

Triangular-Pergola with Bench

Pergola with plant trough and trellis



Figure 1: Triangular-Pergola on a Terrace (Pop-Up)

Key Data

- LOCATION: Outdoor, Pop-Up
- TYPE OF GREENING: Vertical greening, plant trough, trellis
- VEGETATION: Climbing plants, perennials
- CONSTRUCTION: Wooden pergola with plant troughs (wood) and trellis (steel cable)
- IRRIGATION: Automatic irrigation



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Location Selection



Figure 2: Visualisation of a green triangular pergola

- Fix the area and height of the installation site
→ for determining the **maximum dimensions of the greenery**
- Is a ground connection possible?
→ **for raised bed requirements and irrigation needs**
- Determine exposure and shading (from buildings)
→ **for plant selection**
- Irrigation:
 - Water connection
 - Power connection (alternatively, control via battery)
 - Drainage, if necessary
 - Personnel for manual watering (if automatic irrigation is not possible)

Figure 1: Visualisation of a green triangular pergola

Material

The following overview provides an outline of the materials needed, including approximate dimensions and quantities, for a **triangular pergola structure measuring approximately 2.7 x 2.7 m, with a plant trough running 6 linear meters** around a corner.



The exact lengths, quantities, and amounts must be determined based on a detailed plan that accounts for local conditions. The listed dimensions serve as a guideline for material ordering and as a construction aid. However, it is recommended to prepare a construction drawing or sketch based on the actual dimensions of available components or individual size requirements.

For the wooden components, it is generally recommended to choose a local, easy-to-work-with, and durable type of wood. The surface should ideally be planed and untreated. For **outdoor use**, the wood should be weather-resistant—larch, for example, is a suitable option. For **indoor use**, spruce can be used.

In general, it is also possible to use reclaimed or leftover wood. With appropriate surface treatment or processing (e.g., placing the best-looking side facing outward), this can help reduce material consumption and promote reuse.

Wooden pergola

Recommendation for outdoor installation – planed larch wood, untreated surface

- **Square timber ~ 100/100 mm ~ 22 m**
 - 3 pcs. ~ 250 cm (posts)
 - 2 pcs. ~ 300 cm (beams)
 - 1 pc. ~ 400 cm (Diagonal beam)
 - 6 pcs. ~ 70 cm (braces)

- **Wood slats ~ 45/70 mm ~ 16 m**
 - 9 pcs. á ~ 50 - 250 cm (longitudinal timber)

- **U-shaped post bases (Dimensions according to post size)**
 Recommendation: height- and width-adjustable, height > 12 cm
 - 3 pcs. (one for each post)

- **Screws**
 - Wood screws for connections (at least 2 per connection)
 - Anchor bolts for securing post bases to the ground

Wooden plant trough

Recommendation for outdoor installation – planed larch wood, untreated surface

- **Square timber ~ 50/80 mm ~ 16 m** – for frame structure
 - 16 pcs. á ~ 50 cm (crosspieces)
 - 16 pcs. á ~ 50 cm (posts)

- **Wooden boards ~ 26/140 mm ~ 48 m** – for exterior walls
 - 8 pcs. á ~ 350 cm (longitudinal boards)
 - 8 pcs. á ~ 200 cm (longitudinal boards)
 - 8 pcs. á ~ 50 cm (cross boards)
 - Additional boards for the bottom only if needed

- **Spacer/supports** to elevate from ground (for protection against moisture from below, e.g., made of metal, plastic, or rubber Boden)



- **Screws**
 - Wood screws for connections

Wooden Bench ~ 2 m Length

Recommendation for outdoor installation – planed larch wood, untreated surface

- **Square timber ~ 80/80 mm ~ 6 m** – for frame structure
 - 6 pcs. ~ 50 cm (posts)
 - 6 pcs. ~ 50 cm (crosspieces)
 - alternatively, leftover wood from the pergola can be used
- **Wooden slats ~ 45/70 mm ~ 10 m**
 - 5 pcs. ~ 200 cm (seat boards)
 - alternatively, use the same boards as for the plant trough
- **Spacer/supports** to elevate from ground (wood protection against moisture from below)
 - e.g., made of metal, plastic, or rubber
 - optionally, concrete blocks (for use on lawns)
- **Screws**
 - Wood screws for connections (at least 2 per connection)

