NRCS Natural Resources Conservation Service

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Seasonal High Tunnel Interim Practice
Oregon: Supplemental Planning and Implementation Guidance

Purpose of Specification Guide

This guide provides for effective planning, design and implementation of a Conservation Practice Standard. The guidance includes reference information, examples, and other considerations to assist during the conservation planning process. The intent is to improve the design and implementation of conservation practice standards that are appropriate for site specific conditions, identified resource concerns, crop rotations, yield goals and other conservation and production objectives of the client.

Features of Seasonal High Tunnels

Commercially available high tunnel structures are made in numerous widths and lengths. The structures are constructed of metal or plastic bow frames that are covered with a single layer of polyethylene. Ventilation is achieved by a combination of roll-up side vents, end vents, and occasionally roof vents. Generally the end walls are framed-in to create door and ventilation areas. Each structure covers several crop rows, is wide enough to allow crop growth to full maturity; and is tall enough to allow spraying, cultivation, and harvest to occur with the high tunnel structure intact.

Guidance for Planning Seasonal High Tunnel Systems

Site Selection:

eOrganic authors Dr. Alex Stone, Oregon State University and Kristin Pool, Oregon State University summarize important considerations and guidance when placing high tunnels to maximize performance. The following information is taken from it. The complete article can be viewed by following this link: http://www.extension.org/article/18365.

High tunnels and the crop systems they support require daily maintenance, so they should be placed in a location that is accessible by vehicles during all production seasons. A high tunnel system is typically sited in a crop production field, so the impact of the system on the growth and management of the crops around the tunnel must be considered.

There must be sufficient room around a high tunnel for the equipment and/or people that will be necessary to move or maintain it. Other important considerations include orientation, airflow, shading, windbreaks, drainage, soil quality, nutrient management, weeds and other pest populations.

Orientation: As a general rule, manufacturers recommend orienting the ridge to run east to west for locations north of 40 degrees latitude, and north to south for locations south of 40 degree latitude to maximize capturing sunlight.

Shade: Shade can reduce the effectiveness of a high tunnel system since it limits sunlight. Locating high tunnels north of any substantial obstacles is undesirable. A high tunnel should be built at a distance at least twice the height of an obstacle away from the obstacle.

Examples: There is a 25 foot tall tree on your property. The high tunnel should be located at least 50 feet from that tree. If you are building multiple high tunnels that are oriented east-west, the spacing between the tunnels needs to be twice the height of the tunnels. If they are oriented north-south, the spacing can be 4 feet between tunnels.

Drainage: Drainage is a very important consideration in site selection. High tunnels displace rainfall, and if this water is not redirected away from the structure it can enter the high tunnel. To avoid this situation, high tunnels can be built at a higher elevation than the surrounding land, established on well drained soils, and have suitable diversion and/or infiltration of roof runoff water. The site should also be level to insure uniform irrigation and to facilitate crop management operations. High tunnel structures must be situated and managed to minimize the impact of rainfall on crops and soils both inside and outside the covered structure.

Soil Quality, Nutrient and Pest Management: Consider soil quality prior to installing the high tunnel. Well drained soils warm up more quickly and prevent flooding and/or ponding situations within and around the structure. Coarse textured soils like sandy loams or loamy sands are most desirable because they will warm up quickly in the spring, are easily worked, and promote good root development for improved crop productivity and vigor.

The planned nutrient management process is an important consideration prior to building the structure. Document the current soil nutrient status, establish realistic yield goals and provide nutrients and soil amendments according to Land Grant University Guidance to optimize production goals.

Cover cropping and organic amendment management can be difficult in high tunnels, as standard equipment might not fit into the structure making it difficult to incorporate cover crops and amendments within and around the tunnel. Therefore, the best idea is to improve the soil before construction begins. Additionally, if possible, design the high tunnel to accommodate soil management practices such as organic amendments, cover cropping, tillage, and harvest operations.

Know the cropping or vegetative history of the site when siting a tunnel. Avoid locations where there is a risk of soil borne disease, significant annual or perennial weed pressure, or other restrictive physical and chemical attributes of the soils exist. If these conditions do exist, consider correcting the condition prior to constructing the high tunnel.

