

Seasonal High Tunnel System for Crops

Interim Conservation Practice Job Sheet

798

Where used



A seasonal high tunnel system (SHTS) may be used where existing specialty commodity crops are grown in open field conditions, and extension of the growing season is needed due to climate conditions.

Commercially available high tunnel structures are made in numerous widths and lengths and types (round, arch, etc.). High tunnels are constructed of metal frames and covered with a layer of polyethylene. The larger the system, the more thermal mass is stored, and a single layer of poly cover may provide one hardiness zone of protection while a second row cover may provide a second zone of protection.

Ventilation is achieved by opening the roll-up sides and ends or removing the cover. The end walls are generally framed-in to create a door and ventilation area, although doors can be designed to spring open for the warm season.

Plants in the SHTS rely on irrigation water, applied either by hand, drip or sprinkler irrigation, etc. and are normally irrigated daily. An average of 2 to 5 times as much irrigated water may be used on crops in a high tunnel compared to an outdoor system. Plan on 0.12

Gallons/day per SF planted area within the tunnel.

Fertilizer and pesticide use is usually lower because there is no excessive leaching in the soil profile, from rainfall, leading to improved water quality.

The SHTS spans several crop rows which allow for full crop maturity. The tunnel should be high enough to accommodate small farm equipment and not hinder plant growth. Tomatoes, bush crops or crops requiring trellises may need 4 to 6 foot sidewalls to prevent shading of the light transmission.

Most structures are installed on north-south axis to maximize summer light. When the growing season is expected to extend into winter months, consider orienting the high tunnel along a more east to northeast or west or southwest axis (reference "The Passive Solar Energy Book" by Edward Mazria and "High Tunnels" by Ted Blomgren and Tracy Frish).

Structures placed perpendicular to prevailing winds typically receive the most damage, so when strong seasonal winds are a concern, consider placing near a windbreak of trees, shrubs or fabricated material to moderate or redirect the wind (reference Windbreak / Shelterbelt Establishment (380)).

Criteria

The type, shape and height of a SHTS selected shall be based on the

- crop(s) planted, row width, bed width and number of rows (min. 3) and height.
- length of seasonal extension required for plant protection.
- availability of a flat to mild slope site. Do not place SHTS on slopes greater than 4% (parallel to the length or 3% (perpendicular to length)). The manufacturer shall approve placement of SHTS on slopes greater than 3% and provide additional structural components (i.e. length of supports, posts, cover extension to the ground, etc.).

- height extension of farm equipment (minimum of 6 feet high) used inside the SHTS.
- SHTS footprint (minimum of 20' wider and longer than the selected SHTS).
- location and proximity to other elements (trees, buildings, hillsides, etc).
- design for heavy snow and wind loads where this is a concern.

A seasonal high tunnel shall

- not be a greenhouse, nor grow crops in containers, pots, on benches or tables.
- not be placed in the 25 year-24 hour floodplain.
- protect the ground from surface water runoff and erosion.
- be covered by 6 mil polyethylene clear film (4 year minimum warranty).
- have a documented year-round water source, such as a river, stream, pond (min. 1.1 SF surface area per SF of SHST with a minimum 6' depth with adequate watershed and/or spring), irrigation well (minimum of 0.005 GPM per SF of SHTS) or municipal water (PSD notification).
- have a steel constructed frame
- have a maximum four (4') rafter or bow spacing
- have a wind bracing kit or have heavy duty post supplied by a reputable manufacture of SHTS.
- be protected from heavy snows or high winds when they are expected to compromise the structure.
- have manufactured supplied ground posts installed a minimum of 24" or 6" below the frost depth, whichever is greater.
- have purlins connected by cross connectors to the bow, for added strength.
- have roof runoff (10 year -5 minute storm (0.55") directed away from the SHTS to a stable outlet .
- have a minimum length to width ratio of 2:1 and a maximum length to width ratio of 4:1.
- be on a site with productive soils.

- ensure drainage away from the structure.
- be on a site with adequate set back distance from hills, trees or buildings (minimum of 2.5 to 4 times SHTS height) to avoid unnecessary shadows..
- have cemented corner end post, as a minimum, and optimally every other post for structures greater than 20' wide or 20' long.
- be located and aligned based on the landowner's documented decision.

There are many manufactures of SHTS. The width of the SHTS allows it to be categorized as small, medium or large.

