Appendix D

Setting Up and Maintaining Composting Systems

D–1 CONSTRUCTING WIRE MESH COMPOSTING BINS

Wire mesh composting bins are versatile, inexpensive, and easy to construct. They may be used as holding units for slow composting or as turning units for hot composting. Each of the illustrated circular and panel designs has unique advantages. The circle bin (see Diagram 1) can be made for under $10 from hardware cloth or wire mesh. Although chicken wire can also be used, it quickly loses its shape with use and requires support posts. Hardware cloth creates a self-supporting circle which is easier to manipulate and more durable.

A panel unit offers a greater variety of uses than other types of units do. Panels can be added to enlarge the bin, and individual panels can be used for screening coarse materials from finished compost. A sturdy and attractive panel bin (see Diagram 2) can be made with 16-gauge plastic coated wire mesh for under $20.

The wood and wire bin provides a convenient way to compost moderate volumes of yard waste. This bin fits well in small spaces and may be used either as a holding unit for low composting or as a turning unit for hot composting. The bin can be easily moved to turn piles or to harvest finished compost: simply undo the latches, pull the sides apart, and move. Turn the compost at the bin's new location, and remove the finished compost from the bottom of the bin. The wood and wire bin (see Diagram 3) costs around $50 to build using new materials; less, if recycled materials are used.

1. Circular Bin

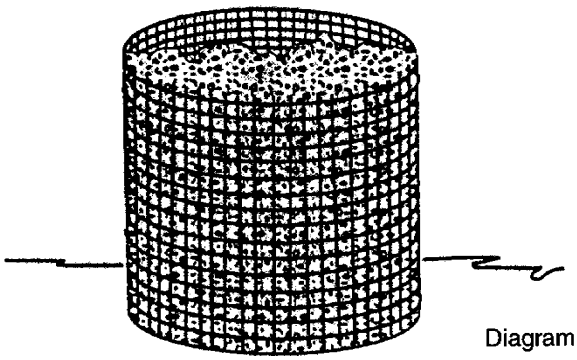

Diagram 1

Materials for the Circular Bin (3½ foot diameter)

___ 12½ feet of 36-inch-wide hardware cloth, or 18-gauge plastic coated wire mesh
___ Four metal plastic clips, or plastic coated copper wire ties

Tools

___ Heavy duty wire or tin snips
___ Pliers
___ Hammer or metal file
___ Work gloves

Construction Details for Circular Bin

Roll out and cut 12½ feet of hardware cloth or plastic coated wire mesh.

If using hardware cloth, trim or file each wire along the cut edge to ensure safer handling when opening and closing the bin. Bend hardware cloth into a circle and attach ends with clips or ties. Set the bin in place for composting. Plastic coated wire mesh bins are made in the same manner, except that bending this heavier material into a circular shape will require extra effort. Also, filing the wire ends may cause the plastic coating to tear. Striking the end of each wire with a hammer a few times will knock down jagged edges.

2. Five-Panel Bin

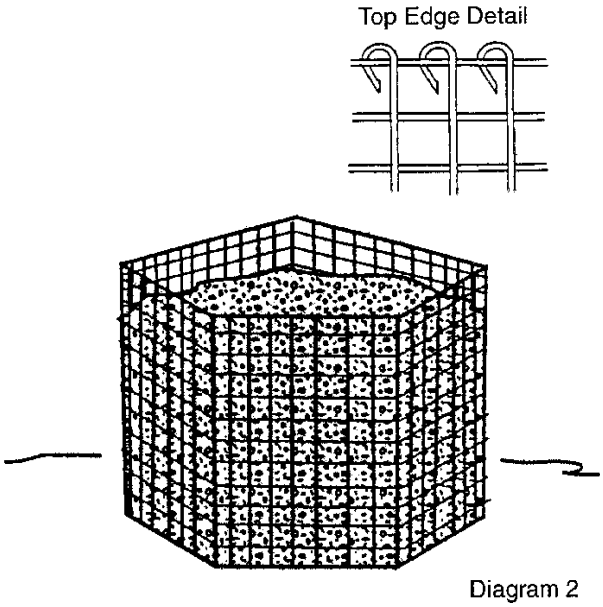

Diagram 2

Materials for the Five-Panel Bin

___ 15 feet of 24-inch-wide 12–16-gauge plastic-coated wire mesh
___ 20 metal or plastic clips or plastic-coated copper wire ties

