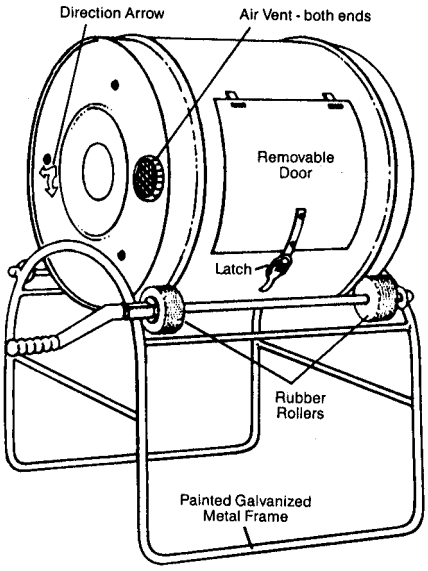


Figure 8 b

In choosing a bin design, always remember that it is air, not the container or the materials the sides are made of, that is the secret to successful composting. Four or six inch panels, even with several inches between them, often seal out too much air. The more open area, the more air can come into the pile. A bin with ventilated sides providing access to air from all directions is the most functional bin design. While an underside passive air flow system can help, it is no compensation for a poor bin design or inadequate mixing. Avoid air-tight bin designs unless you are prepared to let organic material sit for over a year and generate odors.

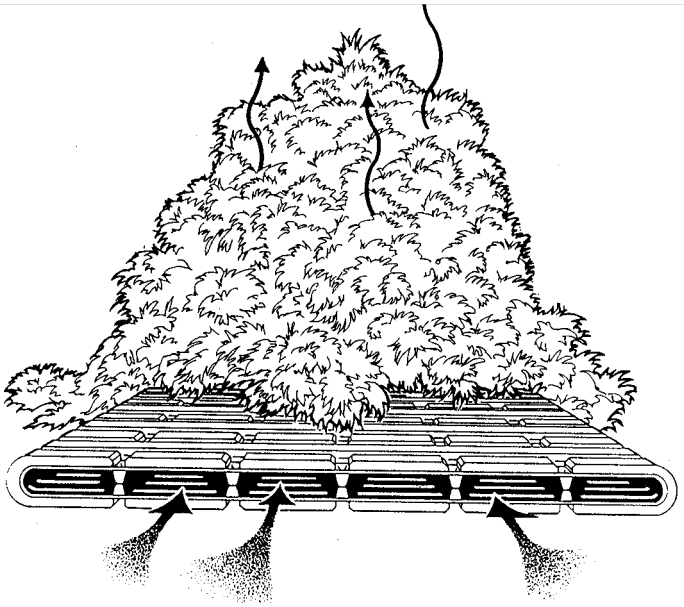


Figure 9

A passive air flow system can provide a professional, high-rate composting process with inexpensive materials. There are several techniques for creating passive air flow within the compost bin. The original air flow bed is referenced in the Rodale (Organic Gardening) composting books and is constructed by fastening a 1/2" section of hardware screen cloth over a series of 2" x 4" boards set on their 2" ends at four to six inch intervals sufficient to form a support base of the bin. (See Figure 10) The space between the boards is left open at one end while the other is sealed with a board to stop air from flowing out again from under the bin. This "elevated floor" technique enables air to be drawn in to the base of the pile and rise upward through the center of the pile via the natural "chimney effect."

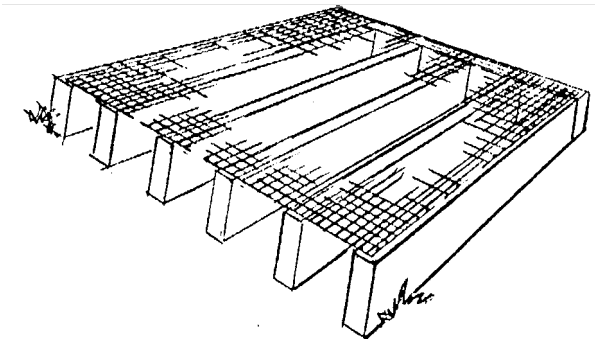


Figure 10

Another approach is to use several lengths of 4" diameter flexible HDPE or rigid PVC perforated drain tile and build a ventilation floor under the compost with the pipes running parallel to each other. The pipes should be exposed on one end with the other buried in the compost or sealed. One manufacturer sells a passive air flow ventilation mat specifically for this purpose that is 36" x 18" x 2" and is placed under active compost piles.

The bin design and layout should be looked at from the point of view of the person doing the mixing. Does the bin require that the person reach over the sides to lift out material? If so, the bin should be torn down to start over with a better bin design. Repeated heavy lifting from a reaching position has been identified as a major cause of back injuries. Be certain that there is plenty of working area around the compost bins so you can get at the pile with proper leverage and without straining. A bin design with sides that can be disassembled and reassembled quickly will make pile turning easy.

