Fact Sheet

COMMONWEALTH OF PENNSYLVANIA • DEPARTMENT OF ENVIRONMENTAL RESOURCES
BUREAU OF WASTE MANAGEMENT • DIVISION OF WASTE MINIMIZATION & PLANNING (#13)

HOW TO MAKE COMPOST

COMPOSTING

Composting is a technique used to accelerate the natural decay process. The technique converts organic wastes to a mulch which is used to fertilize and condition soil. Leaf waste decomposes naturally in about two years. Composting can take as long as a year or as little as 14 days, depending upon the amount of human control.

COMPOSTABLE MATERIALS

Most yard wastes can be composted, including leaves, grass clippings, plant stalks, vines, weeds, twigs and branches. Compostable food wastes include fruit and vegetable scraps, coffee grounds, eggshells and nutshells. Other compostable materials are hair clippings, feathers, straw, livestock manure, bonemeal and bloodmeal.

Materials should **NOT** be composted if they promote disease, cause odors, attract pests, or create other nuisances. These include meat, fish, poultry, dairy products, foods containing animal fats, human/pet feces, weeds with developed seed heads, and plants infected with or highly susceptible to disease, such as roses and peonies.

Materials that should be composted only in limited amounts include wood ashes (a source of lime), sawdust (requires extra nitrogen), plants treated with herbicides or pesticides (the chemicals need time for thorough decomposition), and black and white newsprint (composts slowly, so it should comprise no more than 10% by weight of the total pile).

COMPOSTING REQUIREMENTS

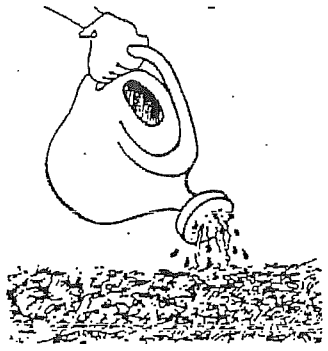
SHREDDED ORGANIC WASTES. Shredding, chopping or even bruising organic materials hastens decay. One way to shred leaves is to mow the lawn before raking, collecting the shredded leaves in the mower bag. It takes at least 3-4 cubic feet of shredded material to form a compost pile.

GOOD LOCATION. The compost pile should be located in a warm area and protected from overexposure to wind and too much direct sunlight. While heat and air facilitate composting, overexposure dries the materials. The location should not offend neighbors.

NITROGEN. Nitrogen accelerates composting. Good sources include fresh grass clippings, manure, bloodmeal and nitrogenous fertilizer. Lime should be used sparingly if at all. It enhances decomposition, but too much causes nitrogen loss, and it usually isn't necessary unless the pile contains large amounts of pine and spruce needles or fruit wastes.

AIR. The compost pile and its enclosure should be well ventilated. Some decay will occur without oxygen, but the process is slow and causes odors.

WATER. Materials in the compost pile should be kept as moist as a squeezed sponge. Too little or too much water retards decomposition. Overwatering causes odors and loss of nutrients.



BUILDING AN ENCLOSURE

Enclosing the compost pile saves space and prevents litter. The enclosure should be collapsible or provide an entry large enough to permit the pile to be turned. It should measure at least 4'x4'x4' (a pile under 3 cubic feet generally does not decompose properly), but no taller than 6' (too much weight causes compaction and loss of oxygen). The enclosure can be built of wood, pallets, hay bales, cinder blocks, stakes and chicken wire, or snow fencing. Prefabricated compost bins are also available.

BUILDING THE PILE

Aside from the basic requirements for decomposition and preventing odors and other nuisances, there is no set method for building a compost pile. One technique may be faster than another, but a variety of methods work well. Piles can be built in layers to ensure the proper proportion of carbon (e.g., leaves, woody materials) to nitrogen (grass, fertilizer), but the layers should be thoroughly intermixed after the pile is built.