Tools

___ Heavy-duty wire or tin snips
___ Pliers
___ Hammer or metal file
___ Work gloves

Construction Details for a Five-Panel Bin

Cut five 3-foot-long sections of wire mesh (24 inches wide). Make cuts at the top of the next row of squares to leave one-inch-long wires sticking out along one cut edge of each panel. This will be the top edge of the bin. Use a pair of pliers to bend over and tightly clamp each wire on this edge. This provides protection against scraping arms when adding yard wastes to the bin. Attach panels using slips or wire ties.

3. Wood and Wire Bin

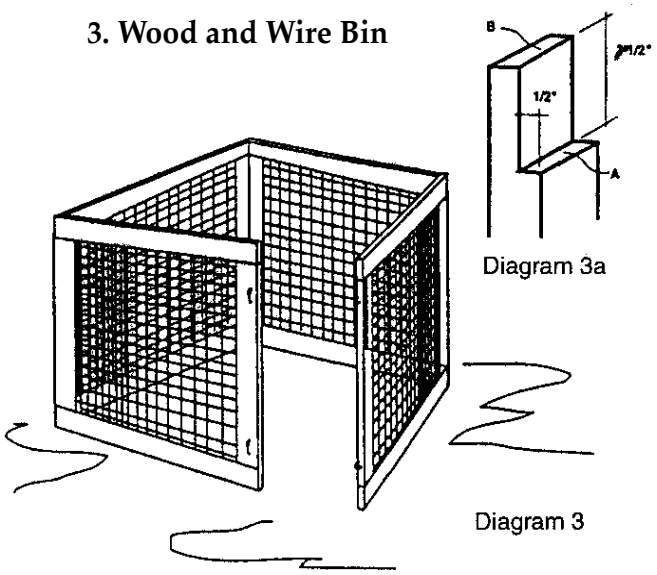

Diagram 3a

Diagram 3

Materials for the Wood and Wire Bin

___ Four 12-foot 2- by 4-inch pieces of fir
___ 12 feet of 36-inch-wide ½-inch hardware cloth
___ 100 1½-inch galvanized No. 8 wood screws
___ Four 3-inch galvanized butt door hinges
___ 150 chicken wire staples or power stapler
___ One 10-ounce tube exterior wood adhesive
___ Six large hook and eye gate latches

Tools

___ Hand saw and chisel, or radial arm saw with dado blade, or circular saw, or table saw
___ Hammer
___ Screwdriver
___ Tin snips
___ Caulking gun
___ Pencil
___ Small carpenter's square
___ Eye and ear protection

Construction Details for the Wood and Wire Bin

Cut each 12-foot two-by-four into four 3-foot-long pieces. Cut a ¾-inch deep and 3½-inch-wide section out of each end, for a total of 32 lap cuts. If using a hand saw and chisel, cut ¾ inch down at the 3½-inch line, at A in diagram 3a. Then cut a ½-inch deep groove into the end of the board at B in diagram 3a.

Place a thick wood chisel in the end groove and split the wood with a hammer to the 3½-inch cut. If using a radial saw, circular saw, or table saw, set blade depth to ¾-inch and make multiple passes until the whole section is removed.

Make four 3-foot square frames from the lap jointed two-by-fours. Put enough construction adhesive to fill the gaps when the laps joints are screwed together. Fasten each joint with four screws.

Cut the hardware cloth with tin snips into four 3-foot square sections. Bend the edges of the cloth back over 1 inch for strength. Lay one onto 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 other ends so that they latch together.