The most elaborate systems have two or three active composting areas, depending on the quantity of the material being composted. The true composting believer will pick up yard waste from a neighbor's yard in order to keep the bins fully active, keep material out of the landfill, build up the topsoil, and enjoy some exercise. A three bin active system allows the composter to keep sufficient space available for blending in fresh material.

Once you have chosen your composting area and constructed your bin(s), the active composting process is ready to begin.

C. Stockpiling

While there is a natural tendency to immediately fill the compost bin with fresh organic matter and hope for the best, the wise composter waits until there is sufficient material accumulated to properly start the composting process. Separate from the active compost bin should be an area where grass clippings, leaves, and other soft stemmed yard debris can be stockpiled. When starting a compost pile from scratch, it is important to have about one cubic yard, or the capacity of your active composting bin, of raw material before you begin. This may require stockpiling or seeking extra raw material from the neighbors. You can also anticipate needing half as much material following thirty days to refill the volume lost during the initial phase of active composting.

When stockpiling green material such as grass clippings, you should turn the stockpile to keep the material aerated while waiting for the active composting process to begin. Once the active compost pile is established and there is an existing quantity of rich, active compost to use for blending, then fresh material can be added without the need for stockpiling. Additional grass clippings or leaves should be watered and mixed with active compost culture in the mixing area before placing them into an active composting pile. This will help prevent passive compost from plugging the natural aeration of the active compost underneath.

D. Inoculating

It is important to recognize that there are two important processes in composting: starting and sustaining the composting reaction. The key to both is mixing. Mixing at the start of the composting process is essential because all raw organic material must be inoculated with micro-organisms before the composting process can begin in earnest. The essential micro-organisms are already present in the leaves and grass clippings, but evenly distributing high populations of the organisms throughout the material accelerates the composting process tremendously. Composting is like starting a yogurt culture, or adding yeast to bread. The active culture must be thoroughly blended in order to produce the desired effect.

Several compost inoculants are available on the market which claim to accelerate the composting process. Some are active bacteria cultures that may help the inoculation process when first initiating the active composting process. Others are enzymes or special bacteria designed to rapidly decompose straw or fibrous material. Still others are blends of exotic nutrients that provide nitrogen as well as micro-organisms. Many composters report positive results using packaged inoculants. However, millions of active composting piles have been created and have generated wonderful compost without extracts and supplements. The existing beneficial micro-organisms in the waste or the added culture from an active composting pile will provide the all the essential micro-organisms sufficient to initiate active composting.

If you have no compost pile to start with and your topsoil has little organic matter in it, you may wish to purchase some inexpensive bags of composted cow manure from the garden center or harvest some old leaf mould from a wooded area to help start your composting culture. Once you start your culture, always leave the bin 25% full of old compost as the seed culture for next batch. There is no reason to keep excess amounts of cured compost in the active bin area if the space is needed for fresh material. Once a pile has cooled, compost can be taken out of the bin to finish curing on the ground. The bin is primarily for heating and aerating. Once you start the composting reaction and have an active culture of micro-organisms, you will discover that initiating the reaction becomes increasingly easy and your piles will heat properly and decompose rapidly.

E. Mixing

Mixing is essential for rapid and efficient composting. It evenly distributes micro-organisms throughout the pile. It blends several types and consistencies of organic material together to produce a "composite", the term from which compost was derived. Mixing allows essential reactions to occur in the compost pile related to air migration, carbon to nitrogen balance, moisture availability, and fresh food for bacteria. When layers of different types or ages of material sit on top of each other without mixing, they tend to want to react and decompose at different rates. This means uneven composting rates, failure of the composting process, odors, and material that does not decay properly. The food in one layer may be just what is needed

in the next layer, and mixing is the technique for getting the layers together.

There are two types of mixing. The first is the initial layering and mixing required for starting an active pile. The second is the mixing necessary to add fresh material to an existing active compost pile. A great deal of information is available in gardening and composting books on the importance of layering materials when starting a compost pile. However, there is hardly any mention of the importance of mixing those layers together before placing the material into the composting bin. All too often, back yard composters think that layering and placing the material in the bin is sufficient and that then they can then leave the pile alone. Not so!

The important thing to remember is to first layer the various materials to be composted outside the bin**.** Good initial mixing technique involves layering materials horizontally several feet high and then digging into the layered pile vertically with a pitch fork and "throwing" fork-funs of layered material into the compost bin until it is full. Proper mixing seeks to blend dry with wet material, brown with green, and outer edges with inner matter. Agitating the material as it is being put in the bin helps eliminate solid or dumpy mats. Layers or mats of organic material can restrict air flow and cause oxygen starvation in the pile.