Airflow: Airflow is used to regulate temperatures in a high tunnel. Sites with naturally good airflow will improve structure performance and reduce the need for daily airflow management. Single high tunnels should be oriented perpendicular to the prevailing winds, while multiple high tunnels should be oriented parallel to prevailing winds.

Windbreaks: Windbreaks can be an important protection strategy. The polyethylene cover on high tunnels can rip or tear, and the entire structure can be destroyed in high winds. Depending on local conditions, a properly located and designed windbreak may reduce the risk of wind damage. Protection from wind will help maintain optimal temperatures in colder periods. However, wind also improves ventilation and maintenance of cooler temperatures during hot periods.

References to help with Site Selection for High Tunnels

Bachmann, J. 2005. Season extension for market gardeners: horticultural techniques [Online]. ATTRA Publication #IP035. Available at: http://attra.ncat.org/attra-pub/seasonext.html (verified 4 Jan 2009).

Spaw, M. and K. Williams. Undated. Site Selection [Online]. http://www.hightunnels.org/. Available at: http://www.hightunnels.org/ForEducators/Planning/SiteSelection.htm (verified 4 Jan 2009).

Wildung, D. and P. Johnson. 2004. Minnesota high tunnel production manual for commercial growers [Online]. University of Minnesota Publication M1218. Available at: http://www.extension.umn.edu/distribution/horticulture/components/M1218-4.pdf (verified 4 Jan 2009).

The High Tunnel Structure

A seasonal high tunnel is a polyethylene covered structure with no electrical, ventilation or heating systems that is designed to modify the climate to create more favorable growing conditions for crops grown in the natural soil beneath it. These structures are generally sold as kits that contain all of the required materials, hardware, and manufacturer recommendations to erect the structure except for the lumber that is needed for baseboards and end walls. Individual kits vary by supplier and manufacturer; therefore, care should be exercised when comparing kits for specific locations and objectives prior to purchase.

The High Tunnel cover material will be inspected periodically and repaired as needed. To prevent damage from heavy snow loads and wind events, the cover will be removed at the end of the growing season and replaced when climate conditions are no longer a threat and crop growth can resume the following spring.

The planning and use of the seasonal high tunnel systems for crop production generally require the planning and installation of other conservation practices to address identified resource concerns and to facilitate the proper functioning of the system to achieve its intended purposes.

Considerations when selecting a high tunnel kit supplier include their familiarity with local climate conditions affecting the integrity of the structure, compatibility with the planned crop system, distance from the site affecting shipping cost, and historical marketing and operational success.

In order to properly evaluate and plan for the benefits of a high tunnel system, it is important to use materials that are durable so the integrity of the structure does not compromise the crop production system.

Washington State University Research and Extension provides excellent guidance pertaining to High Tunnel installation, operation, and crop production at the following website link: http://agsyst.wsu.edu/plasticulture.html#Hightunnels.

Topics include extending the crop growing season, discussion groups, high tunnel construction, structure and production guides, manuals, and a list of potential manufacturers and suppliers in the United States.

Systems Approach

Installation and management of a Seasonal High Tunnel system can impact the amount of roof water runoff that can affect soil and water quality, soil erosion concerns, and crop production goals within and adjacent to the covered area. The high tunnel system should be part of an overall conservation plan that includes supporting conservation practices such as roof runoff, critical area planting, crop rotation and nutrient management, and pest management to manage water quality and quantity as well as other identified resource concerns. Each supporting practice used will be installed and managed according to

current conservation practice standard documentation included in Oregon Field Office Technical Guide, Section IV.

Supporting conservation practices and activities that may apply on a site specific basis include:

Conservation Crop Rotation (328), Nutrient Management (590), and Pest Management (595) may be used to modify the crops/rotations grown, to maximize production, and to manage market demand issues such as soil erosion, water quality, efficiency of water and energy use, and soil quality.

Cover Crop (340) is used to protect the soil surface, impact nutrient / pest management strategies, and to improve water use efficiency within the high tunnel area during periods when cover is removed, or after the entire structure is moved to a new site (after the 3 year interim conservation practice evaluation period is completed).

