# USER MANUAL

This guide is a separate document intended to support our full project report. It contains detailed instructions and pictures explaining the construction, assembly, and storage of ivy wall barriers and row covers.

## I. IVY WALL BARRIERS

This section explains how to construct and assemble ivy wall barriers, as well as how to create enclosures with them. Below is a table containing all of the materials needed to construct one barrier.

### *A. Parts List*

| Item | Unit Price | Quantity per Barrier | Cost |
|---|---|---|---|
| 4' x 8' x 1/2" Plywood | $26.38 | 0.5 | $13.19 |
| 4' x 8' x 1/2" Lattice | $13.57 | 1 | $13.57 |
| 3/8" x 4 1/2" Carriage Bolt | $0.82 | 6 | $4.92 |
| 3/8" x 6" Carriage Bolt | $1.10 | 2 | $2.20 |
| 3/8" Washers | $0.14 | 8 | $1.12 |
| 3/8" Wing nuts | $0.25 | 8 | $2 |
| 8' x 2" x 4" Board | $2.61 | 6 | $15.66 |
| 4 1/2" Deck Screws (box) | $28.87 | 8 screws | $0.58 |
| 3” Deck Screws (box) | $7.97 | 12 screws | $0.80 |
| 1 5/8" Deck Screws (box) | $5.24 | 20 screws | $0.87 |
| 14" Zip Ties (10 pack) | $3.13 | 4 zip ties | $1.25 |
| Mature Ivy Plant | $29.75 | 1 | $29.75 |
| **Total Cost per Barrier** | | | **$85.91** |

*B. Construction Setup*

To construct ivy wall barriers, you will need a space large enough to move 4'x 8' sheets of plywood. You will need a table saw or circular saw, and a drill press with a ⅜" bit (*Figures 1 and 2*). A drill press is ideal because a cordless drill will not make exact vertical holes.

*Figure 1*: Table saw setup

*Figure 2*: Drill press setup

*C. Component Construction*

All components are cut from 2"x4" boards, with the exception of the triangular braces and base plate (*Figures 4 and 10*). See *Figures 3-10* on the next page for the dimensions of each piece. The base plate (*Figure 4*) is cut out of ½ inch plywood, and two base plates can be made from one 4'x8' plywood sheet. Keep the corners you cut off, as they will be used for the braces (*Figure 10*). The drilled holes in *Figure 8* are not centered. If you already know the size of the enclosure you wish to build, you may choose to make two additional corner pieces (*Figure 9*) per corner in your enclosure.

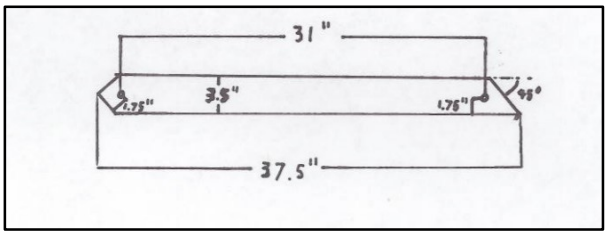


*Figure 3*: Gusset section slanted (x2)

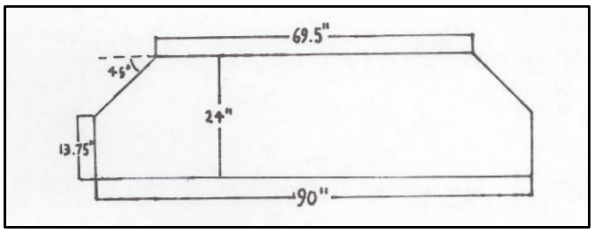


*Figure 4*: Base plate (x1)