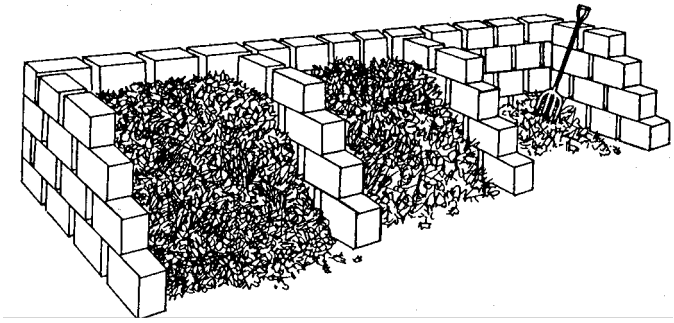


Figure 11

Once a pile is active, fresh material can be added on a periodic basis. In a two bin system, fresh material can be blended in layers in equal parts or at a ratio of 1 to 2 with the old material as it is being forked over into the next bin. The new material is in one stockpile, the active compost is in another. Placing a layer of fresh material on top of the older material before forking it over to the new bin is a labor saving shortcut. In this manner, mixing watering, and turning is performed through the same action. This type of mixing is considerably easier than the extra step of mixing outside the bin, a necessity when starting an active compost pile from scratch. There are several hand held compost mixers available that can help mix a pile without removing it from the bin.

Wood chips assist aeration tremendously. Chips reduce odors by keeping the pile loose and allowing air to move freely through the pile. Unchipped brush or large pieces of wood should never be added to the compost pile since they restrict turning and aerating and large pieces of wood won't decompose within the lifetime of a back yard compost pile. Always chip wood waste first before trying to compost it, but even then limit its volume to no more than 10%.

There are two types of garden shredders sold for residential use. The first chops leaves only. (See Figure 1) The second chips brush and small branches. (See Figure 12) There are reports of neighbors pooling their resources to jointly purchase a commercial gas powered chipper that provides additional power and capacity. Renting a chipper from a rental yard can also save time and effort, especially if it becomes a community project. A tree service firm will often contract to chip brush on an hourly rate, often reducing the rate if several neighbors save their brush for the visit.

Use caution when using a mower to chip brush. Always follow the manufacturer's recommendations to avoid injury or damaging your equipment. One technique for using a lawn mower is to place the material to be chopped over an area of the yard near a fence or against a large sheet of plywood propped up like a backstop. The mower is run over the leaves and brush several times, back and forth, until it is thoroughly chopped.

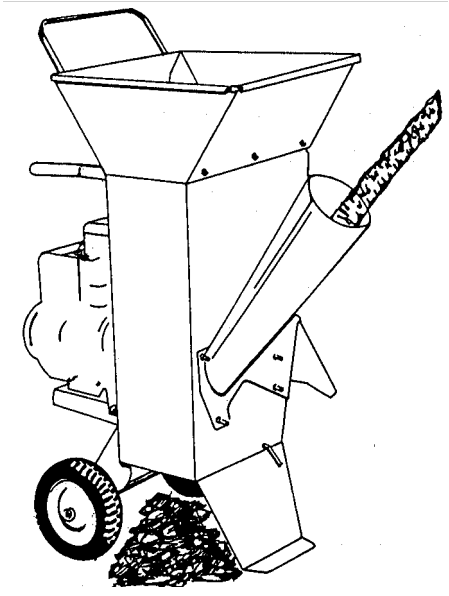


Figure 12

It should be pointed out that what helps COMPOSTING, the process, is not necessarily advantageous for COMPOST, the product. Wood chips are an example since they assist aeration during composting, but can be a nuisance in some planter mixes and may cause nitrogen starvation problems in topsoil. Wood chips may have to be screened out before using the compost. Many gardeners screen their compost whether they add wood chips or not.

F Feeding the Compost

The organisms of decomposition, like all plants and animals, require a balanced diet in order to thrive and reproduce. While organic waste is the basic food for decomposition, not all wastes are equally nutritious. Some wastes like grass clippings are high in nitrogen while woody wastes like leaves, sawdust, wood chips, and paper are high in carbon. Micro-organisms need nitrogen and oxygen in order to decompose carbon and convert it into carbon dioxide (CO_2). If there is too much nitrogen, foul smelling ammonia (NH3) can be produced. If there is too little nitrogen, the carbon is decomposed very slowly.

Organic wastes can be easily rated according to their carbon to nitrogen ratio. Most composting experts recommend a 30-1 carbon to nitrogen ratio as the ideal composting blend. Refer to the carbon to nitrogen ratio chart (See Figure 13) for more information on how to determine and select the proper carbon to nitrogen ratio. For the beginning composter, a slightly higher carbon to nitrogen ratio of 40 or 45 to 1 is recommended to prevent odors from developing.

Carbon To Nitrogen Ratio
(C/N Ratio)

Grass Clippings (Green)	20:1
Grass Clippings (Dry)	25:1
Leaves (Green)	40:1
Leaves (Dry)	80:1
Weeds (Green)	25:1
Wood Chips	700:1
Cow Manure (Fresh)	20:1
Straw (Dry)	100:1

Figure 13

Equal parts grass (25-1) to leaves (60-1) plus 10% wood chips for free air space makes an ideal composting mass. Some composters keep a stockpile of leaves and wood chips over the winter to mix in with the summertime green material. Leaves are less prone to become odorous as they sit over prolonged periods. For composting leaves without grass clippings, adding other green matter supplements or additional fertilizer formulas containing nitrogen can accelerate the rate of decomposition.