Seasonal High Tunnel Structure (small)

In addition to the above CRITERIA; small, semi permanent or portable SHTS, often referred to as cold frames, are 12' to 14' wide, 900 SF or less and

- extend the growing season by 1 to 2 months.
- can remove the cover before, during or after the growing season.
- have a minimum 17 gage galvanized steel tubular steel 1.315" diameter frame.
- have a minimum of 2 purlins.

Seasonal High Tunnel Structure (medium)

In addition to the above CRITERIA; medium, SHTS are 15' to 20' wide, greater than 900 SF and less or equal to 1600 SF and

- extend the growing season by 3 to 4 months.
- have a minimum 14 gage galvanized steel tubular steel 1.66" diameter frame.
- have a minimum of 3 purlins.
- have heavy-duty ground post a minimum of 2.0' in the ground.



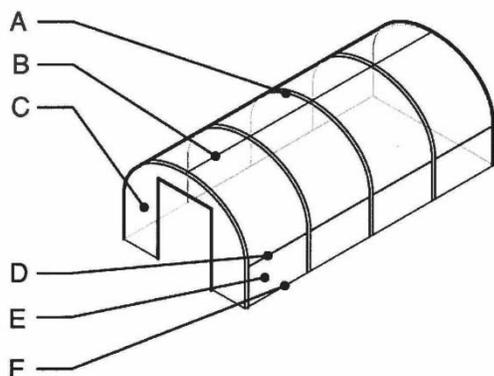
Seasonal High Tunnel Structure (large)

In addition to the above CRITERIA; large, SHTS are wider than 20' and less or equal to 34' wide or greater than 1600 SF, and

- have a minimum 14 gage galvanized steel tubular steel 1.66" diameter frame for frames wider than 20' to 26' wide.
- have a minimum 13 gage galvanized steel tubular steel 1.90" diameter frame when frames are greater than 26' or less than or equal to 34'.
- have a minimum of 5 purlins for SHTS wider than 20' and less than 28' or a minimum of 3 purlins with truss on every bow for SHTS 28" wide or wider.
- have heavy-duty in-ground post a minimum of three (3') in the ground.



Typical terms associated with SHTS are noted in the drawing below.



- A.) Rib, Hoop, Arch, Bow
- B.) Purlin, Ridgepole
- C.) End Wall
- D.) Hip Board
- E.) Side Wall
- F.) Baseboard

Conservation management system

Roof runoff water from the high tunnels or other nearby sources can cause erosion and ponding issues and require the application of other conservation practices such as Diversion (362), Roof Runoff Structure (558) gutters or gravel filled trench, Grassed Waterway (412), Surface Drainage - Field Ditch (607), Mulching (484) and/or Critical Area Treatment (342).

Roof runoff shall be planned by either installing a gutter system (supports designed by manufacturer) and meeting RRS (558) or a surface treatment area having a minimum 1% to a maximum 6% longitudinal slope and extending a minimum of 2' past the end of the structure. Runoff shall be diverted, away from the structure (minimum 2% slope) to prevent ponding near the structure foundation. Runoff can discharge into a Surface Ditch-Field Drain (607), Subsurface Drain (606) or stabilized area.

If gutters are not used to capture roof runoff, erosion may be prevented by installing

- a minimum 4' wide permanent vegetative area (CAP-342) for SHTS's 2178 SF or less, sloped, graded and having permanent vegetation.
- a surface treatment of course gravel (minimum 2' wide x 4" thick) underlain by geotextile such as AASHTO 57, AASHTO #3 or a poorly graded cobble (1"-3") free of fines, sand and soil. Crushed limestone shall not be used.
- a surface treatment of woodchips or mulch (Mulching (484), an average 4" thick x 2' wide placed on top of filter fabric or weed fabric when slopes are less than 2%.
- a permanent vegetated surface ditch (SD-FD (607)) with a stable outlet such as a vegetated "V" ditch that is 0.5' deep with 4:1 SS.
- a combination of the above or other runoff protective measures.

On expansive soils or bedrock, gutter downspout extensions or rock-lined extensions

shall extend a minimum of five (5) feet beyond the structure.

Practices, that address runoff protection, shall be planned and installed as a condition of installation of a high tunnel.

Other key practices are noted on the next page.

Additional practices should be considered as part of a conservation plan, such as nutrient and pest management, crop rotation, and heavy use area protection.