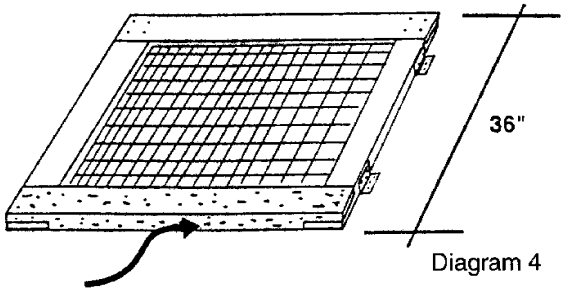

Diagram 4

Example of Wood and Wire Bin Panel

Please Note: It is not recommended to use pressure-treated wood for the composting bin. The treated lumber will contaminate the compost and possibly kill the microorganisms.

D-11 MAINTAINING A VERMICOMPOSTING SYSTEM[1]

Why Vermicompost?

What do worms, food waste, and landfills have in common? They are all part of the reason that people vermicompost.

Vermicomposting is the practice of using worms to transform food waste into a nutrient-rich finished product called vermicompost. Worms are efficient food waste digesting machines that eat over half their body weight in organic matter per day. The castings that they create are rich in nutrients, completely natural, and free!

Most people are becoming aware that putting garbage in a landfill is an option that is less and less desirable. While most people think about paper, plastic, and yard trimmings when they think about garbage, food waste can be a significant percentage of the total waste stream. In fact, for schools and institutions that recycle their paper, food waste is commonly the single largest element remaining in the waste stream.

In a school setting, a vermicomposting system can set the stage for teaching children about a number of different topics. While the biological and environmental lessons associated with vermicomposting are quite evident, teachers have used their worms to teach about a broad range of topics in an integrated curriculum.

The Basics of Vermicomposting

In short, vermicomposting involves setting up some type of container (hereafter called a bin): filling it with moist bedding materials; introducing worms and feeding them on a regular basis; monitoring the conditions in the bin; and adding food, water, and more bedding as the conditions warrant. It sounds so simple and it basically is. However, worms are living creatures and attention does need to be paid to ensure that their living environment meets their needs.

The Worm Bin

Worm bins can vary in size and type of material. Bin sizes can range from small shoe-box-sized bins to large 4- by 8- by 2-foot worm "estates." Obviously, the larger the bin, the more worms it will house and the more food waste they will consume. While several schools vermicompost in a large wood bin nearly all of the food waste they generate, the most common type of bin is a converted plastic storage box approximately 12 gallons in capacity used in the classroom.

The main attributes of a good bin are (1) it keeps the light out; (2) has a snug-fitting lid (for classroom bins); (3) provides ventilation and drainage; and (4) is big enough to handle the desired amount of food waste. The 12-gallon-sized bins can be started with 1,000 worms (about 1 pound) which, once acclimated, will process approximately ½ to 1 pound of waste a day.

Where to Put the Bin

Worms should ideally be kept in an environment that is 55 to 77 degrees Fahrenheit. Because of this, indoor locations are usually preferable for classroom or home bins. The larger wood bins can be kept outside, because the wood bin is thicker and has a larger mass of the vermicompost that insulates the worms and protects them from relatively extreme temperatures. In most areas of California, a shady location will probably be best. In areas with very extreme climates, extra insulation (usually a hard foam core) may be needed to keep the worms active in outdoor bins. (Note: Worms will live at temperatures both above and below the 55 and 77 degree Fahrenheit range. In general, the larger the bin, the greater the ambient temperature flexibility in which the worms can survive.)

Worm Bedding

Once the bin is made, bedding needs to be added. The bedding provides a moist home for the worms, helps ensure a proper carbon-nitrogen balance, and minimizes the food waste odors. The bedding should be at least 6 inches deep after moistening. Along with the bedding, the food waste will be consumed and become vermicompost.

Shredded paper is the most common form of bedding, because it is readily available to most vermicomposters. While newspaper is usually used at homes, the white paper found in schools, offices, and institutions also makes a good bedding material. Glossy advertisements and magazines should be avoided because of the contents of the ink and inability to soak up water. The paper is turned into bedding by simply tearing the paper in long 1-inch-wide strips. If it is difficult to tear, try tearing in the other direction along the "grain of the paper," and it should be easier. Other common bedding materials include

[1]*Worms, Worms, and Even More Worms: A Vermicomposting Guide for Teachers.* Sacramento: California Integrated Waste Management Board, Publication # 322-98-008, August 1999.

composted manure (not too fresh or hot), shredded corrugated cardboard, and straw.