Some experienced composters recommend bone, blood, fish, or cottonseed meal in limited quantities to help supplement nitrogen when the compost pile is made largely from high carbon material such as straw, leaves, sawdust, paper, and wood chips. They also recommend dustings of minerals such as diatomaceous earth (ancient microscopic sea organisms) granite dust, greensand, rock phosphate, and limestone. Some gardening books recommend using chemical fertilizer formulation such as a 10-10-10, a 10-4-4, or even a 20-10-10 to supplement nitrogen. Many packaged compost "starters" contain high nitrogen levels.

Nitrogen is a "high performance" fuel for composting. Additional turning and aeration will be necessary when using added nitrogen. It is important to know exactly how much nitrogen needs to be added and the proper mixing ratio based on the carbon to nitrogen ratio of the woody material before mixing in nitrogen indiscriminately. Too much nitrogen can produce a foul ammonia smell, even a sulfurous rotten egg odor. Not all manures add nitrogen either, especially if they come with straw or wood waste bedding. For more information on composting manures, some of the articles in "BioCycle" magazine and in composting books may be helpful.

Some composting specialists recommend using limestone, lime, or calcium carbonate in various quantities. Aside from adding a few micro-nutrients, however, limestone usually does more harm than good in the compost pile. The composting process does not require added calcium and the acidic shift in the composting process is a necessary and natural indicator of a properly functioning composting pile. The pile will gradually return to near neutral pH without adding lime to create alkaline conditions.

G. Watering

As layers are formed, it is critical to water the incoming material, layer by layer**.** If you wait until after the pile is formed, water tends to sheet off the sides or soak in unevenly when watered from the top. Light watering of dry material is essential in the initial mixing stage. The watering technique should be gentle, as if moistening a new seed bed. If water runs off, turn the pressure down and switch over to a fine spray. Use a sprayer that has a pressure control mechanism so that the mist can be turned down and the water off when necessary. Each layer should be dampened, never soaked! The compost layers should be moist like a squeezed sponge. To prevent odors, it is far better to have too little water than too much. It is easier to add water later than it is to add dry material to compensate for an overly saturated pile.

Watering is best performed once as the layers are formed and again as the layers are mixed and placed in the bin. Old compost helps dry material gradually take on moisture since old compost holds water better than fresh material. If the pile is too wet and odors have developed, steps must be taken to dry it out. Mixing in dry leaves, straw, or old and dry compost can help absorb excess water. Spreading the pile to dry in the sun can also be effective. Rototilling wet compost into the soil is another technique.

Too dry a pile is also a concern. Many a novice composter has regretted not watering during the previous fall when the year old passive leaf pile still looks much like it did the previous year. Letting weeds grow in the compost is a sure means of drying out the pile. Turn under weeds as soon as they appear since their roots compete with the bacteria for moisture and weeds have been known to completely dry an active compost pile in a matter of weeks. Placing a bin in an open area that is exposed to the wind can also quickly dry the pile, especially if the pile has too much free air space. The presence of ants can be an indicator of too little moisture.

H. Aerating

Once the stockpiled material is properly layered with older and active compost, lightly watered, has the proper carbon to nitrogen ratio, and been thoroughly mixed, the active composting process will begin. For optimum aeration, the bin should have a built-in passive air flow system or aeration mat accessory of some sort. If possible, face the open end of the aeration system toward the prevailing wind, which is often from the northwest in the Upper Peninsula and from the southwest in Lower Michigan. This provides a slight boost and adds a little extra air to the center of the pile. Some bins may need to have a slot cut in the wood at the base or modified in some manner to allow air to enter from outside the bin. Keep the open end of the aerated bin base free of debris, leaves, and compost so that air can be drawn in without restriction.

Begin placing the material from the mixing area into the bin until it is full. Since the material will decompose quickly and shrink to less than one half its original volume in a few weeks, a little extra on the top is suggested. When adding the mixture to the bin, remember to add water to dry spots as required. Once the bin is filled, an important additional step is essential to make full use of the air flow principle by poking and aerating the pile with a 1/4" to 1/2" rod (See Figure 14).