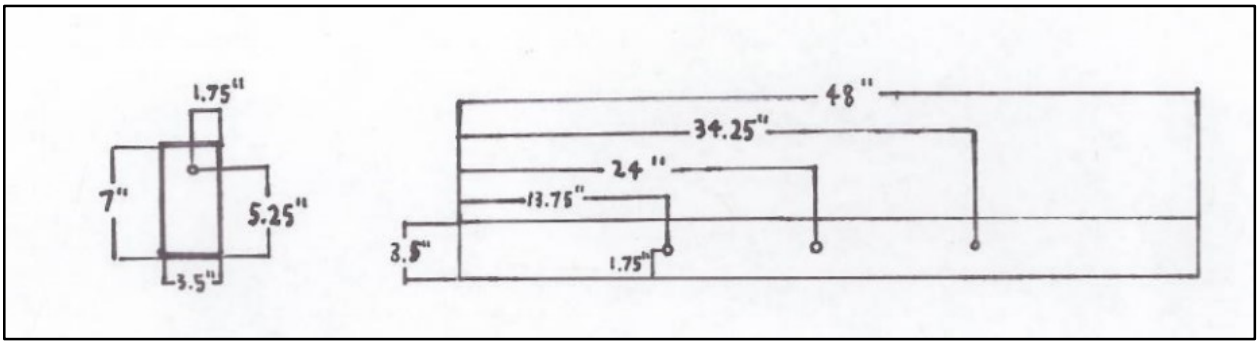


*Figure 5*: Horizontal gusset (x2)

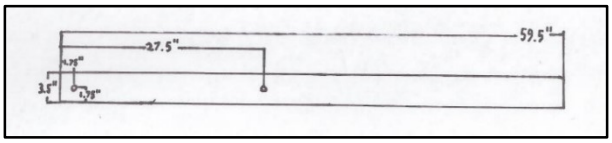


*Figure 6*: Upright (x2)

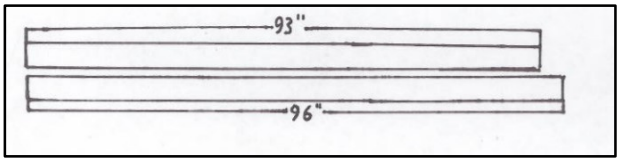


*Figure 7*: Top and bottom horizontals (x2)

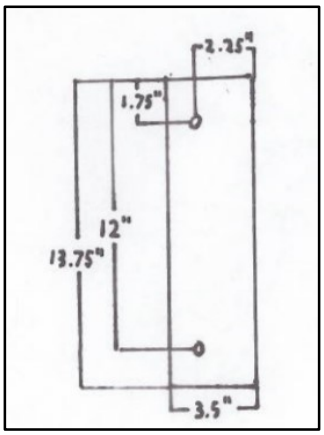


*Figure 8*: Base plate rail (x2)

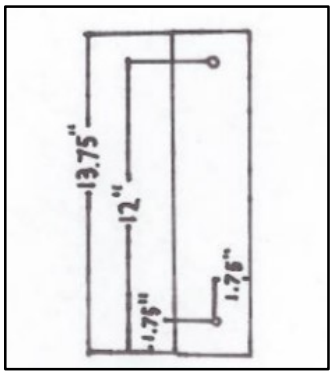


*Figure 9*: Corner slat (x2)

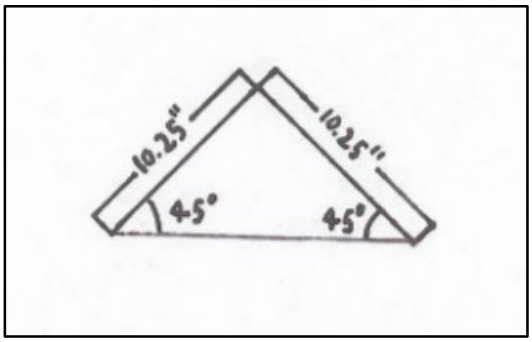


*Figure 10*: Brace (x2)

*D. Component Assembly*

To construct the horizontal gusset components out of the parts in *Figure 5*, use two 3" wood screws to attach the small section perpendicular to the large section, flush with the end. It is important when making the second horizontal gusset that they are mirrors of each other as in *Figure 11.* You will need one set of two mirrored gussets per barrier. To construct the base plate component, you will screw up through the bottom of the plywood into the rails using 3" wood screws (*Figure 12*). Make sure to place your screws so they do not intersect the holes. Orient the rails so that when they are attached to the plywood, the holes are 1.75" off of the ground.