As a general rule, fill the bin with dry bedding material and then dampen it to a point where it is thoroughly wet but not dripping wet. The worms can be harmed if the bedding is too dry or too wet. "As damp as a wrung-out sponge" is commonly used to describe the proper moisture level of the bedding and a three to one ratio (by weight) of water to bedding is a recommended guideline. A pint of water weighs approximately a pound. As water is added, continue to fluff the bedding materials to avoid compacted bedding and to ensure that all of the bedding is damp throughout the bin.

Obtaining Worms

A plastic box with moistened shredded newspaper in it will not be an effective vermicomposting system without worms! Once you obtain a nice supply of worms, place the worms on the bedding material and watch them burrow. Within ten minutes, they should all have disappeared into the bedding.

"Red wigglers" are the species of worm commonly used for vermicomposting. Also known as redworms or manure worms, red wigglers thrive in high-nutrient environments and like to live close to the surface. Worms are commonly sold in one-half pound increments and start at about $15 a pound. Appendix D, section III, is a listing of worm suppliers known by the California Integrated Waste Management Board. Many of these suppliers will ship worms via the mail. Bait shops often sell redworms but offer them in much smaller lots for a higher price. Remember that one pound of worms will consume one-half to one pound of food waste and bedding a day.

Rather than buying worms, you may want to ask a friend who has a worm bin to share some of his or her worms, or look for them in piles of composted manure. (If the manure is fresh, smelly, and messy, do not look in it for worms; you want the aged, less-smelly manure, which is more likely to have the red wigglers.)

Barring a worm tragedy, you should not have to buy more worms once you get your bin started. In fact, a properly balanced bin will produce enough worms to share with others. Extra worms can be used to start a second bin, shared with a friend, or sold. Releasing extra worms into the garden is not good for the worms, because it is not their normal habitat and is detrimental to the worms. However, the worms are a wonderful addition to a compost pile.

The worms commonly found in the garden are NOT the types of worms that go in a worm bin. Nightcrawlers and other garden worms like to burrow deep into the soil and do not like to be disturbed. They are not appropriate for a worm bin and will probably die. Do not try to use these worms for composting unless you are doing a comparative educational study or a designed experiment.

Feeding the Worms

Worms should not have to live on bedding alone; fruits, vegetables, coffee grounds, and grains are all welcome edibles. Try not to feed the worms any meat, dairy, or oily foods, because these items are foul smelling when they beak down. Some foods decompose slower than others do. It is best to chop up the large food items so they can break down quickly in the worm bin. Microorganisms such as bacteria and fungi aid worms, which do not have teeth, by breaking down pieces of food. Care should be taken to not overload the bin with acidic items, such as too many orange peels.

Placing the Food

Food waste should be placed under the bedding material or dug into the worm castings and not left on top of the bedding. This will minimize the food's potential for producing odors and attracting fruit flies. Add additional bedding when necessary, especially when the vermi-compost is too moist. Rotate the burial of the food waste throughout the bin. Make a chart to help keep track of where the worms were fed last. Another way is to start in one corner of the worm bin with food placement and work around the bin until you return to that corner, and then repeat the pattern.

How Much to Feed?

In general, err toward underfeeding rather than overfeeding. If you get back to your initial placement location and find that not much of the food was eaten, consider reducing the amount of food or stop feeding for awhile. A bin in which worms are fed less than they can handle will not be as productive as a bin that receives the perfect amount of food; but a bin that is overfed

can smell bad, have lots of excess moisture, and result in massive deaths of worms. Important note: Worms in newly established bins should be fed lightly at first until they acclimate and become comfortable (and hungry) in their new surroundings.

Keeping the notes just cited in mind, you can schedule daily small feedings or less frequent larger feedings. Feeding should probably occur at least biweekly. This decision should be based on convenience and educational goals. It will be necessary to feed the worms during the school's break. It is important that you or a student take the bin home during the vacation.