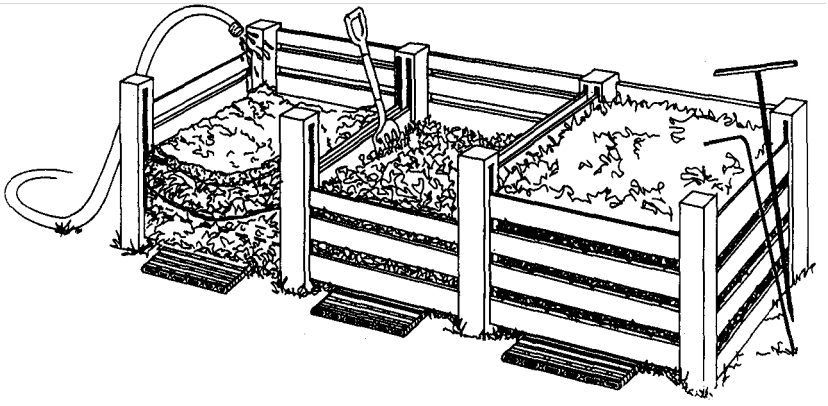
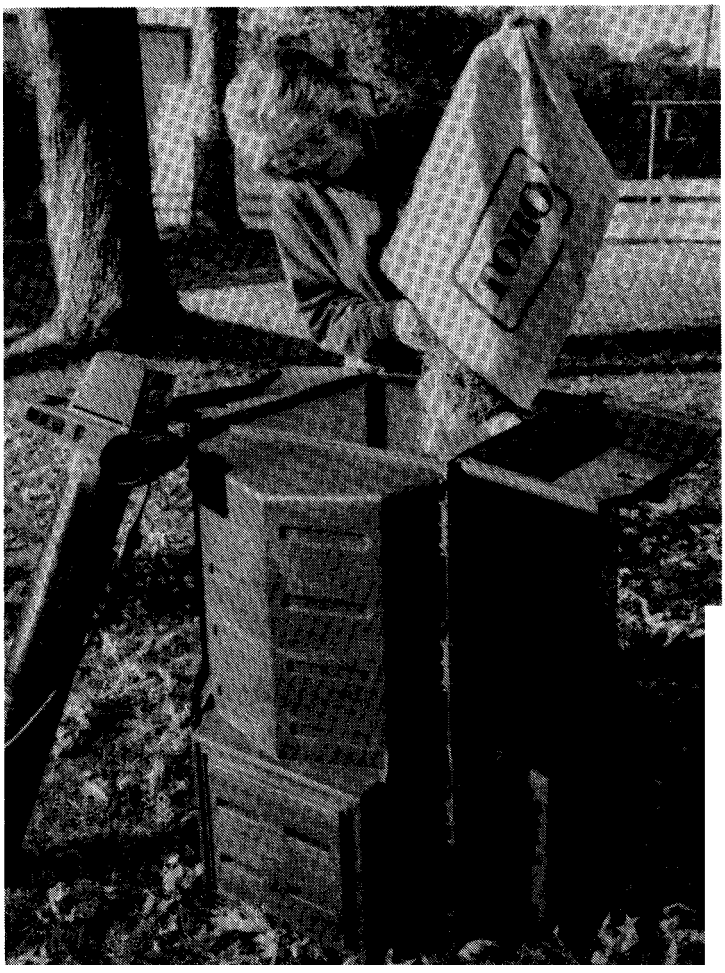


Figure 14

The passive air flow principle works on the convection action of the warm mass inside the bin causing air to rise as it is drawn in through the underside perforations connected by air channels outside the bin. To get the "chimney effect" to function properly, poking ventilation holes in the compost mixture is important to ensure that the compost is sufficiently porous to allow air to pass through it freely from the base. Poke holes every three to six inches over the entire top of the pile, plunging down all the way to the ground or to the ventilated air flow base itself.

Passive aeration can occasionally perform too well and remove too much moisture before the decomposition process is completed. Turning and watering the pile may be necessary. Passive aeration is self regulating because as the pile cools, the convection of the "chimney effect" is reduced and less air is drawn in. As one can imagine, a cubic yard of material generating temperatures over 140° for weeks on end can evaporate a significant quantity of water. On the other hand, the risk of losing heat and air due to excess precipitation is likewise a common problem. Air and moisture are equally important and neither should be allowed to become dominant over the other.



I. Active Composting

Once mixed, watered, formed, and poked, the material will become an active compost pile. Within a day, the pile will heat to over 140° F and will maintain elevated temperatures for weeks. The mass will shrink of its own accord and continue decomposing without additional turning. If the pile was under mixed, over watered, or is being initiated for the first time, turning after the first three to five days will give the pile an additional boost. Another turn of the pile after 10 to 14 days will further accelerate decomposition, although turning while mixing in new material saves this additional step.

Each time the pile is turned or new material is added, the pile should be poked again to keep the new layer from sealing off the air from the bottom. Once an active composting culture is established, the process of turning can be reduced to only that necessary for incorporating new material or blending undecomposed spots. During the warm summer months, some compost piles decompose so quickly that one bin can often handle several cuttings of grass between regular turnings. (see Figure 15)

If the pile cools prematurely or generates odors, turn it immediately, blending in fresh material or adding moisture as necessary. If the pile is over saturated with water or is foul smelling, add equal quantities of dry leaves or straw. If none is available, spread the compost out to dry. It is not neighborly to allow a compost pile to become an odor nuisance.

Once you become familiar with the principles of active composting, your appreciation for the value of the role of aeration will grow. Regular poking, turning, free air space, proper ventilation, porous side walls, and proper heating action all work together to reduce the labor of composting. With proper ventilation, your compost pile should reduce in volume more quickly, generate fewer odors, typically requiring only one turning following mixing, and produce finished compost in significantly less time than passive composting techniques.