MAINTENANCE

Turning and mixing the pile with a pitchfork or shovel, or shifting it into another bin, provides the oxygen necessary for decomposition and compensates for excess moisture. A pile that is not mixed may take 3-4 times longer to decompose. Recommendations for mixing the pile vary from every 3 days to every 6 weeks. More frequent turning results in faster composting. Odors indicate that the pile is too damp or lacks oxygen, and that more frequent turning is necessary.

Occasional watering may be necessary to keep the pile damp, especially in dry weather. Covering the pile with black plastic reduces the need for watering; it also prevents rainwater from leaching out the nutrients.

A pile that is decomposing properly should generate temperatures of 140°-160° F at its center. The heat kills most weed seeds, insect eggs and diseases. The pile should be turned when the center begins to cool. Turning the pile maintains the temperature and ensures that all material is exposed to the center heat. When the compost is finished, the pile will no longer heat up.

Small amounts of fresh materials may be added but should be buried inside the pile to avoid pests and speed composting. It is better to add fresh materials to a new pile.

FINISHED COMPOST

Finished compost is dark brown, crumbly, and has an earthy odor. Depending upon seasonal temperatures, a well-built, well-tended pile generally yields finished compost in 2 weeks to 4 months. An unattended pile made with unshredded material may take longer than a year to decompose.

SAMPLE INSTRUCTIONS FOR FAST COMPOSTING*

- shredded leaves (about ⅔ by volume)
- fresh grass clippings (about ⅓ by volume, or slightly more for faster decomposition)

Begin the pile with a 4" layer of leaves. Add a 2" layer of grass clippings. Repeat the layers until the pile is about 4' high.

Chop vertically through the pile with the tines of a pitchfork to thoroughly bruise and mix the materials. Add just enough water to moisten the pile, then cover it with a black plastic garbage bag. Using the same chopping technique, turn the pile on the second day after the pile is built, again on the fourth day, then every three days until the compost is finished. Except in dry weather, no further watering should be necessary.

The compost should be finished in about two weeks.

ALTERNATE COMPOSTING METHODS

Compost can be made in a garbage can, barrel or drum** that has a secure lid. Drill holes in the sides and bottom of the container to allow for air circulation and water drainage, and place it upright on blocks. Fill ¾ of the container with organic wastes, add a little nitrogenous fertilizer (about ¼ cup for a 55-gallon barrel), and moisten the materials. Every few days, shake the container or turn it on its side and roll it to mix the compost. The lid should be removed after turning to allow air penetration. This method yields finished compost in about 2-4 months.

Another method is to use a 30- or 40-gallon plastic garbage bag. Fill the bag with organic materials, nitrogen and lime (one cup per bag helps counteract acidity caused by anaerobic composting). Shake well to mix materials. Add about 1 quart of water and close the bag tightly. Bags can be stored outdoors in the summer and in a heated basement or garage during the winter. No turning or additional water is necessary. The compost should be finished in about 6-12 months.

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* Instructions are based on composting techniques presented in *Make Compost in 14 Days*, Rodale Press, Inc., Emmaus, PA 18049 (1982).

** Do not use any container that once held toxic chemicals.

The following troubleshooting chart is a guide to more efficient composting using a turning unit.

SYMPTOMS	PROBLEMS	SOLUTION
The compost has a bad odor.	*Not enough air; pile too wet*	*Turn it; add coarse dry materials such as straw, corn stalk, etc.*
The center of the pile is dry.	*Not enough water; too much woody, coarse material*	*Turn and moisten materials; add fresh green wastes, chop or shred coarse wastes.*
The compost is damp & warm in the middle, but nowhere else	*Too small.*	*Collect more material & mix the old ingredients into a new pile.*
The heap is damp and sweet-smelling but still will not heat up.	*Lack of nitrogen.*	*Mix in a nitrogen source like fresh grass clippings, fresh manure, bloodmeal or ammonium sulfate.*

COMPOST PROCESS

1. Pungent odor of fresh material disappears after 2-3 days, replaced by "cooking" odor. 110-120 degrees in 3 days.

2. Earthy odor after 5-6 days. Color turning from grey to deep brown. 150 degrees in 5 days.

3. Compost is not finished just because it looks and smells like compost. The final drop in temperature to 100-110 degrees (or near air temperature) indicates finished process. A pile of one cubic yard can take anywhere from a couple of weeks to a year.