*Figure 11*: Mirrored gusset components

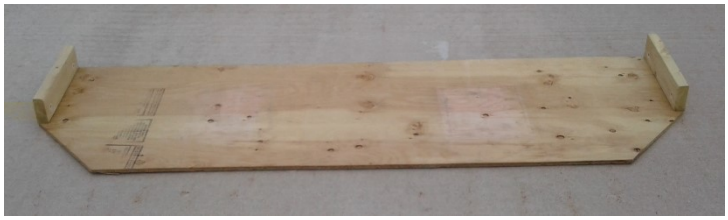

*Figure 12*: Base plate

To construct the frame (*Figure 13*), lay out the uprights and horizontals so that the top horizontal sits on top of the uprights, and the bottom horizontal is in between the uprights. The top and bottom horizontals should be 4 feet apart, and both uprights should be 8 feet apart so that a 4'x8' sheet of lattice will fit flush on it. Screw the frame together using 4 ½" deck screws. Using 4 2" wood screws, attach the triangular braces in each top corner of the frame.

To attach the lattice, flip the frame over so the braces are touching the ground, and lay the lattice on top of the frame (*Figure 14*). Using 1 ⅝" deck screws, screw the lattice onto the frame. If you have access to a handheld drill and drill bit, drill pilot holes (roughly the diameter of the deck screws) in the lattice to avoid splitting.

*Figure 13*: Assembled frame

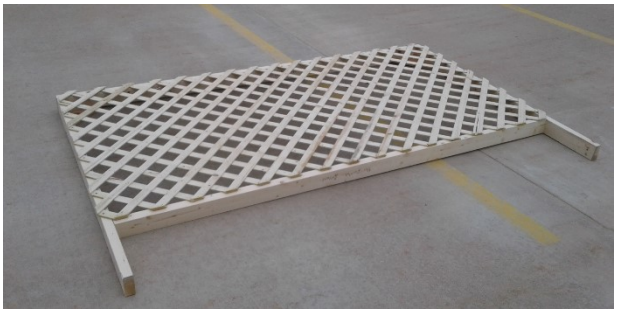

*Figure 14*: Lattice

At this point the frame, gussets, and base plate components are fully assembled.

*E. Barrier Assembly*

It is possible to assemble the barriers alone, however, we recommend that at least two people assemble them together. To assemble the barriers, you will need zip ties and a hammer. To start, lay out a base plate (*Figure 15*).

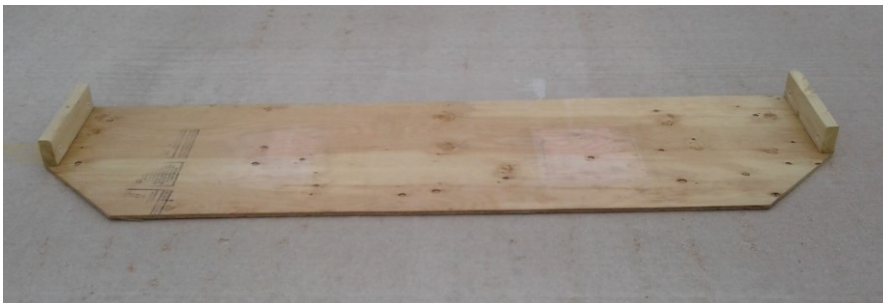

*Figure 15*: Base plate

Next, lay a horizontal gusset on either side of the plate so that the small vertical pieces are facing away from the base plate, as shown in *Figure 16*. Line up the holes in the horizontal gussets with the holes in the base plate rails. Put a 4 ½" carriage bolt facing inward through the pilot holes on each side that are furthest from the vertical gusset pieces. You will likely need to drive the bolts through the holes with a hammer (*Figure 17*).