Trellis Support – Steel Cable

- **Steel cable 4 mm [d] ~ 50 m**
- **Cable clamps 4 mm [d] ~ 20 pcs.**

Vegetation Support Layer

- **Waterproof plant trough:**
 - Dimpled membrane (Building requirements)
 - And/or pond liner, e.g., made of EPDM
- **Inspection pipe, diameter 5 cm, length ~60 cm, 2–4 pieces**
 - e.g., drainage pipe (PP) DN 50 + cap
- **Optional: Tank valves (4 pieces) + drainage hose for targeted water discharge**
- **Drainage layer, height 5 cm, approx. 150 liters**
 - e.g., expanded clay, clay granulate, or mineral aggregate
- **Separation layer – fleece, ~100 cm wide, approx. 7 linear meters**
 - e.g., recycled fleece (200 g/m²)
- **Planting substrate, approx. 1200 liters**
 - e.g., intensive green roof substrate
 - or planting substrate with mineral and organic components (peat-free)
- **Cover layer / mulch material, 3 cm thick, approx. 100 liters**
 - garden fiber / wood fiber
 - or mineral aggregate
 - do not use bark mulch (inhibits growth)



Support/Mowing Edge – only for grass/soil installation

- **Concrete blocks for mowing edge and supports** – as needed
 - e.g., concrete edging stones 100/20 cm as mowing edge
 - and/or paving stones as base (for pergola posts, raised beds, benches)
 - optionally paving grit for leveling

Automated Irrigation System

- Water connection
- Supply pipe (e.g., PE pipe 25 mm or 16 mm)
- Drip pipe, approx. 12 linear meters
- e.g., PE pipe 16 mm or micro-drip line with emitter spacing ~20 cm
- Ground spikes for drip lines
- Control unit
- Solenoid valve, as required (depending on control unit)
- Connectors (T-, L-, and straight connectors)
- Automatic drain valve
- Optional: Water meter
- Optional: Frost sensor (for winter operation) + 2-core cable

Plants

- **Climbing plants** (twining, winding), **small shrubs, perennials, herbs**
 → **Note the type of climbing habit, site exposure, and moisture requirements!**
- **Tying material** (e.g., twine, clips, wire)

Tools

- Tape measure, folding ruler
- Marking square
- Pencil
- Wood saw: circular saw or mitre saw, hand saw
- Cordless drill/driver + bit set
- Wood drill bits
- Masonry/concrete drill bits
- Optional: wood planer
- Power sander
- Sandpaper
- Utility knife
- Staple gun + staples
- Wrench/spanner (for ground anchors, cable clamps)
- Cable cutter
- Scissors (for cutting fleece)
- Pruning shears
- Buckets
- Shovels
- Hand trowels
- Watering can or garden hose
- Ladders ~2 m standing height (2 pieces)
- Spirit level
- Hammer
- Rubber mallet



- Chisel

Step-by-Step Instructions

Once all materials have been procured, preparations and assembly can begin.

To ensure an efficient installation, many tasks can be carried out simultaneously. As soon as the basic pergola structure (posts and beams) is in place, work can continue in parallel on the pergola itself, the plant trough and the trellis system.

Step 1: Planning Sketch and Measurements

With the overall dimensions determined, a detailed plan can be drawn up and the exact component lengths calculated. It is advisable to create a complete list of all cutting lengths.

To ensure that all beams are positioned at the same height, either traditional joinery methods can be used, or additional metal brackets or supports can be attached to the posts. For outdoor use and improved durability, the use of brackets or extra supports is recommended as part of constructive wood protection.

Step 2: Pergola Assembly

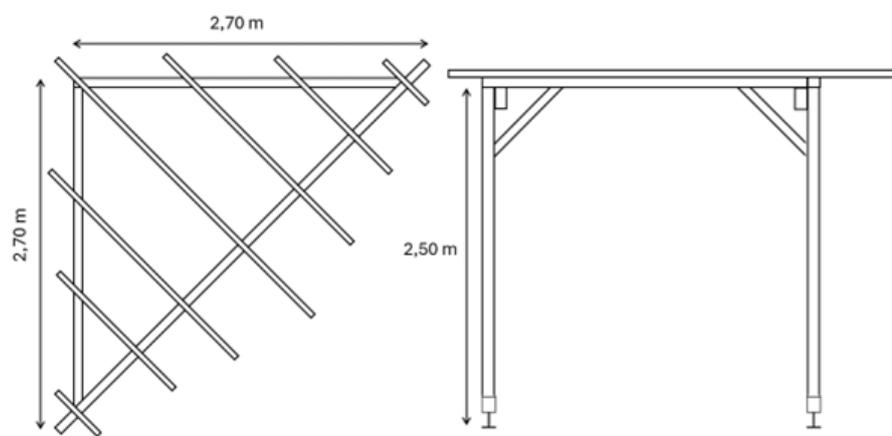


Figure 3: Triangular-Pergola (2.7 x 2.7m) top view (left) and side view (right)

First, all lengths are transferred onto the timber ("marked out"), then the wood is cut and processed accordingly. After that, the pergola is assembled.