The best method for determining how much to feed your worms is through observation. Divide the bin into quadrants/burial sites, so students can keep track of where they deposited food. Have the students monitor the amount and type of food. Rotate the burial sites. When they reach the first burial site and there is quite a bit of food left, put the worms on a diet. Allow the worms time to process the food in the bin before continuing to feed.

Preparing the Food

The smaller the pieces of organic materials, the faster the materials will break down. Cut up large pieces of vegetables and fruits. Shred paper napkins, towels, scrap paper, etc. Some vegetables can take a long time to break down, including carrots, broccoli stems, and grape stems. Your class may choose to feed the worms weekly. Store the food waste in a tightly sealed container, such as a coffee can with a lid, so it will be available when the class is ready to feed the worms.

Other Things to Add to the Bin

Worms have gizzards and need a small amount of gritty material to help grind up the food waste. Finely crushed eggshells, rock dust, or a small handful of soil will help the worms digest their food better. Before adding the soil, check to make certain that the area where the soil came from was not treated with pesticides. Rock dust is from ground up rocks and is available at nurseries or garden stores. The rock dust is rich in minerals and will help balance the pH level in the bin.

Monitoring the Bin

When feeding the worms, it is a good idea to check the overall conditions of the bin. If children do the feeding, you may want to have them record certain bin conditions as a way of both monitoring the bin and teaching them about experimental observation.

Things you may want to add after starting the bin:

- Add additional bedding if there is excess moisture in the bin (add DRY bedding); there are lots of fruit flies in the bin; or the existing material is reduced and you want to continue feeding.
- Add additional water if the bedding looks too dry. This usually occurs in wood bins, because the plastic bins tend to retain moisture.
- Add rock dust to reduce the acidity of the vermicompost, to assist the worms in breaking down their food, and to discourage fruit flies.

Remember to monitor the bin to ensure that overfeeding is not occurring.

Harvesting the Vermicompost

Vermicompost is ready to harvest when there is a large amount of castings compared to the amount of food, paper, and worms in the bin. The finished product is rich, black, and relatively homogeneous.

Stop feeding the worms in all or part of the bin to prepare for harvesting. This enables the worms to finish off the remaining food and paper, creating a finished product. It is common to feed in one-half of the bin and wait for the other half to finish. In time the worms will migrate over to the section still being fed. For multiple bins set up a schedule by not feeding one bin at a time. This way, the food waste is distributed to the other bin(s), thus facilitating the vermicomposting harvest and keeping the other vermicompost systems in production.

Once the bin contains fairly homogeneous vermicompost, it is time to harvest. It is not recommended that the vermicomposting material be completely uniform, because the more homogeneous the material, the more stressed the worms become. (Note: Some people prefer to remove the last bits of paper and food from the vermicomposted material and place them in a new bin for additional processing.) Since worms are present in the finished area, a simple worm sorting process should be followed.

Place a tarp or paper on the ground or on a table in a well lit area. Scoop out some vermicompost and shape it into a cone on the tarp or paper. The worms do not like the light, so they will burrow down into the vermicompost to get away from the light source. Remove the top layer of vermicompost, which will now be relatively worm-free, and place it in a container. Repeat the process until there is a small amount of vermicompost and lots of worms. Place these worms in a different container.

Scoop out more of the finished vermicompost from the bin and repeat the process until all of the finished vermicompost is harvested. Adding moist bedding, worms, and rock dust can restart the empty bin.

Harvesting Larger Bins

With larger bins it may be rather cumbersome to sort through all of the vermicompost for the worms. Therefore, it is recommended that worms in only one portion of the bin be fed; then wait for the worms to migrate over to the fresh food source. It could take a month or more for the migration to happen.

In addition deep bins may have a considerable amount of finished vermicompost underneath the unprocessed food and bedding. If the selective feeding method takes too long, consider removing the top six inches or so of unfinished food waste and bedding, setting this material aside, and harvesting the vermicompost underneath it. Most of the worms are located in the unfinished top section of the bin. Once the harvesting is complete, place the unfinished material back in the bin for further processing.