Figure 15

Part 3 How to Use Compost

Just as fresh organic matter can be used as mulch, so can compost at any stage of maturity. Spread around shrubs, trees, and in the garden, a one to three inch layer of compost can be used as concentrated mulch. Most people, however, believe that once the time and effort has been invested to make true compost, it is best to use it in ways other than as mulch.

Like some wines and cheeses, compost improves with age. For a person unfamiliar with the composting process, it is often difficult to tell when compost is "cured" or ready to use. Fresh compost reacts with soils differently than well aged compost and should be used with discretion. Uncured compost mixed directly into gardens or planter mixes can "burn" plants through a stress condition called

"phytotoxicity". Fresh compost can damage young seedlings by fostering the fungus diseases known as damping off and root rot. (see Figure 16) Fresh compost, like fresh manure, can also rob the soil of nitrogen temporarily while it finishes its curing process.

There are many ways to determine if compost is cured. One is a visual test. If the material no longer looks like leaves or grass, it is at least beyond the "fresh" phase. Another test is to wet a sample of compost and determine if it generates unpleasant odors. If you turn the pile, moistening the dry areas, and it does not heat up in a day or two, the compost is at least "stable". But the fact that a pile has stopped heating is not always an indication that the compost is cured since it may have cooled from the lack of air or water.

If the compost looks dark, crumbles in the hand, can be screened at a 1/2" screen, has a pleasant odor, it is probably "cured". Age is not a good indication of stability since the rate of decomposition is determined by nutrient balance, mixing, moisture, and aeration. Some compost from active processes is more stable at one month than many stockpiles years old. Aging compost an additional six months even after it seems cured is a good insurance policy. Fully cured compost smells like rich forest topsoil.

Stable compost can be blended into soil mixes and is suitable for most outdoor planting projects. It is typically mixed with other ingredients such as peat moss, shredded bark, sand, or loamy topsoil when used as an outdoor planter mix. Mixing ratios vary, but 10% compost is considered to be a minimum, 30% optimum, and 50% maximum in planting shrubs and trees.

Cured compost is suitable for all planting projects and can be also used in potting soils in the same formulas as planter mixes, often supplemented with light weight materials like vermiculite, perlite, or sphagnum moss. Fully cured compost will not burn plants and can be blended directly into the root zone when planting seeds and seedlings. Cured compost is occasionally used as a lawn top dressing and for covering fresh grass seed. The top dressing application rate is approximately one cubic yard per 1000 square feet.

Stable and cured compost probably has its greatest value when rototilled directly into the soil. One cubic yard of compost covers 108 square feet at three inches, 216 at two inches, and 324 at one inch. The rule of thumb is to spread compost no more than one third the depth of the rototiller. A one inch layer of compost should be tilled in three inches, a two inch layer tilled in six inches, and a three inch layer tilled in nine inches. Two or more passes with the tiller helps blend the compost with the topsoil and break up any clumps of material.

Rototilling avoids the need for shredding or screening cured compost. Most shredders and screens handle compost poorly anyway and are often not worth the effort except when making potting soils or lawn top dressings. One of the best times to rototill compost is before seeding or sodding a new lawn. Many landscapers and sodding companies are unfamiliar with using compost, but most communities should have a professional who can assist you in using compost in your yard. While compost may seem a significant initial cost in a lawn, it will often pay for itself within five years in water savings alone.

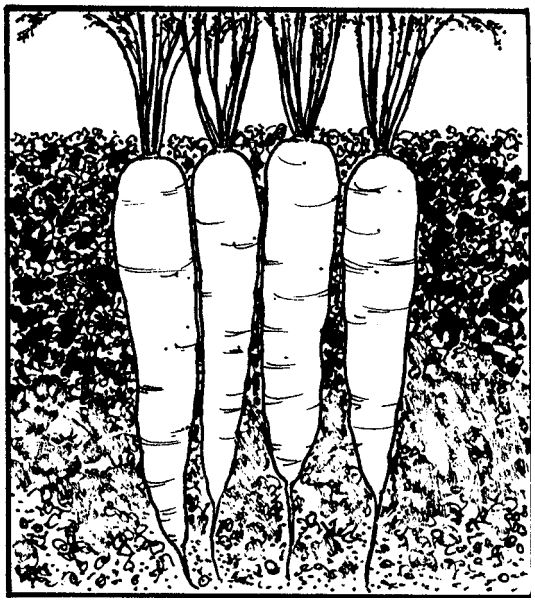


Figure 17

Residents can support composting by becoming compost users, promoting resource recovery by stimulating the market for compost. Using compost rather than chemical fertilizers reduces nitrogen runoff, protecting our lakes and streams. Organic matter conserves water by loosening clay soils and binding sandy soils.

Compost stimulates plant growth through time release nutrients while protecting the landscape against weather extremes, especially drought, by keeping soils warmer in the winter and cooler in the summer. The healthy soil eco-system fosters rapid decay of grass clippings, eventually enhancing the soil food chain that supports the wild bird population.

