

# 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. High tunnels are constructed of metal frames and covered with 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. The crop grows under the SHTS, therefore it cannot depend on rainwater or water stored within the soil profile to provide it's water needs. An average of 3 to 5 times as much water may be used for crops in a high tunnel compared to an outdoor system.

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.

### Criteria

The type and shape of Seasonal High Tunnel System selected shall be based on the

- type of crop(s) planted, row width, number of row (min. 3) and height.
- length of seasonal extension required for plant protection.



- availability of site with a flat to mild slope of 3% or less is preferred. Do not place SHTS on slopes greater than 6% (parallel to the length) or 3% (perpendicular to length). The manufacture shall approve placement of SHTS on slopes greater than 3% and provide additional structural components (i.e. length of supports, etc.).
- SHTS footprint being a minimum of 20' wider and longer than the selected SHTS.
- height of farm equipment (minimum of 6 feet high) used inside the SHTS.
- crops planted in natural soil profile or raised beds.

A seasonal high tunnel shall

- not be a greenhouse.
- not be placed in the 25 year-24 hour floodplain.
- protect the ground from surface water runoff and erosion.
- be round or gothic arch style and covered by 6 mil polyethylene clear film (4 year minimum warranty).
- have natural ventilation (roll up sides/ends).
- have a documented year-round, reliable water source, such as a river, stream, pond (min. 1.1 SF surface area per SF of SHST and minimum 6' depth), irrigation well (minimum of 0.003 GPM per SF of SHTS) or municipal water (PSD notification).
- not grow crops in containers, pots, on benches or tables.
- have a steel constructed frame, four (4') rafter or bow spacing and a wind bracing kit supplied by a reputable manufacture of SHTS.
- have the plastic removed when heavy snows or high winds are expected to compromise the system.
- have manufactured supplied ground posts installed a minimum of 24" or 6" below the

frost depth, whichever is greater.

- have the purlins connected to cross connectors at the bow, for added strength.
- have a minimum length to width ratio of 2:1 and a maximum of 4:1.
- have roof runoff (10 year -5 minute storm (0.55") directed away from the SHTS to a stable outlet (min. 2% slope).
- be on a site with good soils and positive 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 maximum height) to not restrict sunlight.
- be located and aligned based on the landowner's decision.
- have wind bracing installed as recommended by manufacture.

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

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

There are many sizes and types of seasonal high tunnel structures. The size of the SHTS selected may fall into one of the following categories of small, medium or large. The minimum length to width ratio is 2:1 and the maximum is 4:1.

#### Seasonal High Tunnel Structure (small)

Small, semi permanent or portable SHTS, often referred to as cold frames, are 12' to 15' wide, 900 SF or less and

- extend the growing season by 1 to 2 months.
- normally remove the cover before, during or

after the growing season.

- have a minimum 17 gage galvanized steel tubular steel 1.315" diameter frame.
- are manufactured equal or better than the Rimol Catamount Series.

#### Seasonal High Tunnel Structure (medium)

Medium, semi-permanent medium round or gothic arch style SHTS are, 16' to 20' wide, greater than 900 SF and less or equal to 1600SF and



- extend the growing season by 3 to 4 months.
- have a minimum 14 gage galvanized steel tubular steel 1.66" diameter frame.
- have the purlins (min. 3) connected to bows by a manufactured strapping system.
- have heavy-duty ground post a minimum of 2.0' in the ground.
- are manufactured equal or better than the Rimol Eastpoint Series.

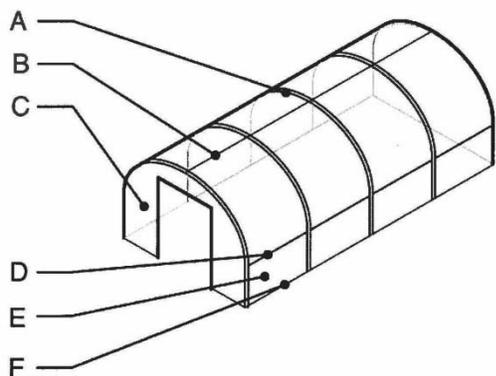
#### Seasonal High Tunnel Structure (large)

Large, semi-permanent round or gothic arch structures, are 22' to 34' wide, greater than 1600 SF, and



- have a minimum 14 gage galvanized steel tubular steel 1.66" diameter frame. (22'-26' wide SHTS)
- have a minimum 13 gage galvanized steel tubular steel 1.90" diameter frame (28'-34' wide SHTS).
- have the purlins (min. 5) connected to bows by a manufactured strapping system.
- have a truss assembly with every other bow. (min.)
- have heavy-duty in-ground post a minimum of three (3') in the ground.
- are equal or better than Rimol manufacture Nor'Easter (30' and 34' wide) or Northpoint (22' and 26' wide) Series.