4. Turning causes a temporary drop in temperature. The temperature goes back up within 3-4 days after turning.

5. Anaerobic pile obvious because of smell. If it smells putrid, turn the pile as often as twice each day for 3-7 days. The change in smell will be noticeable and resulting compost is OK.

6. Inoculants are unnecessary. Each group of microbes is site specific and generates the enzymes required to do the specific job at hand. Outside enzymes and microbes may or may not be appropriate for the pile contents. Studies have shown no increase in lag time, finish time, or quality by using starters.

Bibliography

The Rodale Book of Composting, Easy Methods for Every Gardener, Deborah L. Martin and Grace Geshuny, Editors, Rodale Press, 33 Minor Street, Emmaus, PA, 18098, Copyright 1992.

Backyard Composting, Your Complete Guide to Recycling Yard Clippings, Harmonious Press, P.O. Box 1865, Ojai, CA. 93024, 800-833-0720 ext. 47

The Biocycle Guide to The Art and Science of Composting, The J.G. Press, Inc., Emmaus, PA 18098, Copyright 1991.

BIOLOGY OF COMPOST

What's in the Pile?

MICROBES – all are primary consumers, feeding directly on wastes.

1. Bacteria
   Responsible for 80-90% of the activity in the pile.
   Initial breakdown of organic matter.
   A wide variety of bacteria are present in waste. They produce specific enzymes to decompose complex proteins and carbohydrates to simple sugars and amino acids.

2. Actinomycetes ăk'tĭ'-no-mī'sēt'
   Appear in the pile near the end of the process. Present in the outer 4-6" of pile.
   Good paper decomposers – cellulose and lignin.
   Use many organic compounds as energy sources.
   Responsible for earthy odor after 5-6 days.

3. Fungi
   Appear in the pile around the same time as the actinomycetes.
   Work much the same way actinomycetes do.
   Found in the outer 4-6" of the pile, probably because of high temperatures and low oxygen inside the pile.

INVERTEBRATES

1. Earthworms, maggots, sowbugs, nematodes, millipedes, potworms, beetle mites, slugs and snails.
   Primary or First level consumers feed directly on waste.
   Responsible for quick physical breakdown of organic matter.

2. Springtails, mold mites, beetle mites, feather winged beetles, rotifera, protozoa nematodes, soil flatworms, predatory mites.
   Second level consumers feed on the initial decomposers.

3. Ground beetles, rove beetles, centipedes, pseudoscorpions, ants, predatory mites.
   Third level consumers prey on secondary consumers and each other.

The flow of energy and nutrients resulting from feeding by microbes and invertebrates makes up the food web.

ENVIRONMENTAL FACTORS AFFECTING SURVIVAL

1. Nutrition – concentration and availability of N, P, K, and C.
   a. The more abundant and available the nutrients are, the more microbes there are, the more rapid the compost!
   b. C/N ratio is the most important balance in composting. Optimum is 25-30:1
      C is required as source of energy.
      N needed to make protoplasm.
   c. Examples of high Nitrogen sources are grass clippings, garbage, yard wastes, animal manures (except bedding), "green stuff." Examples of high Carbon sources are dry leaves, straw, paper, wood chips, "brown stuff".
   d. Above 30:1, microbial activity is slow. Pile doesn't hear up, or temperature drops. Can be speeded up by adding N source.
   e. When C/N ratio is lower than 19:1, excess N is lost to the atmosphere.