References

WVU Extension Service: Construction of High Tunnels: Resources for Organic Farmers (<http://www.extension.org/article/18369>)

Cornell University High Tunnels (www.hort.cornell.edu/hightunnel)

Penn State Center for Plasticulture, High Tunnels (<http://plasticulture.cas.psu.edu/H-tunnels.html>)

WVU Extension Service: Organic Vegetable Production Systems, Season Extension (<http://www.extension.org/article/18622>)

High Tunnel Raspberries and Blackberries, 2009, (<http://www.fruit.cornell.edu/Berries/bramblepdf/High%20Tunnel%20Production-2009%20rev.pdf>)

High Tunnels: “Using Low Cost Technology to Increase yields, Improve quality and Extend the Season” by Ted Blomgren and Tracy Frisch (<http://www.uvm.edu/sustainableagriculture/hightunnels.html>)

Season Extension: Introduction and Basic Principles (<http://www.ces.ncsu.edu/chatham/ag/SustAg/SeasonExtensionOctober2005a.pdf>)

Hightunnels Website (www.hightunnels.org)

Midwest Season Extension; Projects and Programs (<http://midwestseasonextension.org/programs.html>)

Salinization:

“Salinity and Plant Tolerance”; Utah State University Extension; (<http://extension.usu.edu/files/agpubs/salini.htm>).

Nitrates:

Sideman, Eric PhD. “Nitrate Accumulation in Winter-Harvested Crops: A Growers’ Guide”, Main Organic Farmer and Gardener. June-August 1999, p 40-41

Cold Stress Physiology:

“Responses of Plants to Environmental Stress”, Levitt, J., Orlando, FL: Academic Press. 1980

Temperature Management in High Tunnels”;

Lewis Jett, PhD, WV Extension Service (http://www.hightunnels.org/PDF/JETT_High_Tunnel_Temp_Mgt.pdf)

High Tunnel resources or structural suppliers (NRCS does not endorse or recommend any manufacture): Agra Tech, Inc (Pittsburg, California) www.agra-tech.com/; FarmTek (Dyersville, Iowa) www.farmtek.com (such as Gro-Max Gothic tunnels or Premium Round Style); Haygrove Tunnels (Elizabethtown, Pennsylvania) www.haygrove.co.uk; Keeler Glasgow (Hartford, Michigan) www.keeler-glasgow.com; Rimol Greenhouse Systems (Hooksett, New Hampshire) www.rimol.com; Poly-Tex Inc. (Castlerock, Minnesota) www.poly-tex.com are located in the area. Reference (<http://www.hightunnels.org/resources.htm#StructureSuppliers>) for additional information.

Seasonal High Tunnel System – Job Sheet

Producer _____ Location _____
 Field Office _____ Conservation Contract _____
 Crop(s) _____ Expected Months of Use _____

Material Information

- High Tunnel Structure Size; _____ width X _____ length X _____ height (min. 6.0' clearance), elevated _____ Ft above natural ground
- Type: _____ (Gothic, hoop, etc.), _____ Manufacturer; _____ Orientation
- Wind Brace Kit, _____ % Slope (longitudinally), _____ Post In-ground Support Length (Ft)
- Rafter or Bow; Spacing _____ (ft.); Gal. Steel Tubing Bows or Trusses _____ Dia., _____ Gage
- Water source _____ delivers _____ GPM @ _____ PSI, and is _____ ft from SHTS.
- Irrigation Water; SHTS crop uses _____ GPM and _____ GPD with _____ irrigation.
- Roof Runoff System -Gutter _____ type, _____ length(ft), _____ downspout dia. (in) and _____ number
- Runoff Protection Area; _____ wide (ft) x _____ length (ft) x _____ thickness (in) _____ protective material/veg.; _____ % slope; _____ : 1 side slope; _____ bottom width (ft)
- Underground Outlet _____ dia., _____ ft., _____ x _____ gravel w/ _____ SF geotextile

Supporting Practices and Documentation:

- Cover Crop (340)
- Critical Area Planting (342)
- Diversion (362)
- Grassed Waterway (412)
- Irrigation Pipeline (430)
- Irrigation System, Microirrigation (441)
- Irrigation Water Management (449)
- Nutrient Management (590)
- Pumping Plant (533)
- Roof Runoff System (558)
- Subsurface Drain (606)
- Underground Outlets (620)
- Water Well (642)
- Windbreak/Shelterbelt Establishment (380)
- Water Harvesting Catchment (636)

