SKILL GUIDE · WATER & FOOD

Building a Walipini: The Underground Greenhouse

The Water & Food chapter's Tier 3 Greenhouse / Season Extension item names a greenhouse as a way to extend Utah's short growing season. A walipini is a specific, real design for that: a sunken pit greenhouse that uses the earth's own stable temperature to hold cold-hardy crops through winter without burning any fuel. See Building a Jean Pain Compost Heat Mound for actual supplemental heat on top of this, since a walipini holds temperature, it doesn't generate it.

Where this comes from

In the 1990s, the Benson Institute, a humanitarian arm affiliated with Brigham Young University, built a prototype underground greenhouse with local farmers near La Paz, Bolivia, at high altitude where nighttime frost is a year-round risk. They called it a **walipini**, Aymara for "place of warmth," and published a free construction manual afterward that's largely responsible for the design spreading to North American gardeners since.

How it actually works

The core mechanism is easy to misstate: soil isn't insulation here, it's **thermal mass**. Dirt's actual insulating value is low, roughly R-0.125 to R-0.25 per inch, so matching a standard R-8 insulated wall would take on the order of 11 feet of solid soil. What a 6–8 foot pit actually buys is stability: soil at that depth holds close to the region's mean annual temperature, commonly 45–62°F across the continental US depending on location, largely immune to a single cold night the way the air above ground isn't. Add passive solar gain through an angled, south-facing glazed roof, and the combination holds cold-hardy crops well above killing temperature through winter. It doesn't add heat the way a furnace does, it buffers against losing what's already there, which is exactly why this design's real ceiling is season extension for cold-hardy greens, not tropical fruit through a hard winter.

Real design specs

Element	Spec	Why
Pit depth	6–8 ft in most of the continental US; 3–4 ft in USDA zones 3–4, paired with a taller glazed wall	Deeper reaches more stable soil temperature; shallower zones need the glazing to compensate for a colder, less stable subsoil
Orientation	Long axis east–west	Maximizes the south-facing glazed roof area exposed to low winter sun
Glazing angle	Calculated to sit perpendicular to the sun at solar noon on the winter solstice, for your specific latitude	Maximizes penetration and minimizes reflection during the weakest sun of the year, the actual design constraint that matters most
Glazing material	Twin-wall polycarbonate (8–10mm) typical	Roughly R-1.6 to R-2, 80–82% light transmission, and a real 10–15 year service life; plain poly sheeting is cheaper but degrades and insulates far less

USDA zones 4 through 8 see the clearest benefit from this design; below that, insufficient winter sun makes even a correctly built walipini struggle to hold useful daytime warmth.

WARNING

The viral '$300 walipini' figure is a different structure than the one you'd actually build

The Benson Institute's original Bolivian pit, and the "$300 underground greenhouse" figure that gets repeated from it, was an unframed dirt pit with loose plastic sheeting, no drainage system, and no code requirements to meet. A real North American build with proper perimeter drainage, framing, and polycarbonate glazing runs closer to $15–40 per square foot, commonly $2,000–6,000 for a 10×20 ft structure once professional excavation ($500–2,000 depending on soil and access) is included. Budget for the real version, not the headline number.

Building it: the real sequence

1. Call 811 (the national "call before you dig" hotline) to get underground utilities marked before any excavation, then lay out the pit's dimensions and orientation on the ground.
2. Excavate to the planned depth, sloping the floor slightly toward one low corner or edge so water has somewhere to go rather than pooling in the middle.
3. Lay a thick layer of gravel or crushed stone across the pit floor, and install the perimeter French drain (a gravel-filled trench with perforated pipe, sloped to daylight or a dry well) before building anything

on top of it; retrofitting drainage after the walls and roof are in is a much bigger job.

4. Build the retaining walls for the pit's below-grade sides. For a timber-framed wall, set treated posts (commonly 6x6) into concrete or compacted gravel footings roughly 3 feet deep, wrap the buried portion of each post in 6-mil plastic sheeting to slow rot, then connect the posts with horizontal boards to form the wall face.
5. Frame the sloped roof structure over the walls, angled per your latitude's winter-solstice sun as covered above, then install and seal the glazing, sealing every edge and seam against drafts is what actually keeps the structure's heat retention working as designed.
6. Mound the excavated soil against the three non-glazed sides (typically north, east, and west) as an additional earth berm, adding further thermal mass and wind protection beyond the pit walls themselves.
7. Install the ventilation, a thermal chimney vent near the roof peak and ground-level intake vents, before planting anything; adding it as an afterthought after a mold or overheating problem shows up is a much worse way to learn you needed it.

What actually rules a site out

- **A high water table.** Keep at least 5 feet of clearance between the pit floor and the water table; digging into or near it turns the structure into a basin that floods rather than a stable growing space.
- **Poor drainage.** A real perimeter French drain and correct site grading are what actually prevent flooding and foundation instability, not hope that the soil drains on its own.
- **No ventilation plan.** A sunken structure traps humidity and summer heat both; a thermal chimney or ground-level passive vents are what prevent mold, disease, and a greenhouse that cooks its own crops in July.

Northern Utah note: check the water table before digging, not after

Wasatch Front groundwater runs seasonally high, commonly 0–10 feet deep in parts of the valley, peaking March through June, exactly the months a spring build is most tempting. Check actual local groundwater depth (Utah Geological Survey data, or a local well log) before committing to a full 6–8 foot pit; a shallow water table is a real, common reason to build the shallower, taller-glazed-wall version instead, or an above-grade alternative entirely. Valley-floor clay soils here also shrink and swell significantly with moisture, a real structural risk for below-grade walls that a sandier, foothill-adjacent site doesn't carry to the same degree.

Sources

- Benson Institute origin, Bolivia, and the "place of warmth" naming: Walden Labs; original construction manual: Open Source Ecology
- Soil as thermal mass versus insulation, real R-value, and mean earth temperature by depth: Greenhouse Score
- Design specs, orientation, glazing angle, and glazing material comparison: Eco-Savvy; Ceres Greenhouse Solutions
- Realistic North American construction costs versus the Bolivian original: CF Greenhouse; Craft Camp
- Water table clearance, drainage, and ventilation requirements: Charley's Greenhouse
- Wasatch Front groundwater depth and seasonal timing: Utah Geological Survey; clay shrink-swell soil risk: AccuRite Excavation
- Construction sequence (utility locating, excavation, drainage, retaining wall framing, roof framing, berming): Mother Earth News; Harvest Savvy