Using the Vermicompost

The finished material (also know as castings) is now ready to be put in the garden, in houseplants, or in outdoor plant pots. This is an excellent material to start seeds in, because it is complete with the required natural nutrients that a plant needs to grow. The vermicompost and extra worms are also valuable and can be sold as a fundraising project for the students.

D–III ASSEMBLING WORM BINS

Plastic Worm Bin

Convert a plastic bin into a new home for worms and see your organic food waste transformed into nutrient-rich compost. Plastic bins are easy to assemble and maintain. Plastic bins also retain moisture and may require regular additions of dry bedding. This bin can be used indoors or outdoors and is a convenient size for the classroom.

Cost

A new 12-gallon plastic bin and one pound of worms (1,000 worms) can be purchased for approximately $25. Reduce the costs by asking a friend to donate worms from his or her established worm bin, and/or reuse an old plastic storage bin.

Materials

To create a plastic worm bin, you will need:

___ One non-transparent plastic storage container (21 inches long by 15 inches wide by 12 inches high) with a secure fitting lid
___ Four 2-liter pop bottle caps or wooden blocks (scrap wood blocks will work) for the base of the worm bin
___ Four ⅝-inch screws or white glue to fasten the bottle caps or wooden blocks to the bin
___ Plastic sheet or tray for underneath the bin

Tools

Power drill with ¼-inch bit

Note: Please be safe! Wear earplugs and eye protection when drilling.

Assembly of Plastic Bin

Drill holes in the bottom of the plastic bin, approximately three inches apart, for ventilation and drain
wooden block
bottle caps un
four corners of
the ⅝-inch scr
This will allow
circulate and
the liquid to
drain from
the base of
the worm
bin. To col-
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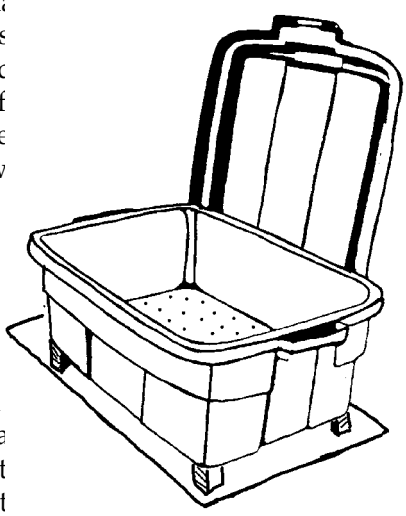
(Hint: An old TV tray works great!)



Conclusion

The worm bin is ready for worms. Please refer to the front of Appendix D, section II, for information on maintaining a successful vermicom-posting system.

Large Wooden Worm Bin

Build a wooden worm bin estate! Basic carpentry skills are required to construct this wooden worm bin. If you follow the directions and diagrams, the project should be relatively simple. A wooden worm bin breathes well, so it may occasionally need watering to maintain the proper moisture content.

Cost

This wooden bin can be built for about $30 with new wood and hardware, or for less money if using recycled or scrap materials.

Materials

Lumber

___ One 4- by 8-foot sheet of ½-inch exterior grade plywood
___ One 8-foot 1- by 2-inch board

Hardware

___ 36 1-inch galvanized screws
___ Eight 1½-inch galvanized screws
___ Two 3-inch door hinges
___ Approximately 12 ½-inch galvanized screws

Tools

___ Tape measure
___ Saw
___ Two sawhorses
___ Long straight-edge or chalk snap line
___ Power drill with ¼-inch bit

Note: Please be safe! Wear earplugs, eye protection, and a dust mask when sawing, hammering, and drilling.