Other _____

SEASONAL HIGH TUNNEL

SPECIFICATIONS

- Call 1-800 Miss Utility (800-245-4848) and have all above and underground utilities marked prior to construction.
- Check and adhere to local building codes, ordinances and laws prior to construction.
- Locate away from structures that may cause snow drift, block ventilation or sunlight and from overhead branches or other obstacles.
- Prepare site according to manufacturer’s instructions.
- Lay out building location according to site plan, pay special attention to slope, surface runoff, grading (away from structure), orientation and windbreaks (as appropriate).
- Assemble high tunnel structure according to manufacturer’s instructions.
- Install support post a minimum of six” below the frost line and a minimum of 2.0’ on small or medium SHTS, and 3.0’ deep on large structures. Medium to large structures should include concrete around corner post and every other post or according to manufacture recommendations.
- Install Wind Braces (supplied by manufacturer).
- Install Roof Runoff System with a stable outlet.
- Install supporting practices as required, according to construction plans provided.

Minimum Structural Criteria for a Seasonal High Tunnel System *

Size	Small	Medium	Large
Width	12'-15'	16' – 20'	22'-34'
Length	-----1W:2L or 1W:4L-----		
SF	900Sf	1600 SF	> 1600SF
Wind Bracing	-----	All Models	-----
Extend Growing Season	1-2 months	3-4 months	3-4 months
Minimum # Purlins(min.)	3	3	5 or 3 with trusses (>=28' wide)
Heavy Duty Ground Post Depth	2' (Min.)	2' (min.)	3' (min.)
Frame (Gal. Steel Tubing)	17 ga., 1.315 Dia.	14 ga., 1.66" Dia.	14 ga., 1.66" Dia. (22'-26') 13 ga., 1.9" Dia. (28'-34')
6 mil Clear Greenhouse Grade, 4 year warranty polyethylene film			

*4' max. rafter spacing, posts depth a minimum of 0.5' below frost depth, post diameter according to manufacture recommendations, recommend end post and every other post be placed in concrete where wind loads are a concern, all units include a wind brace kit

SEASONAL HIGH TUNNEL

Operation and Maintenance

- Periodically inspect structure and cover for damage. Reinstall and/or repair promptly.
- Follow manufacturer's instructions for operation and maintenance of the high tunnel structure.
- Avoid damage to structure from equipment operated in and around the seasonal high tunnel.
- Inspect runoff control measures after every significant rainfall event. Repair promptly.
- Remove and store high tunnel cover at the end of each growing season to prevent damage from snow or wind loads as needed. Replace cover prior to use in the spring, as needed.
- Verify Soil PH within the SHTS throughout the year adjust as needed.
- Check Soil Salinity for salts buildup- which could impact crop production.
- Rest soil every 3 to 5 years and plant cover crops to increase soil fertility, remove excess nutrients.
- Aerate areas that may become compacted to maintain water infiltration within the structure.
- Do not use animal manures as compost where plant material may come in contact with the ground and it is for human consumption (unless treated and approved for application). Do not incorporate decomposed plant material unless properly composted (verify weed seeds, fungus, bacteria, etc. is destroyed by checking composting temperatures of 140 deg. F. to 170 deg. F for a minimum of 7 to 21 days).

Seasonal High Tunnel System – Layout and Location

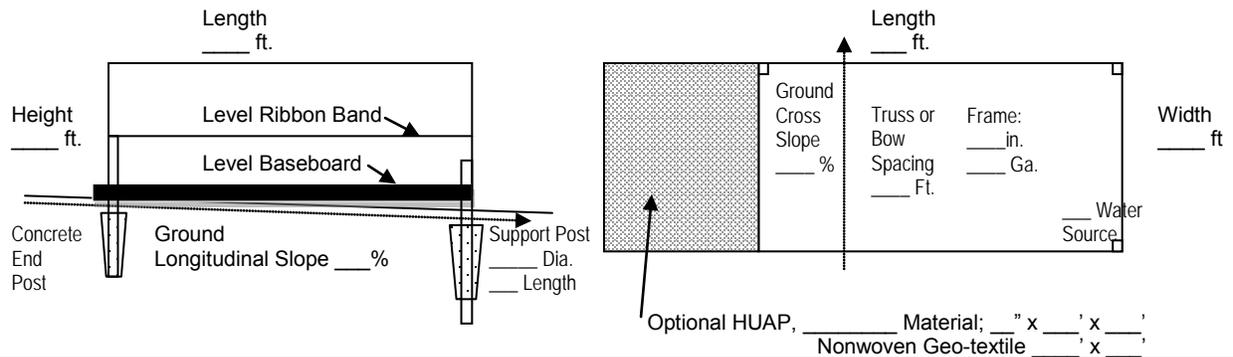
Plan view of seasonal high tunnel system site shown below.