Soils that have compost applied properly represent a long term investment in the home, markedly increasing property values. The humus will continue to provide benefits for generations in the form of deeper roots, better water retention, and more luxuriant plant growth. The practices of mulching, composting, and using compost work together to conserve natural resources, protect the environment, lower costs, and beautify the community.

As we seek to find a home for yard waste, perhaps we need look no further than our own back yard. Mulching, composting, and soil improvement work together to solve the environmental problem of overfilling landfills while simultaneously bringing life to the landscape.

Compost Bin Manufacturers

This partial list was derived through a review of resource recovery magazines, lawn and garden catalogs, vendors at the 1990 National Hardware Association Annual Hardware Show, and lawn and garden product distributors. Some of these firms may not sell directly to consumers. No recommendation is made for any model, style, or manufacturer. Check with your local hardware, department store, or lawn and garden retailer for availability in your area. Many gardening and specialty magazines and catalogs advertise compost bins, aerators, mixers, and inoculants that can be purchased through the mail.

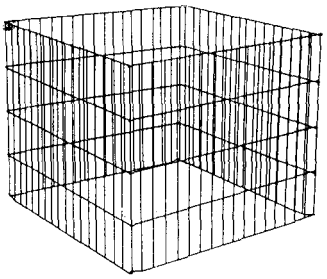
Bins

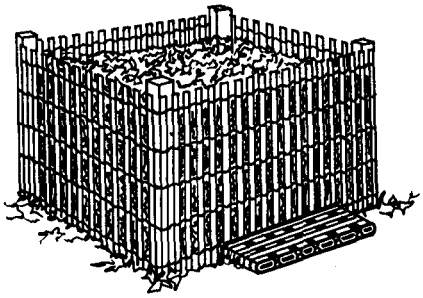
Keystone Steel and Wire
7000 SW Adams St.
Peoria Illinois 61641

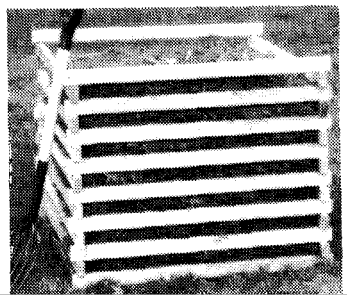
Spread All Manufacturing
2237 Marshaltown Blvd.
Marshaltown, IA 50158
800-383-5601

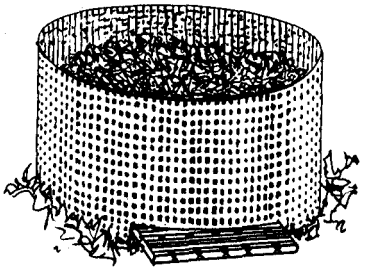
Vision Sales Inc.
Bartlett, IL. 60103
708-837-2967

Southwestern Products, Inc.
PO Box 421
Joplin, MO 64802
800-624-3800









Evergreen Bins
PO Box 70307
Seattle, WA 98107
206-783-7095

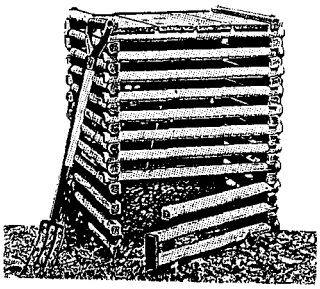
The Natursoil Company
1015 W. St. Germain, #400
St. Cloud, MN 56301
612-253-6153

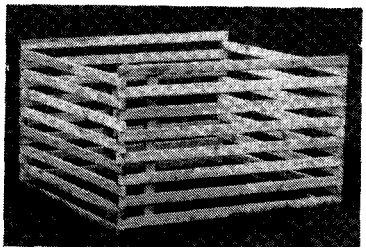
R.C. Sales
Box 427
Shaftsbury, VT 05262
802-442-2071

K-D Wood Products
PO Box 645
Bingham, ME 04920
207-672-4333

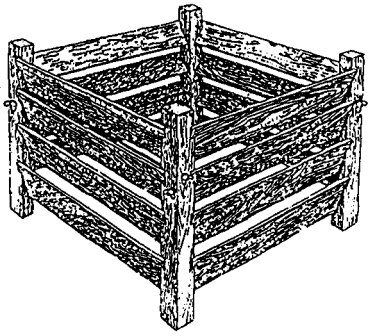
BioBin
8407 Lightmoor Court
Bainbridge Island, WA 98110
206-842-6641

Zema Corporation
PO Box 12803
Research Triangle Park, NC 27709
800-334-5530





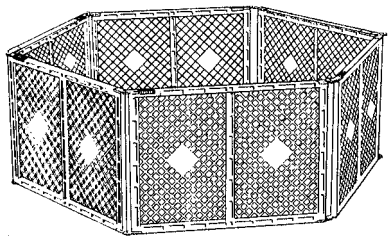
Al-ko Kober
25784 Borg Road
Elkhart, IN 46514
219-264-0631