2.1 Cutting and Preparing the Wood

1. Transfer length measurements onto the timber (marking).
2. Cut the wood to exact lengths
→ The upper beams should—where possible—extend beyond the posts for constructive wood protection.

Exception: At right-angled corners, use timber joints to ensure beams are aligned at the same level.

3. Cut a timber joint for the two beams at the right-angled corner, or install additional metal brackets/supports and place the beam in between the posts.
4. Bevel or sand the edges.
5. Pre-drill holes for screws (*minimum distance from end grain edge: > 2 cm*).

2.2 Assembly

1. Anchor the **post bases** to the ground (concrete surface or point foundation).
2. Prepare beam connections to the posts using appropriate screws:
 - a. Mark and align the connection point on the post
 - b. Pre-drill holes
 - c. Partially screw in the screws (about halfway)
3. Provide one **ladder** per **post** and have cordless screwdriver + bit set ready.
4. Screw the two **outer posts** onto the post bases (check with spirit level) and hold in position.
5. Position the **diagonal beam** evenly from both sides on top of the posts (using the markings) and screw it in place.
6. If needed, install **additional brackets** or **supports** on top of the posts.
7. Place the remaining two **beams** and fasten them.
8. Mount the diagonal **braces** between posts and beams to stabilize the structure.



Step 3: Plant Trough Assembly

First, all lengths are transferred onto the timber ("marked out"), then the wood is cut and processed.

Next, frames are assembled and combined with the wooden boards to form the plant troughs, which are then screwed together.

Numbers in Figure 4 have commas instead of decimals

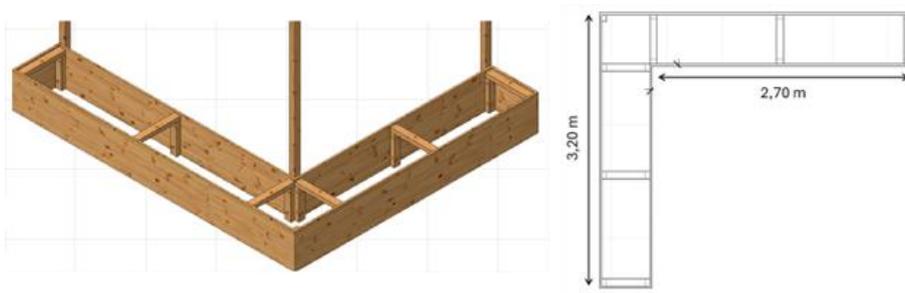


Figure 4: Plant trough visualisation and top view

3.1 Laying the Substrate Support (only for grass/soil location)

1. Mark the outer dimensions and post locations (supports) of the raised beds.
2. Remove grass or soil according to the dimensions of the concrete blocks.
3. Optionally, add **paving grit** – for improved support and easier leveling.
4. Lay the **concrete blocks** evenly and level them using a spirit level.

3.2 Cutting and Preparing the Wood

1. Transfer length measurements and drilling positions onto the timber.
2. Cut the wood to exact lengths.
3. Bevel or sand the edges.
4. Pre-drill holes for screws (*minimum distance from end grain edge: > 2 cm*).

3.3 Screwing Together

1. First, form individual **rectangular frames** ("O"-shaped) from the **square timbers** and screw them together.
2. Attach spacers underneath to elevate the structure from the ground.
3. Then screw the inner **longitudinal timbers** to the pergola posts.
4. Next, place the **frames** in position and attach them to the already fixed longitudinal timbers.
5. Now attach the remaining **longitudinal and cross timbers** to the frames.
6. If needed or desired, insert and screw in **bottom boards**.