Contour Farming (330) and Row Arrangement (557) may be used within and around the structure to realign the fields so as to reduce soil erosion and sedimentation, manage surface drainage, and to facilitate irrigation management.

Integrated Pest Management (595) can reduce risks of pesticide runoff and/or leaching. The development of an integrated pest management plan would also include opportunities to establish beneficial and pollinator insect habitat, as well as other prevention, avoidance, monitoring, and suppression strategies.

Grassed Waterway (412), Diversion (362), and Underground Outlet (620) are all potential alternatives for diverting surface water away from the high tunnel to a stable outlet, and can be used to convey runoff from diversions, concentrated flows, and stabilize ephemeral/gully erosion if needed.

Irrigation System, Micro-Irrigation (441) and Irrigation Water Management (449) may be implemented to efficiently and uniformly apply irrigation water and ag-chemicals to maintain soil moisture for optimum crop growth, and to reduce the risk of contaminant transport by runoff or leaching.

798 Job Sheet/Specifications Guidance

- Complete the general operation description, location, date, and planner information.
- Attach Conservation Plan Map: Delineate and identify fields/CMUs, and the high tunnel site plan. Include adjacent crop land use, soils information, and elevation/topography map layers. Include associated conservation practices and soil/crop systems planned for the area around the site. Map information will include nearby sensitive areas, buffers, and other existing or planned practices or features.
- Document the site-specific resource conditions on the site. These include soil and crop information necessary to document the Benchmark conditions. Identify resource concerns and evaluate alternatives for planning. Record the dominant soil map unit used for planning, hill slope length and steepness, soil loss tolerance (T) for the site, critical periods for snowfall/ rainfall/wind, and the annual precipitation used for planning.
- Identify the practice purpose, any other resource concerns that need to be considered in the design, and the client's objectives for implementation. Record the kit manufacturer and planned installation date. Describe the length, width, center height and square footage under the cover, as well as the orientation of the structure relative to solar energy input. Document the planned site preparation and describe the re-vegetation plan for disturbed areas.

- Provide before and after installation data for the site. This includes the crop rotation, planting dates, total biomass yield (expressed as dry matter lbs/ac), STIR rating, SCI, evaluation of sheet and rill erosion, and wind erosion estimates. Dry matter yield for biomass produced is the harvested portion plus the above-ground residue produced for each crop expressed in lbs/acre. The above-ground production can be estimated using the RUSLE2 vegetation record or the Crop Nutrient Tool in USDA PLANTS database for crops. The Soil Tillage Intensity Rating (STIR), Soil Conditioning Index (SCI), and erosion estimates represent the average annual values for the entire rotation.
- Provide a general description of Pest Management and Nutrient Management activities planned. Attach the Pest Management job sheet and the Nutrient Management job sheet for the crop system within the High Tunnel.
- Identify any supporting practices and their installation dates. Attach the appropriate job sheets and documentation for each supporting practice implemented.
- Document the planned operation and maintenance requirements for the high tunnel system itself and the surrounding area. Document any permit requirements that are needed and met for the High Tunnel system.
- An area is provided in the job sheet to sketch the crop system layout under the High Tunnel cover. This should include irrigation system design, raised bed locations/orientation, crop rotation plans, travel lanes, and any other crop system layout information needed.
- Part of the Operation and Maintenance for this interim conservation practice is an annual review of its implementation and effects on resources during the first 3 years of operation.
- For the first year after installation of the high tunnel and for the following 2 years, complete the 798 interim practice annual review form that is included with this specification guide.

Oregon NRCS is participating in a national 3-year pilot to test the validity of the potential conservation benefits of the Seasonal High Tunnel system. Use of the interim practice requires annual reporting by Oregon NRCS to National Headquarters. These reporting requirements are identified in National Bulletin 190-10-10. Ensure that each contract holder participating in the seasonal high tunnel pilot understands the operation and maintenance requirements for annual evaluation and reporting due each December for three consecutive years.

An Interim Conservation Practice Annual Evaluation form (pages 6-9) of this document is to be completed for each installed High Tunnel System for Crops that is installed in Oregon.