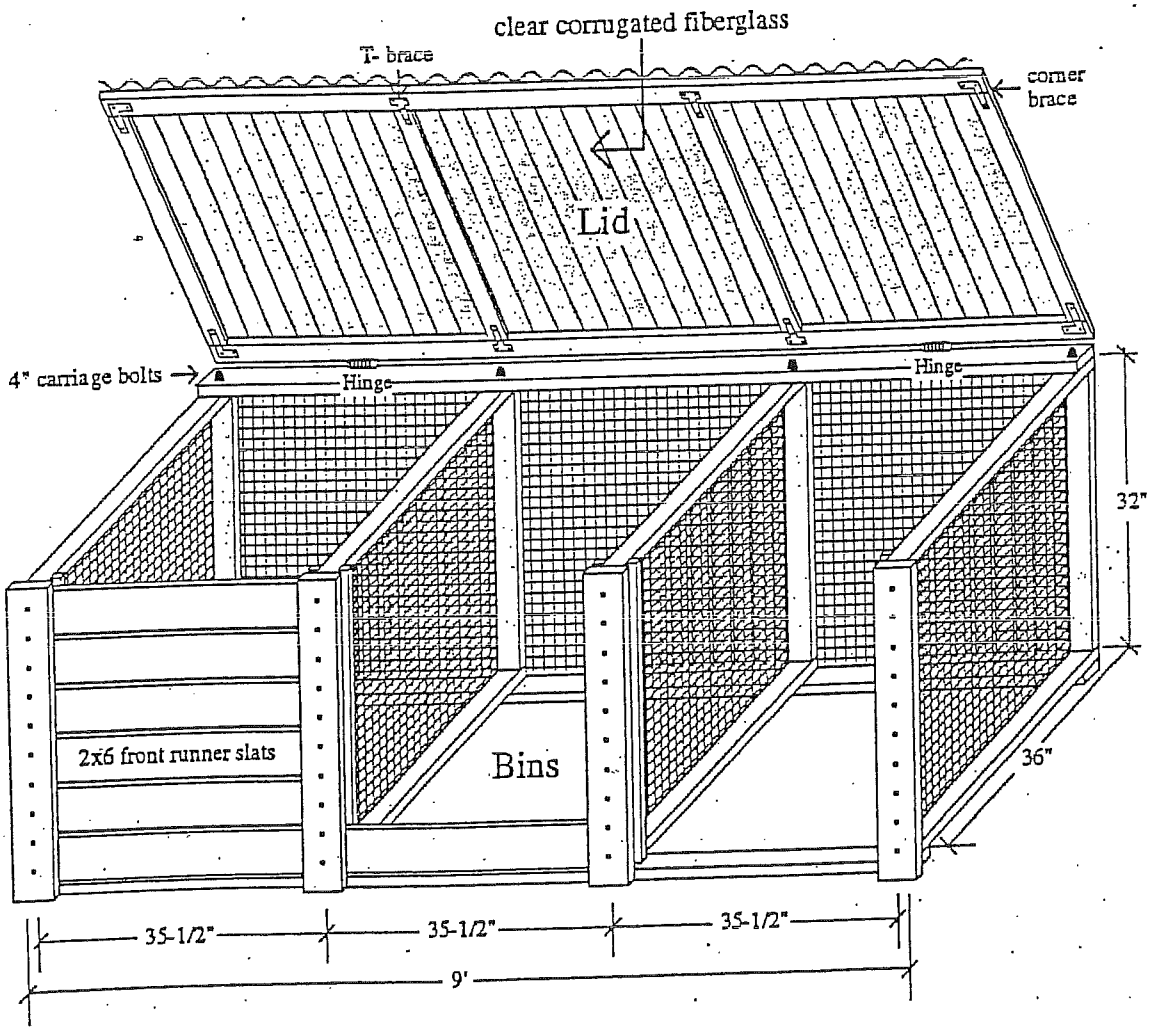
2. Temperature
   a. Each group of organisms has an optimum range.
      Mesophiles: prefer 50-119 degrees.
      Thermophiles: prefer 120-160 degrees.
   b. Mesophiles are most efficient.
   c. Thermophiles important since most weed seeds and pathogens can't survive high temperatures.
   d. Temperature rise and fall indicates finished compost process.