*Figure 16*: Base plate with gussets

Next position the frame as in *Figure 18*, and drive 6” carriage bolts inwards through the remaining pilot holes on each side. Have one person support the frame while the other inserts the bolts. Secure all bolts with a washer and wing nut.

*Figure 17*: Driving bolts

*Figure 18*: Adding the frame

Next add the slanted gussets on either side as in *Figure 19* and use 4 ½” bolts to secure them to the vertical gusset piece and the frame. Now your barrier is fully assembled. Move it to wherever you need it, and then place three milk crates filled with dirt back on the base plate to plant your ivy (*Figure 20*).

*Figure 19*: Attaching the gusset

*Figure 20*: Fully assembled barrier

*F. Building Enclosures*

To build an ivy wall enclosure, you will want to construct several barriers and use zip ties to secure the barriers to each other. We recommend 14” zip ties, but 11” ties will work. To make corners, you will need to align the baseplates of the barriers as in *Figure 21*.

*Figure 21*: Base plate corner alignment

You will need to construct two barriers, leaving one side without gussets on each barrier (*Figure 22*).

*Figure 22*: One corner barrier

On the side with no gusset, insert a corner slat (*Figure 9*), and drive bolts through facing inward, as in *Figure 23*. Place the barriers as close together as possible and secure the corner with zip ties as in *Figure 24*. You may need to link several zip ties together depending on the size you purchase.

*Figure 23*: Corner slat in barrier

*Figure 24*: Securing corners with zip ties

Your corner barriers are now complete (*Figure 25*).

*Figure 25*: Barrier corner

To make straight sections, the orientation of the base plates does not matter. Secure straight sections of two barriers using zip ties as in *Figure 26*.

*Figure 26*: Straight section

To make a transition between a 90-degree angle and a 270-degree angle in your enclosure, you will need to orient the baseplates as in *Figure 27*.

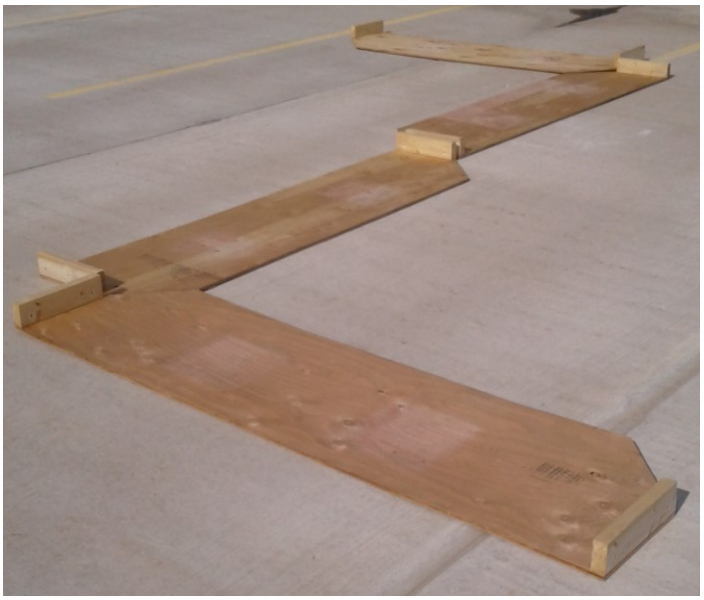

*Figure 27*: 90 to 270-degree corner transition

Then place the barriers as in *Figure 28*.

*Figure 28*: 90 to 270-degree transition

Two barriers are necessary to make the transition so that the corners of the baseplates do not overlap. If you wish to make a 90 to 270-degree transition but do not have the space for two barrier lengths, you may wish to construct a custom baseplate for that section of your enclosure (*Figure 29*), so that the transition can be made in one barrier length.