REFERENCES

Community Garden Guide Season Extension - High Tunnel, NRCS http://www.plant-materials.nrcs.usda.gov/pubs/mipmctn5922.pdf

University of Minnesota: Introduction to High Tunnels". Spaw, M. and William, K. http://www.hightunnels.org/foreducators.htm

"High Tunnel Production Manual". Penn State University College of Agriculture, Department of Horticulture. White, L. and Orzolek, M. 2003 excellent overview methodology

"High Tunnels". Ted Blomgren; Cornell Cooperative Extension: Tracy Frisch; Regional Farm and Food Project. video productivity and vigor

Seasonal High Tunnel Cropping System for Crops
Interim Conservation Practice Annual Evaluation

High Tunnel System Identification	
Site Location Reference	
Operator/Client	
NRCS Field Office Assistance	

Interim Practice Review Completion Dates

Year 1		Year 2		Year 3	

High Tunnel Location (Attach conservation plan map with Legal description for interim practice review)

Installation Date		Size (sq ft)		Manufacturer	

Installation Materials Cost $		Installation Labor Cost $	

Structural and Crop System Operation Maintenance Performed and Annual Costs

Year 1 (add additional lines if needed)

Description		Cost $	
Description		Cost $	
Description		Cost $	
Description		Cost $	
Description		Cost $	
Description		Cost $	
Description		Cost $	
Description		Cost $	
Description		Cost $	
Description		Cost $	
Description		Cost $	
Description		Cost $	
Description		Cost $	
Description		Cost $	
Description		Cost $	
Description		Cost $	
		Total $	$0.00

Year 2 (add additional lines if needed)

Description		Cost $	
Description		Cost $	
Description		Cost $	
Description		Cost $	
Description		Cost $	
Description		Cost $	
Description		Cost $	
Description		Cost $	
Description		Cost $	
Description		Cost $	
Description		Cost $	
Description		Cost $	
Description		Cost $	
		Total $	$0.00

Year 3 (add additional lines if needed)

Description		Cost $	
Description		Cost $	
Description		Cost $	
Description		Cost $	
Description		Cost $	
Description		Cost $	
Description		Cost $	
Description		Cost $	
Description		Cost $	
Description		Cost $	
Description		Cost $	
Description		Cost $	
Description		Cost $	
		Total $	$0.00

Conservation Practices and Resource concerns addressed for Seasonal High Tunnel System

Conservation Practices	Resource concerns
Seasonal High Tunnel System for Crops (798)	

Supporting Conservation Practices	Date	Resource concerns

Crop Production before and after High Tunnel Installation

Before				After			
Crop	Year	Harvest Yield w/ units	Biomass Yield DM lbs/acre **	Crop	Year	Harvest Yield w/ units	Biomass Yield DM lbs/acre **

** Dry Matter Yield = Harvested portion and above ground residue produced as lbs/acre

Average Annual Rotation Soil Quality and Erosion estimates

Time Period	Sheet/Rill tons/acre	Wind tons/acre	SCI	STIR
Prior crop rotation or 3 years				
Year 1				
Year 2				
Year 3				
3 year average				

Extension of Growing Season with High Tunnel System

Planting or Begin growth in Spring	Benchmark 3 yr average	Year 1	Year 2	Year 3	After Installation 3 yr average
Planting or Begin growth in Spring (Date)					
End of Growing Season in the Fall (Date)					
Total Growing Season # of days					

Nutrient Applications Before and After High Tunnel System

Time Period	Applied Nitrogen Ave Lbs/acre available N	Applied Phosphate Ave Lbs/acre P2O5	Applied Potash Ave Lbs/acre K2O
Prior crop rotation or 3 year			
Year 1			
Year 2			
Year 3			
3 year average			

Pesticide Application Record: 3 years prior to High Tunnel System Installation

Year	Pesticide Product	Product Application Rate w/ appropriate units

Pesticide Application Record: 3 years after High Tunnel System Installation

Year	Pesticide Product	Product Application Rate w/ appropriate units

Identify and evaluate the effectiveness of conservation practices installed to address drainage and erosion concerns: What additional drainage or erosion features were installed to address the structure? If installed, how effective were they?

Record other observations, evaluation and recommendations