3. pH
   a. Fungi tolerate a wider range than bacteria.
      Bacteria tolerate 6.0-7.5 Fungi tolerate 5.5-8.0
   b. pH drops when compost process begins. After a few days, pH reaches 8-9.
   c. Don't try to adjust the prevailing pH of the pile. Adding lime causes greater N loss:
      Don't add lime.

4. Aeration
   a. Oxygen availability extremely important – this is an aerobic process.
   b. Adequate aeration provides rapid decomposition, higher temperatures, less smell-happy microbes.
   c. Aeration is accomplished by chopping and stacking, turning, stirring, or tumbling.
   d. Monitor aeration by smell. Putrification is a sign of anaerobic conditions. Open the pile and turn it!
   e. Aeration can be excessive if it cools the pile or increases evaporation too much.

5. Moisture content
   a. Directly related to oxygen content since either air or water fills pore spaces.
   b. Add water during turning.
   c. Optimum = glistening appearance of composting material – squeeze test.
      Excess = seepage or drainage from pile.
      Insufficient = dry, dusty appearance indicated by drop in temperature
   d. Microbial activity inhibited when moisture level is below 25%, stops at 10%.

Wood and wire stationary 3-bin system



This system is used to compost large amounts of yard and kitchen wastes in a brief period of time. Wastes are stored until enough are available to fill an entire bin. Materials are then chopped, moistened and layered to ensure a hot compost. Piles are turned weekly for aeration. A pile made with a balance of fresh greens and brown yard debris such as dried leaves and finely chipped branches, and turned weekly can be ready to use in three weeks. The texture of the finished compost depends on the materials composted. This unit can be built for approximately $130. Construction requires basic carpentry skills and tools.

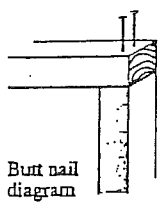
Materials

2	18-foot treated 2x4s*
4	12-foot treated 2x4s *or 8* 6-foot treated 2x4s
2	6-foot 2x2s
1	16-foot cedar 2x6
9	6-foot cedar 1x6s
22 feet	36-inch-wide 1/2-inch hardware cloth
12	1/2-inch carriage bolts 4 inches long
12	washers and 12 nuts for bolts
3 pounds	16d galvanized nails
1/2 pound	8d galvanized casement nails
250	poultry wire staples or power stapler w/1-inch staples
1	12-foot and 18-foot sheet 4-ounce clear corrugated fiberglass
3	8-foot lengths of wiggle molding
40	gasketed aluminum nails for corrugated fiberglass roofing
2	3-inch zinc plated hinges for lid
4	flat 4-inch corner braces with screws
4	flat 3-inch T-braces with screws
2	6-foot-long 2x2s *or 4* 34-inch-long 2x2s

Tools

Hand saw or circular power saw, drill with 1/2-inch and 1/8-inch bits, screwdriver, hammer, tin snips, tape measure, pencil, 3/4-inch socket or open-ended wrench, carpenter's square, (option-power stapler with 1-inch-long galvanized staples), safety glasses and ear protection.

Construction details



Build dividers: Cut two 31-1/2-inch and two 36-inch pieces from each 12-foot 2x4. Butt end nail the four pieces into a 35-inch x 36-inch square. Repeat for other three sections. Cut four 37-inch-long sections of hardware cloth, bend back edges 1 inch. Stretch hardware cloth across each frame, check for squareness of the frame and staple screen tightly into place every 4 inches around edge.

Set up dividers: Set up dividers parallel to one another 3 feet apart. Measure and mark centers for the two inside dividers. Cut four 9-foot pieces out of the two 18-foot 2x4 boards. Place two 9-foot base boards on top of dividers and measure the positions for the two inside dividers. Mark a center line for each divider on the 9-foot 2x4. With each divider, line up the center lines and make the base board flush against the outer edge of the divider. Drill a 1/2-inch hole through each junction against the outer edge of the divider. Drill a 1/2-inch hole through each junction centered 1-inch from the inside edge. Secure base boards with carriage bolts, but do not tighten yet. Turn the unit right side up and repeat the process for the top 9-foot board. Using the carpenter's square or measuring between opposing corners, make sure the bin is square and tighten all bolts securely. Fasten a 9-foot-long piece of hardware cloth securely to the back side of the bin with staples every 4 inches around the frame.