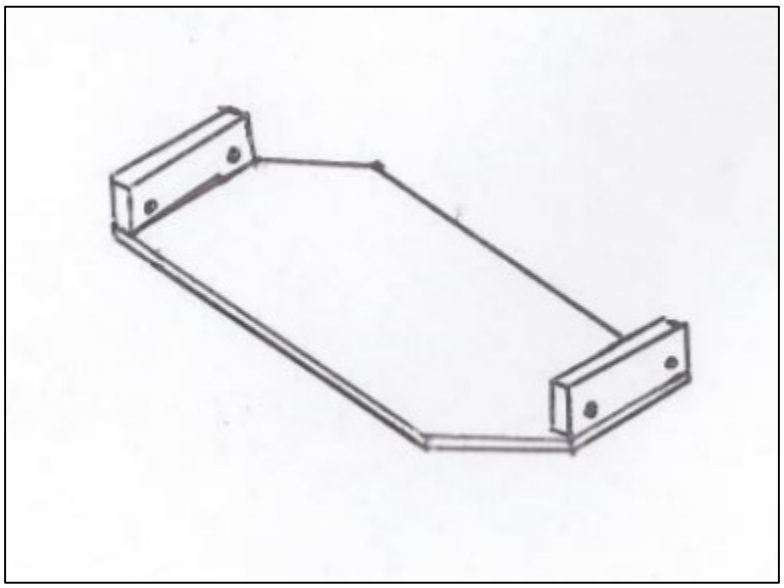

*Figure 29*: Custom baseplate for 90-270 degree transitions

*G. Weatherproofing*

During the winter you may wish to disassemble the barriers and put them in storage, while leaving the base plate with the milk crates of dirt in place so as not to disrupt the root structure. To do this you should clip the ivy stalks and remove the frame and gussets. If you do not plan to disassemble the ivy wall over the winter, we recommend putting a coat of external enamel on all wooden surfaces of the barrier in order to increase its longevity. To store the barriers when not in use, you will need roughly 64 square feet of space, as in *Figure 30*.

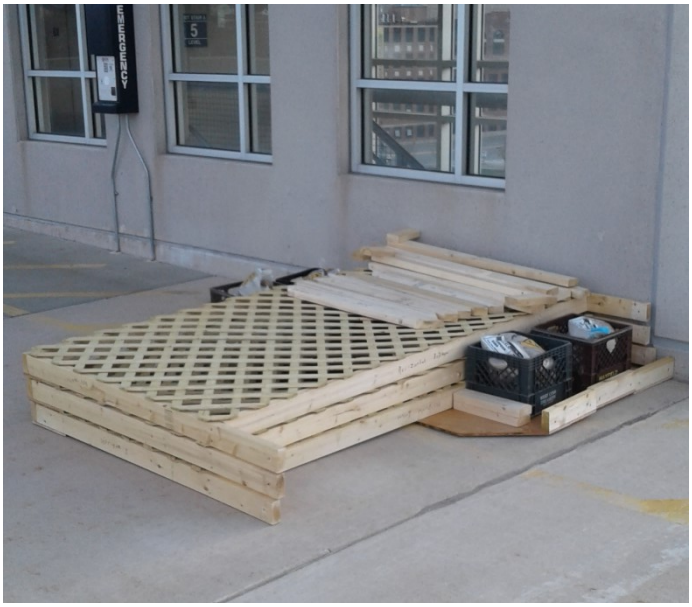

*Figure 30*: Barrier component storage

## II. Row Covers

This section describes how to assemble row covers. Below is a table containing all of the materials needed to construct one 18’ x 2’ planter row of row covers.