Assembly of Wood Worm Bin

Preparation

1. Measure and cut the sheet of plywoood as indicated in Diagram 1.

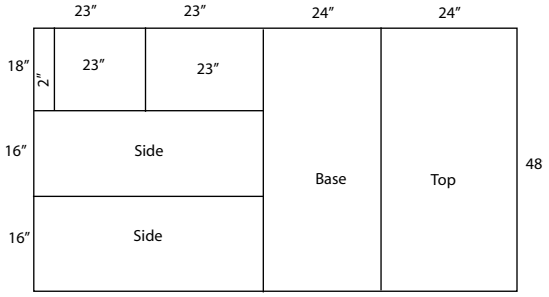


Diagram 1

Bin

1. Cut four 16-inch lengths from the 1- by 2-inch board.
2. Place one 16-inch piece on each side of the end panels, so they are flush with the top corner and edge of the end panels.
3. Secure the 1- by 2-inch boards using 1-inch screws. Four screws per board should be plenty.
4. Form the box by attaching the side panels to the end panels, as shown in Diagram 2.

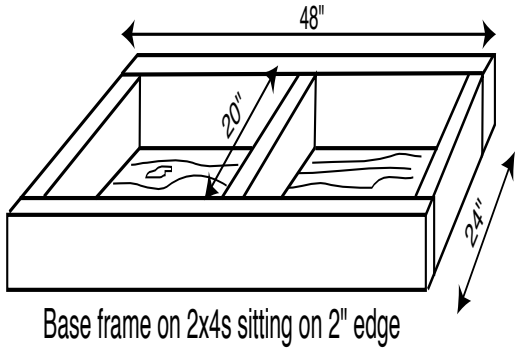


Diagram 2

5. Secure the side panels to the end panels by drilling 1-inch screws through to the 1- by 2-inch board at each corner of the box.

Base

1. Set the base panel on top of the box, so that the corners and edges are flush.
2. Secure the base panel to the box by drilling 1-inch screws through to the 1- by 2-inch board at each corner of the box.
3. Using a ¼-inch drill bit, drill holes into the base panel. One hole every 3 to 4 inches should allow for sufficient ventilation.
4. Cut the remaining 1- by 2-inch board into two 16-inch pieces. These will be the "feet" of the bin.
5. Set each piece on the base panel, over the end panel, so that the 2-inch side is horizontal.
6. Secure each 1- by 2-inch piece using 1½-inch screws.
7. Flip the box over, so that the feet are touching the ground.

Lid

1. Attach the two hinges to one side of the top panel, as shown in Diagram 3, using ½-inch screws.

2. Secure the lid to the box by drilling ½-inch screws through the bottom of the hinges into the backside of the box. You may need extra hands to do this!

Conclusion

This worm bin can house approximately 4 pounds of worms and process approximately 4 pounds of food waste each day. Please refer to the front of the guide for information on maintaining a successful vermicomposting system.

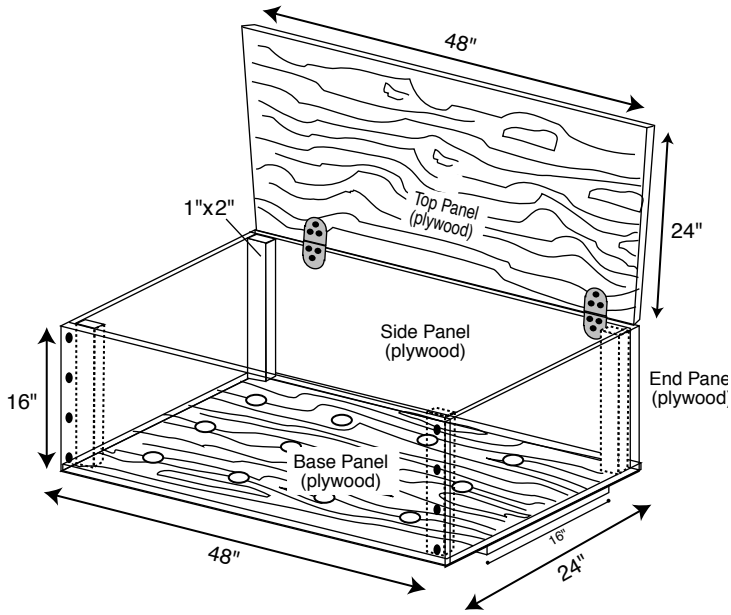


Diagram 3