Front slats and runners: Cut four 36-inch-long 2x6s for front slat runners. Center the boards on the front of the inside dividers flush with the top edge and nail securely. To create back runners, cut the 2x2s into 34-inch-long pieces. Nail back runner parallel to front runners on side of divider leaving a 1-inch gap for slats. Cut all the 1x6-inch cedar boards into slats 31-1/4-inch long.

Fiberglass lid: Use the last 9-foot 2x4 for the back of the lid. Cut four 32-1/2-inch 2x2s and one 9-foot 2x2. Lay out into position on ground as illustrated on front page and check for squareness. Screw in corner braces and T-braces on bottom side of the frame. Center lid frame, brace side down on bin structure and attach with hinges. Cut wiggle board to fit the front and back 9-foot sections of the lid frame. Pre-drill wiggle board with 1/8-inch drill bit and nail with 8d casement nails. Cut fiberglass to fit flush with front and back edges. Overlay pieces at least one channel wide. Pre-drill fiberglass and wiggle board for each nail hole. Nail on top of every third hump with gasketed nails.

*For those who are not comfortable with the use of chemicals to pressure-treat wood, cedar and redwood are the best alternatives for resisting rot and insects.

Metro Home Composting Demonstration Centers

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Portable wood and wire composting bin

This portable bin provides a convenient way to compost moderate volumes of yard wastes with minimal labor. Yard wastes are simply added to the bin as they are generated. With no effort except occasional moistening, compost will be ready in six months to two years. Chopping or shredding materials, maintaining adequate moisture by watering and covering with plastic or heavy fabric, and occasional turning will produce finished compost in a shorter time. Texture of the finished compost depends on the materials composted and how long they are left in the bin. Mixing fresh greens with brown yard wastes will produce the best results.

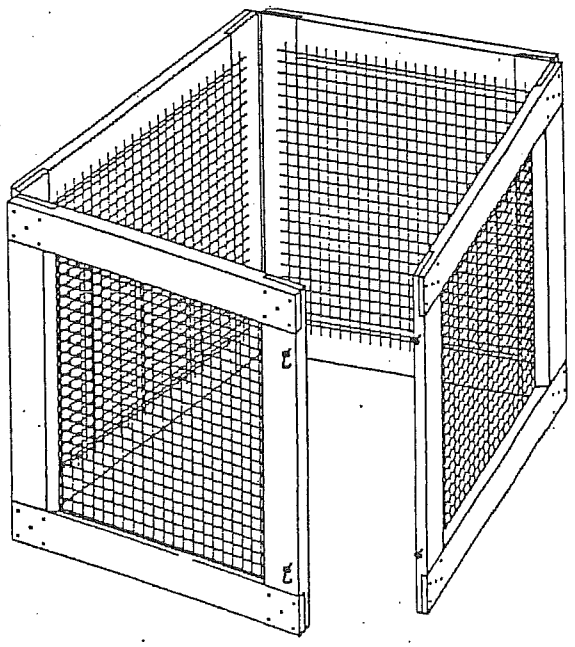
This flexible bin fits well in small spaces, and may be used either as a holding bin or as a portable turning unit. The bin can be easily moved to turn piles or to harvest finished compost and build a new pile. Simply undo the latches, pull the sides apart and move it. Compost may then be turned into the bin at its new location. Finished compost can be removed from the bottom. The bin costs around $50 to build using new materials, less if recycled materials are used.