### *A. Parts List*

| Item | Cost per Item | Number per 18 ft Row | Total per 18 ft Row |
|---|---|---|---|
| Row cover fabric (6’ x 50’) | $23.95 | 6’ x 18’ | $9.58 |
| Row cover hoops (100 pack) | $106.00 | 5 | $5.30 |
| Grommets (12 pack) | $3.44 | 15 | $4.30 |
| 1” carabiners (2 pack) | $1.79 | 10 | $8.95 |
| 1” Split Rings (100 pack) | $5.60 | 10 | $0.56 |
| **Total Cost (per 18 ft row)** | | | **$19.79 - $28.18** |

To reduce the cost of the row covers, you may wish to purchase 1” split metal rings in bulk instead of carabiners. 1” split rings were included in the parts list, as they are much cheaper than carabiners, but were not used during our prototype testing. We cannot guarantee their effectiveness, but you may wish to try them for your row covers.

### *B. Assembly*

To assemble row covers, first insert the metal hoops into the soil as shown in *Figure 31*. We recommend placing a hoop every 4 feet. During testing, the hoops we used were 58” in length, and we recommend that all hoops used be at least this long to leave enough room for the plants. We also recommend purchasing hoops in bulk so as to lower the cost. These hoops may be longer than 58”, and as long as the fabric is measured accordingly, this increased length won’t be a problem. Make sure that the

fabric you are purchasing is wide enough for the hoop length you have chosen to use. If hoops are too long, they can be bent or cut at the ends.

*Figure 31*: Inserting hoops

Next you will need to cut the row cover fabric to size. You will need to measure the length of the hoop to ensure there is enough fabric to cover the row. If you use milk crates on your farm, you will want to leave enough fabric on one side to tuck under the milk crates. If you do not use milk crates, leave excess fabric on both sides and weigh it down with soil, rocks, bricks, or pieces of wood. To size the fabric for milk crate rows such as the one pictured above, or normal crop rows, measure the length of the hoops and add one foot for the width, and measure the distance between at least 4 hoops for the length. It is important the length of the fabric span from one hoop to another so that closed seams can be created by attaching the ends of two fabric pieces to one hoop. Once the fabric is cut to size, use a sharpie to mark where the grommets holes should go. Grommets are placed in line with the hoops, so they should be as far apart as the hoops in the rows. You will need three grommets per hoop. The grommet hole for attachment to the milk crate should be placed roughly 1” in from the end of the fabric (*Figure 32*). Two grommet holes for attachment to the hoop should be placed where the apex of the hoop will be (*Figure 33)*. Determine this distance by measuring from the lower holes in the milk crate to the topmost point of

the hoops with a tape measure. In our prototype, which used 58” length hoops, this distance was roughly 2’. Next, insert the grommets into the fabric at the marked points using a grommet tool kit and a hammer. Follow the instructions that come with grommet tool kit if you are unsure how to insert them.


*Figure 32*: Attaching to the milk crate

*Figure 33*: Upper grommets placement

Once the grommets have been inserted, tuck roughly 1’ of the fabric (the side without grommets) under one side of the milk crate row. Then use 1” carabiners or split rings to attach the top of the fabric to the hoop as in *Figure 33*, and to the sides of the milk crates as in *Figure 32*.

If your farm does not use milk crates, only the grommets for hoop attachment are needed. Both ends of the fabric will be held down with weights as previously described.

### *C. Opening and Closing Row Covers*

To “open” the row covers, our testing revealed that it is best to move from hoop to hoop sequentially, fully opening the covers at each hoop and then moving on to the next one. This method ensures that you maintain the most control over the fabric. First, unclip the carabiner or metal clip from the milk crate, then unclip them from the hoop, and then pull the fabric to the side that is tucked under the row, as in *Figure 34*. To secure the fabric in this open position, clip both carabiners/rings to this side of the milk crate.

*Figure 34*: Row cover fabric pulled to one side

If you do not use milk crates, when you wish to access the rows, remove the weight from one end, unclip the fabric from the hoop, roll back the fabric to the other side, and weigh it down again while you work. To close the row covers, regardless of whether your farm uses row covers or not, simply reverse the opening procedure.

### *D. Storage*

Over the winter you may leave out the hoops, but we recommend removing the fabric, folding it up, and storing it in a dry location. This will increase the longevity of the fabric.