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 a gutter system (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 base and the structure foundation. If not guttering is present, runoff can discharge into a Surface Ditch-Field Drain (607) or Subsurface Drain (606).

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 and graded as noted above.
- a surface treatment of coarse 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 or weed fabric.
- a permanent vegetated surface ditch (SD-FD (607)) with a stable outlet such as a grassed "V" ditch (0.5' deep and 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](http://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](http://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](http://www.hightunnels.org/PDF/JETT_High_Tunnel_Temp_Mgt.pdf)

High Tunnel resources or structural suppliers (NRCS does endorse or recommend any

manufacture): Agra Tech, Inc (Pittsburg, California) [www.agra-tech.com/](http://www.agra-tech.com/) ; FarmTek (Dyersville, Iowa) [www.farmtek.com](http://www.farmtek.com) ; Haygrove Tunnels (Elizabethtown, Pennsylvania) [www.haygrove.co.uk](http://www.haygrove.co.uk) ; Keeler Glasgow (Hartford, Michigan) [www.keeler-glasgow.com](http://www.keeler-glasgow.com) ; Rimol Greenhouse Systems (Hooksett, New Hampshire) [www.rimol.com](http://www.rimol.com) ; Poly-Tex Inc. (Castlerock, Minnesota) [www.poly-tex.com](http://www.poly-tex.com) are located in the area or 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 \_\_\_\_\_  
 Water Source \_\_\_\_\_; GPM \_\_\_\_\_, Distance to SHTS \_\_\_\_\_ (ft), Irrigation Method \_\_\_\_\_

**Materials List**

- High Tunnel Structure, size(s) \_\_\_\_\_ width X \_\_\_\_\_ length X \_\_\_\_\_ height
- Type \_\_\_\_\_ (Gothic, hoop, etc.) \_\_\_\_\_ Manufacturer
- Wind Brace Kit \_\_\_\_\_, Orientation \_\_\_\_\_ Slope (longitudinally) \_\_\_\_\_
- Rafter or Bow Spacing \_\_\_\_\_ (ft.); Gal. Steel Tubing Bows or Trusses \_\_\_\_\_ Dia., \_\_\_\_\_ Gage
- 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 Required:**

- Cover Crop (340)
- Critical Area Planting (342) -job sheet attached
- Diversion (362)- plan attached
- Grassed Waterway (412)- plan attached
- Irrigation Pipeline (430 DD/EE)
- Irrigation System, Microirrigation (441)
- Irrigation Water Management (449)
- Nutrient Management (590)
- Pest Management (595)
- Pumping Plant (533)
- Roof Runoff System (558) –plan attached
- Subsurface Drain (606)- plan attached
- Underground Outlets (620)- plan attached
- Water Well (642)
- Windbreak/Shelterbelt Establishment (380)
- Surface Ditch-Field Drain (607) –plan attached
- Water Catchment Basin (636); Other: \_\_\_\_\_

### High Tunnel System Construction

- 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 minimum of 2.5 feet in ground. Medium or Large structures may include concrete around post at corners and every other post (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.

### 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 a minimum of 2 times per year, throughout the SHTS and adjust as needed.
  - Check Soil Salinity for 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 where plant material is for human consumption (unless treated and approved) Do not incorporate decomposed plant material unless properly composted (verify weed seeds, fungus, bacteria, e-coli, etc. has been destroyed by composting temperatures of 140 deg. F. to 170 deg. F for a minimum of 7 to 21 days).
- 
- 
-

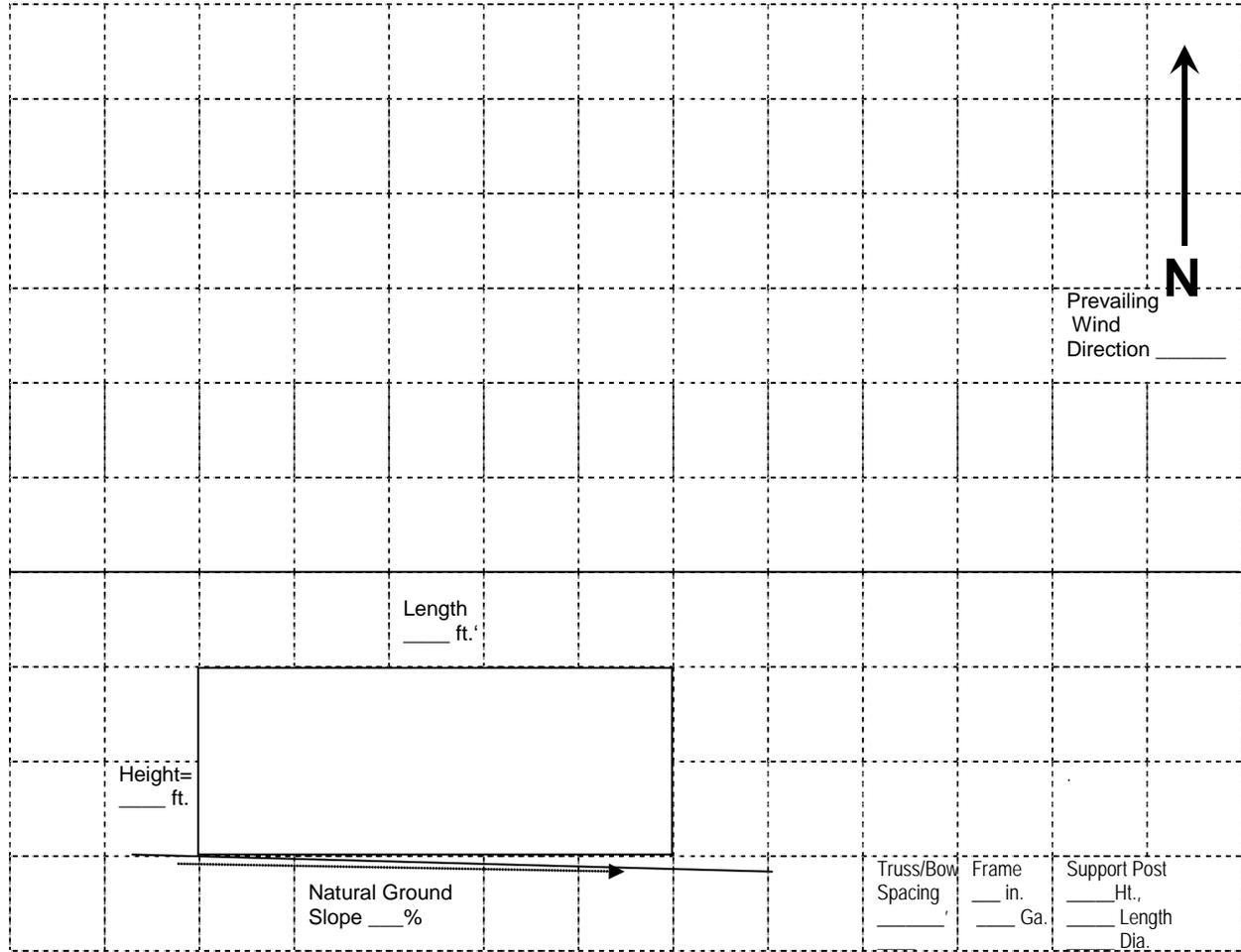
**Seasonal High Tunnel System – Layout and Location**

Plan view of seasonal high tunnel system site shown below.

Landowner Name \_\_\_\_\_

Prepared By: \_\_\_\_\_ Date: \_\_\_\_\_

Scale 1"= \_\_\_\_\_ ft. (NA indicates sketch not to scale: grid size=1/2" by 1/2")



Additional Specifications and Notes:
Roof Runoff-

**Seasonal High Tunnel System – Construction Checkout**

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

<b>Supporting Practices Installed</b>
<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 _____

<b>CHECK OUT:</b>	
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: _____

The United States Department of Agriculture (USDA) prohibits discrimination in its programs on the basis of race, color, national origin, sex, religion, age, disability, political beliefs and marital or familial status. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication program information (Braille, large print, audiotape, etc.) should contact the USDA Office of Communications (202) 720-2791.

To file a complaint of discrimination write USDA, Director, Office of Civil Rights, Room 326-W, Whitten Building, 14th and Independence Avenue, SW, Washington, DC 20250-9410 or call (202) 720-5964 (voice or TDD). USDA is an equal opportunity provider and employer.

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

Producer \_\_\_\_\_ Location \_\_\_\_\_  
 Field Office \_\_\_\_\_ Conservation Contract \_\_\_\_\_  
 Report Date \_\_\_\_\_ Copy sent 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: \_\_\_\_\_

- Benefits for soil quality: \_\_\_\_\_  
 Benefits for water quality: \_\_\_\_\_  
 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:

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_