3.4 Sealing / Lining and Drainage Installation

1. Line the inside with **dimpled membrane** and/or **pond liner** (all the way to the top).
→ Fix the liner along the upper inner edge of the frame using a staple gun, spacing staples approx. every 20 cm.
2. Install the drainage system:



- a. Either install **tank valves** (2 per long side of each box), positioned either laterally, 3 cm above ground level, or at the bottom, protruding 3 cm into the interior (to create a small water reservoir).
 - Drill/cut openings, insert the valves, and secure/seal them tightly.
- b. Optionally, connect a **drainage pipe** to the tank valves and lay it with a downward slope.
3. Without tank valves: Fold up the **lower dimpled/sealing foil** approx. 3 cm at the side and lay additional dimpled/sealing foil above this section in an overlapping manner. This allows excess water to drain once it exceeds the reservoir height.
 - **Every outdoor plant trough must have a drainage option!**
4. Prepare **inspection pipes**: Drill multiple small holes in the lower part of each pipe and wrap the perforated area with fleece to prevent substrate from entering
 - Use one inspection pipe per tank valve (or, if no tank valves are used, one per plant trough)

Step 4: Trellis System Installation

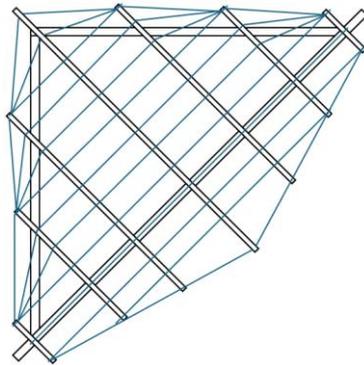


Figure 5: Example for rope pattern

1. **Drill holes** (minimum 5 mm diameter, or larger for multi-cable intersections) through all slats for horizontal cable routing (drill through the narrow side).
 - **Evenly space the holes**, e.g., every 30 cm.
 - Consider **diagonal angles** of cable routing (e.g. lay on the ground as planned and temporarily lay a rope pattern over it as a "marking guide").
2. Secure the **slats** vertically to the beams of the pergola (the drilled holes must be oriented horizontally).
3. Thread the **wire rope** horizontally through all the battens and secure it at the beginning with rope clamps. Continue to pull in a snake shape and tension after each change of direction.
4. At the end, **tension** the cable again and fix it with **cable clamps**.
 - Leave extra loops at both the beginning and end for future tension adjustments (strain relief).
5. For **vertical supports**, attach additional cables from each climbing plant or across entire sections of the plant trough frame up to the outermost slat or beam, and secure them.

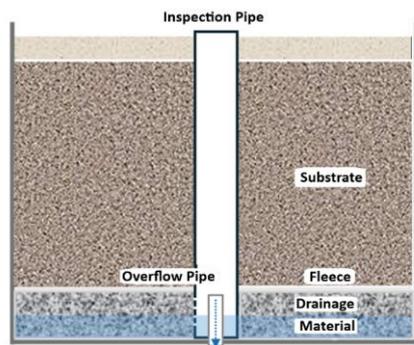


Figure 6: Layer construction plant trough

Kommentiert [SP1]: translate diagram to english

Step 5: Filling / Layer Construction

1. Place the **inspection pipe** upright onto the tank valves and ensure it remains vertical.
2. Add approx. 5 cm of **drainage material** to the bottom.
3. Cut the **separation fleece** to size and make holes for the inspection pipes.
4. Insert the **fleece** and pull it up along the inner sides of the planter box.
5. Fill in the **planting substrate**.
→ For large root balls, leave enough space accordingly.

Diagram labels are in German

Step 6: Planting

1. Remove the **root ball** from its nursery pot and gently score the bottom of the roots (this helps the plant establish better).
2. Place the plant in the planter and fill in with **substrate**.
3. Firmly press the substrate down with your hands all around and continue filling until approx. 5 cm below the upper edge.
4. Apply approx. 3 cm of mulch material.
5. Secure the climbing plants to the trellis using binding material.
→ **Important: For vigorous twining or strangling climbers (e.g. Wisteria), tie them parallel to the cable (do not allow them to wrap around the cable directly)!**
6. Water thoroughly – the substrate will absorb a lot of water initially.

Step 7: Assembly of (mobile) Wooden Bench

First, transfer all length measurements onto the wood (marking), then cut and process the timber. Next, build the supporting frame and screw it together with the slats or decking boards to form the bench.

It is recommended to permanently attach the bench to the pergola structure. This increases overall stability and ensures that the bench cannot be removed or stolen.



7.1 Cutting and Preparing the Wood

1. Transfer length measurements and drilling positions onto the wood.
2. Cut the wood to the exact lengths.
3. Bevel or sand all edges.
4. Pre-drill screw holes (*maintain a distance of > 2 cm from end grain edges*).



Figure 7: Mobile Bench

7.2 Screwing Together

1. First, assemble the **individual frame** from the **square timbers** and screw it together.
2. Attach spacers underneath to lift it off the ground or alternatively place concrete blocks in the lawn.
3. Then place the **frame** in position and, if necessary, fix it to the pergola posts or plant trough for added stability.
4. Finally, attach the **seat surface (slats or boards)** to the frame.

Step 8: Installing an Automated Irrigation System

An automated irrigation system is always recommended – if possible – in order to ensure consistent watering, including during holidays or changes in students or staff.

8.1 Required Connections

- Water connection (ideally frost-proof and usable in winter) with a minimum pressure of 3.5 bar
- Power connection (for irrigation controller)
Alternatively: battery-powered controller
→ **Reliable battery replacement is essential!**
- Best location for connections: in a frost-free interior space (e.g. storage room, basement, etc.)
- Route the piping with a downward slope leading outdoors
- → For outdoor installation without winter operation, frost protection is not required.

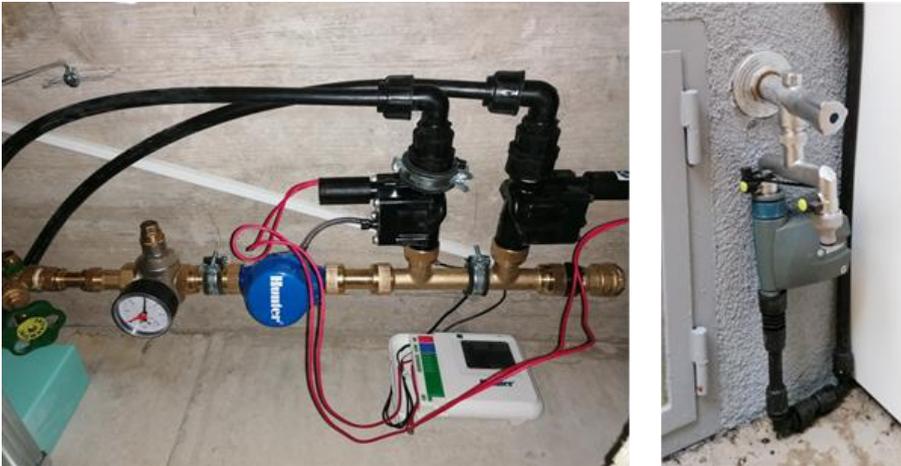


Figure 8: Control unit with solenoid valves in the interior (left) and with battery control unit outside (right)

8.2 Installation

- Interior control system:
 - the pipe leading outside should have a downward slope from the solenoid valve to ensure frost-proof drainage.
 - Optionally connect a water meter.
 - Connect the solenoid valve.
 - Mount the controller and connect it to the solenoid valve.
 - Lead a 2-wire cable for the frost sensor outdoors and connect it.
- Outdoor control system:
 - Use a valve box for the solenoid valve and controller
 - or use a controller with integrated valve connected directly to the water source.
- Lay the **supply line** to the planted areas.
- Install an **automatic drain valve** at the lowest point of the system.
 - It closes when pressure builds and opens when pressure drops.
- Lay **drip lines** across the planting areas and fix them with ground spikes.
- Close the drip line loops (e.g., using end caps or connectors).
- If needed, install the **frost sensor** outdoors and connect it to the controller.
- Check connectors and joints for **leaks**.
- **Irrigation Timing and Duration**
 - **Start time / frequency** – depending on substrate volume, location, and season
→ *Once per day up to three times per week*
 - **Duration per cycle** – depending on emitter spacing, flow rate, and substrate volume → Approximately 3 to 30 minutes

Greenery Maintenance and Care

- Visual inspection – daily → vital plants, intact irrigation system?
- Establishment care:
 - Watering ~1x per day
After good root development → less frequent (up to 3–5x per week)
 - Guiding and tying shoots to the trellis
→ **Unwind young shoots of vigorous climbers/stragglers and tie them parallel!**
 - Remove brown leaves and dead shoots as needed
 - Fertilizing (spring/summer), e.g., with slow-release/granular fertilizer
- Check for water accumulation and drainage (~ weekly)
 - Water level in inspection pipe max. ~6 cm
 - Check drainage function and clean if necessary
- Pruning and replanting
 - Prune back dead or overgrown shoots as needed
 - Remove (above-ground) dead leaves/shoots from perennials in spring
 - In case of plant loss – remove the entire root ball and replace
- Automated irrigation system and winterizing
 - Adjust watering times and duration according to demand (e.g. spring – summer – autumn – if applicable: winter)
 - Winterize before the first frost – if system is not frost-proof
 - Turn off supply line
 - Open valves and drainpipes
 - Remove controller if necessary and store in a frost-free location
 - In winter, manual watering may be necessary – if system is not frost-proof
 - In spring (once there are no more frost days) – reinstall and activate



Figure 9: Plant care

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