Materials

1	12-foot pressure-treated (or rot-resistant alternative) 2x4*
3	12-foot fir 2x4
12 feet	of 36-inch-wide 1/2-inch hardware cloth
100	1-1/2-inch galvanized No. 8 wood screws
4	3-inch galvanized butt door hinges
150	poultry wire staples or power stapler
1	10-ounce tube exterior wood adhesive
6	large hook and eye gate latches

Tools

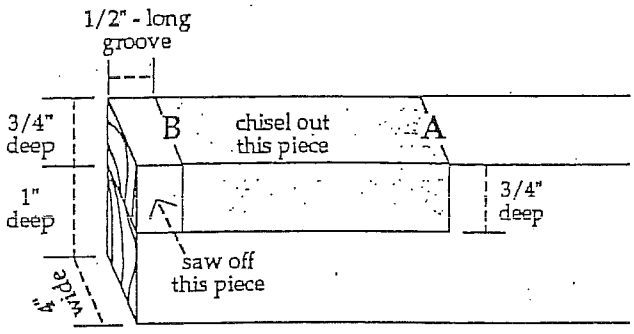
Hand saw and chisel, radial arm saw with dado blade, circular saw or table saw. Hammer, screwdriver, tin snip, caulking gun, pencil and small carpenter's square. Use eye and ear protection.



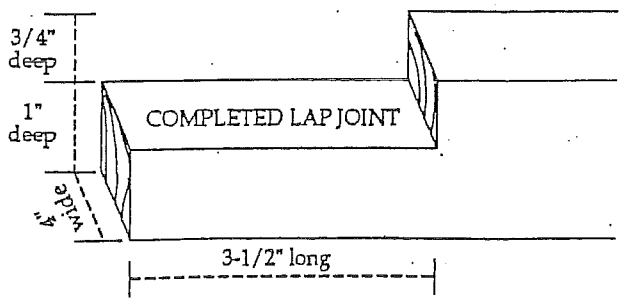
* For those who are not comfortable with the use of chemicals to pressure-treat wood, cedar and redwood are the best alternatives for resisting rot and insects.

Construction Details

Cut each 12-foot 2x4 into four 3-foot-long pieces. Cut a 3/4-inch-deep and 3-1/2-inch-wide section out of each end, for a total of 32 lap cuts. If using handsaw and chisel, cut 3/4-inch down at the 3-1/2-inch line (at A in the diagram).

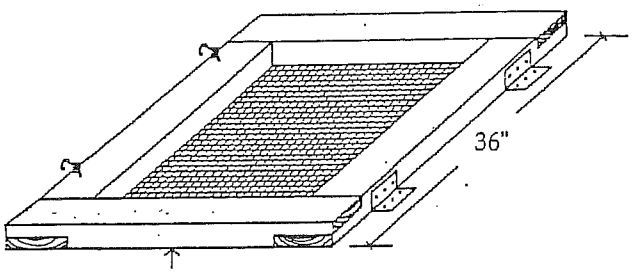


Then cut a 3/4-inch-deep and 1/2-inch-long groove into the end of the board (at B in the diagram). In order to remove the block, measure in 1-inch at the top of the board (at B in the diagram). Draw a line across the top parallel to the 4-inch width of the board. With the handsaw, cut a groove 1/2-inch deep along the line. Place a thick wood chisel in the end groove and split the wood with a hammer to the 3-1/2-inch cut. If using a radial arm saw, circular saw or table saw, set blade depth to 3/4-inch and make multiple passes until the whole section is removed.



Make four 3-foot-square frames from the lap jointed 2x4s. Use one pressure-treated 2x4 on each frame. Use enough construction adhesive to fill the gaps when the lap joints are screwed together. Fasten each joint with four screws. Using tin snips, cut the hardware cloth into four 3-foot sections. Bend the edges of the cloth back over 1 inch for strength. Lay one into each of the four frames. Center and tack each corner with a poultry wire staple. Hammer place a staple every 4 inches along all four edges of the hardware cloth. Try to tension the cloth so it will not sag when filled with compost.

Connect each pair of frames together with two hinges. Then put the hook and eye gate latches on the other ends so that the sections latch together.



Pressure treated lumber on bottom (or rot resistant alternative)

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