Compost Tumblers

Plant Right
7201 Rawson Road
Victor, NY 14564
800-752-6802

Green Magic Tumbler
Gardener's Supply
128 Intervale Road
Burlington, VT 05401
800-548-4784

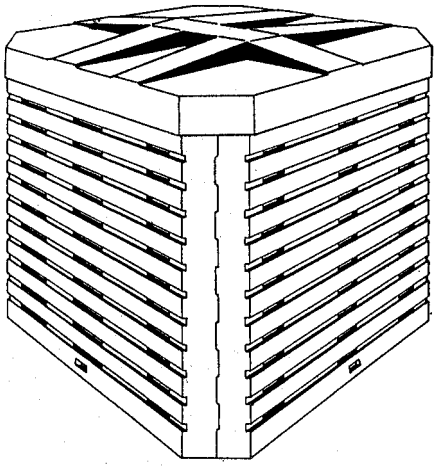


Kemp Compos-Tumbler
160 Koser Road
Lititz, PA 17543

Plastic Bins

North States Industries
1200 Mendelssohn Ave. Suite 210
Minneapolis, MN 55427
612-541-9101

Ringer
9959 Valley View Road
Eden Prairie, MN 55344
612-941-4180



Brave Industries, Inc.
115 E. Front Street
Annawan, IL 61234
800-627-1280

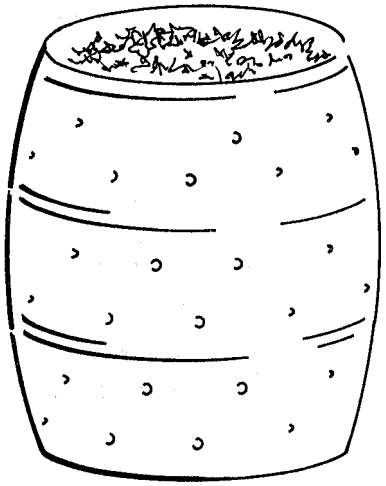
Plastigone Technologies
10700 N. Kendall Drive
Miami, FL 33176
305-274-8497

Kompost Industries Inc.
1640 Superior Avenue
Costa Mesa, CA 92627
714-548-8531

Bio Industries, Inc.
450 S. Lombard Rd.
Addison, IL 60101
708-953-9040

Compost Systems
16 Hillview
Barrington, IL 60010
800-848-3829

Barclay Recycling, Inc.
75 Ingraham Rd.
Toronto, Ontario M6M 2M2
416-240-8227

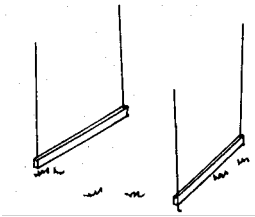


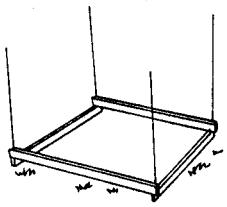
Shape Plastics
PO Box 1037
Crystal Lake, IL 60012
815-455-6310

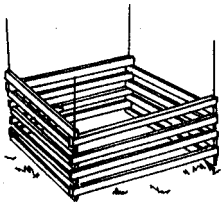
Solar Cone, Inc.
Box 67
Seward, IL 61077
815-247-8454

A Plastic 55 gallon drum can be turned into an effective compost bin in a few simple steps. Merely cut off the top and bottom of the barrel with a sabre saw and cut a series of 2" to 3" holes in the sides for aeration.

A lid can be formed by cutting off the top of the barrel 6" to 10" down along the side. The barrel is then inverted and the lid placed over what was the bottom of the drum. For more information on barrel and other composters, contact Wayne Koser through the Resource Recovery Section of the Waste Management Division at 517-373-4741.







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Magazines

"Mother Earth News" PO Box 70, Hendersonville, N.C. 28793 704-393-0211

"National Gardening" 180 Flynn Avenue, Burlington, VT 05401 802-863-1308

"Organic Gardening" 33 East Minor Street, Emmaus, PA 18098

"Harrowsmith" PO Box 1000, Charlotte, VT 05445

"BioCycle" PO Box 351, Emmaus, PA 18049 215-967-4135

Sources for Additional Information

The Self Help Garden Project c% Ingham
County Health Department Food Bank
PO Box 30161 Lansing, MI 48909
517-887-6388

Institute for Local Self-Reliance
1717 18th St. NW
Washington, D.C. 20009

Urban Options
135 Linden Street
East Lansing, MI 48823
517-337-0422

Project Grow Community Gardens
PO Box 8645
Ann Arbor, MI 48107
313-996-3169

Community Compost Education Program
4649 Sunnyside Ave. N
Seattle, WA 98103
206-633-0224

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33 E. Minor St.
Emmaus, PA 18098

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Michigan Dept. of Natural Resources
Waste Management Division
Resource Recovery Section
PO Box 30241
Lansing, MI 48909
517-373-0540