Landowner Name _____

Prepared By: _____ Date: _____

Scale 1"= _____ ft. (NA indicates sketch not to scale) or _____ see attached sheet.

Call MUWV (800-245-4848) to locate and mark all utilities within the building area.



Additional Specifications and Notes:
Roof Runoff-

Seasonal High Tunnel System – Construction Checkout

Seasonal High Tunnel Structure – as-built measurements	
Length (ft)	Height in Center (ft)
Width (ft)	Structure Manufacturer
Orientation:	Water Source

Supporting Practices Installed
<input type="checkbox"/> Manufactured Gutter System <input type="checkbox"/> Critical Area Planting <input type="checkbox"/> Roof Runoff <input type="checkbox"/> Underground Outlets <input type="checkbox"/> Diversion <input type="checkbox"/> Other _____

CHECK OUT:	
Amount Completed: _____ square feet.	Mark As-Built location on plan map.
Remarks _____	
This practice meets NRCS standards and specifications	<input type="checkbox"/> Yes <input type="checkbox"/> No
Check out by: _____	Date: _____

Seasonal High Tunnel Structure – as-built measurements	
Length (ft)	Height in Center (ft)
Width (ft)	Structure Manufacturer
Orientation:	Water Source

Supporting Practices Installed	
<input type="checkbox"/>	Manufactured Gutter System
<input type="checkbox"/>	Critical Area Planting
<input type="checkbox"/>	Roof Runoff
<input type="checkbox"/>	Underground Outlets
<input type="checkbox"/>	Diversion
<input type="checkbox"/>	Other _____

CHECK OUT:	
Amount Completed: _____ square feet.	Mark As-Built location on plan map.
Remarks _____	
This practice meets NRCS standards and specifications	<input type="checkbox"/> Yes <input type="checkbox"/> No
Check out by: _____	Date: _____

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Seasonal High Tunnel System – First Year Annual Report **page 1 of 2**

Producer _____ Location _____
 Field Office _____ Conservation Contract _____
 Report Date _____ Copy to Program Manager (SO) _____
Report Due On or Before _____, 20_____

- Actual cost of Seasonal High Tunnel System \$_____ (attach copies of bills)
 Tunnel is _____ ' wide x _____ ' long, Manufactured by _____.

First year maintenance requirements: (add more sheets if necessary)

Activity or Item (list)	Cost
	\$

- Cropping history before installation of Seasonal High Tunnel: (add more sheets if necessary)

Crop (type)	Crop Year	Yield	Nutrients (Fertilizer)			Pesticide(s)		
			Type	Rate	Timing	Type	Rate	Timing

- First year's crop in Seasonal High Tunnel:

Crop (type)	Crop Year	Yield	Nutrients (Fertilizer)			Pesticide(s)		
			Type	Rate	Timing	Type	Rate	Timing

Seasonal High Tunnel System – First Year Annual Report

Benefits for

- plant quality: _____
 soil quality: _____
 water quality: _____
 Other: _____
 Producer's recommendations and observations:

Seasonal High Tunnel System – Year 2 and 3 Subsequent Report **page 2 of 2**

Producer _____ Location _____
 Field Office _____ Conservation Contract _____
 Report Date _____ Copy sent to Program Manager (SO) _____

Report Due On Or Before _____, 20_____

- This year's maintenance requirements : (add more sheets if necessary)

Activity or Item (list)	Cost
	\$

- This year's crop in Seasonal High Tunnel:

Crop (type)	Crop Year	Yield	Nutrients (Fertilizer)			Pesticide(s)		
			Type	Rate	Timing	Type	Rate	Timing

- This year's growing season:

Crop (type)	Crop Year	Season Dates	Length of Growing Season (Days)

- Benefits for plant quality: _____
 Benefits for soil quality: _____
 Benefits for water quality: _____
 Producer's recommendations and observations:

