NRCS Natural Resources Conservation Service

West Virginia

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 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. The crop grows under the SHTS; therefore it cannot depend on rainwater or water stored within the soil profile to provide its 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 tunnel must be constructed level so consider the elevation difference from one side or end to the other. The manufacture shall approve placement of SHTS on slopes greater than 3% and provide additional structural components (i.e. length of supports, posts 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, 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 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 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, four (4’) rafter or bow spacing and a wind bracing kit or have heavy duty post supplied by a reputable manufacture of SHTS.
- remove plastic when heavy snows or high

winds are expected that will compromise the structure.

- 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 cemented corner end post, is semi-permanent, as a minimum, and optimally every other post as well.

Most structures may be placed 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 a windbreak of trees, shrubs or fabricated material 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 may fall into one of the following categories; 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, SHTS are 16' 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 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)

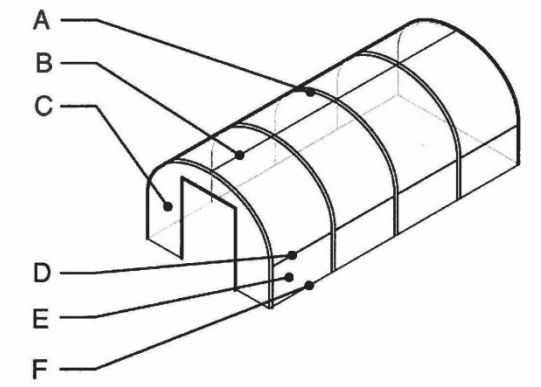
Large, SHTS are 22' to 34' wide, greater than 1600 SF, and

- 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. 4) 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 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 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 or weed fabric.
- 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 Programshttp://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 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 Sytle); Haygrove Tunnels (Elizabethtown, Pennsylvania) www.haygrove.co.uk ; Keeler Glasgow (Hartford, Michigan) www.keeler-glasgow.com ; Rimol Greenhouse Systems (Hookesett, 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 _____

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:
  - o Gutter _____ type, ____ length(ft), _____ _____ downspout dia. (in) and number
  - o 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

- 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 aways 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.

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 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. has been destroyed by composting temperatures of 140 deg. F. to 170 deg. F for a minimum of 7 to 21 days).

_____
_____
_____
_____

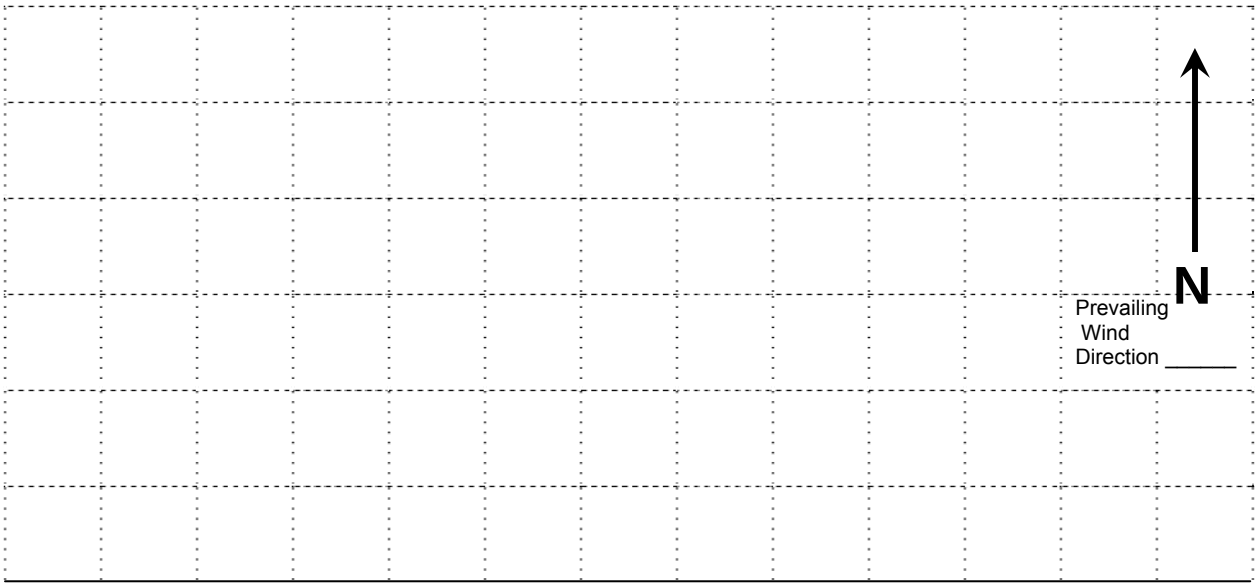
Seasonal High Tunnel System – Layout and Location

Plan view of seasonal high tunnel system site shown below.

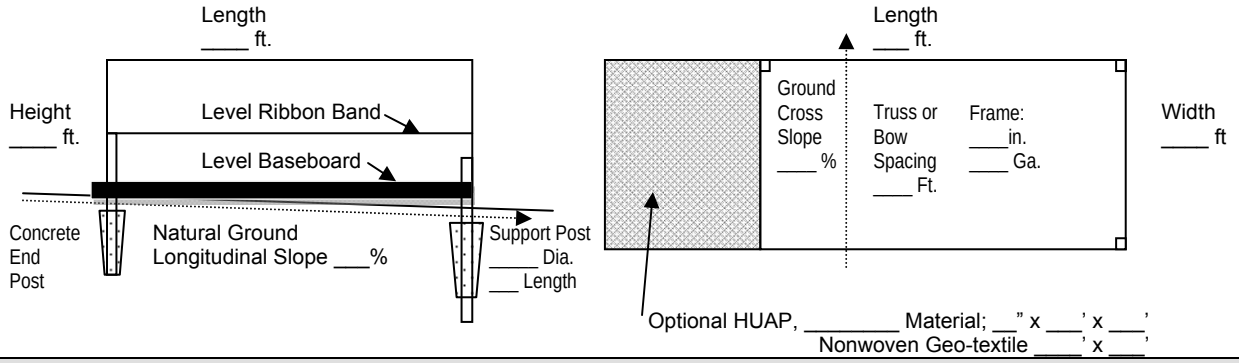
Landowner Name_____

Prepared By: _____ Date: _____

Scale 1"=_____ ft. (NA indicates sketch not to scale) 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

- ☐ Manufactured Gutter System
- ☐ Critical Area Planting
- ☐ Roof Runoff
- ☐ Underground Outlets
- ☐ Diversion
- ☐ Other _____

CHECK OUT:

Amount Completed: _____square feet. Mark As-Built location on plan map.

Remarks_____

This practice meets NRCS standards and specifications ☐ Yes ☐ No

Check out by: _____ Date: _____

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:

_____
_____
_____