NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

HIGH TUNNEL SYSTEM

(Sq. Ft.)

CODE 325

DEFINITION

An enclosed polyethylene, polycarbonate, plastic, or fabric-covered structure that is used to cover and protect crops from sun, wind, excessive rainfall, or cold, to extend the growing season in an environmentally safe manner.

PURPOSE

To improve plant health and vigor.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to land capable of producing crops in the ground, where sun or wind intensity may damage crops, or where an extension of the growing season is needed due to climatic conditions.

Crops must be grown in the natural soil profile, and not on benches/tables, in portable containers, hydroponically, etc. Permanent raised beds (up to a maximum 12 inches deep) may be installed to improve soil condition, fertility, and access.

This practice does not include greenhouses or low tunnel systems that may cover single crop rows.

This practice cannot be used to provide shelter or housing for any livestock or poultry or to store supplies or equipment.

CRITERIA

The high tunnel structure shall be planned, designed, and constructed from a manufactured kit in accordance with the manufacturer's recommendations. The tunnel frame shall be constructed of metal, wood, and/or durable plastic, and be at least 6 feet in height at the peak of the structure. If needed for enclosure, end wall coverings can be greenhouse-grade plastic, polycarbonate, wood, or other suitable material.

Significant modifications to the high tunnel structural design shall be verified and approved by the manufacturer prior to construction to ensure that any warranties remain in effect.

Select structures with the entry/exit point sized to facilitate movement of equipment and supplies used for the production of planned crops.

Select high tunnel cover material that is sufficiently thick to withstand seasonal temperature changes, and has a minimum 4-year manufacturer's warranty. For polyethylene covers, use a minimum 6-mil greenhouse grade, single (or double) layer, UV-resistant material. An appropriate thickness of shade cloth may be used in place of, or in addition to, the impervious plastic cover to lengthen the growing season for cool-season crops. When shade cloth is used alone, end walls are not required.

The high tunnel shall be manufactured with side covers that can be completely removed or manipulated (e.g., rolled up or pulled aside) to control internal temperatures and humidity.

If vents, fans, or heaters will be attached to the high tunnel frame, they must be installed in accordance with the high tunnel manufacturer's design and recommendations.

Where snow/ice loads may damage the structure, the tunnel cover shall be removed at the end of the growing season, unless the structure is designed to withstand expected snow/ice loads. If the structure will be used for the entire year,

snow/ice loads must be properly managed to ensure structural integrity.

Where wind loads may damage the structure, select a tunnel cover and structure designed by the manufacturer to withstand expected wind loads or manage the tunnel system in a manner that limits wind damage.

Construct the high tunnel on level ground or on a naturally occurring slope not to exceed five percent.

Locate the structure near a suitable water source for irrigation.

Avoid buried public utilities when selecting the location for the structure.

Plan supporting conservation practices to address all environmental concerns (e.g., erosion, irrigation, and/or runoff) associated with the installation and use of the high tunnel system.

Runoff shall be directed away from the tunnel structure to avoid ponding. Runoff may be captured and used for irrigation purposes.

Runoff may empty into surface or underground outlets, or onto the ground surface when properly protected. Surface and underground outlets shall be sized to ensure adequate capacity and provide for clean-out as appropriate. When runoff from high tunnels empties onto the ground surface with potential for erosion, a detention basin, storage reservoir, stable outlet, or protected surface shall be provided.

Surface or ground outlets such as rock pads, rock filled trenches with subsurface drains, concrete and other erosion-resistant pads, or preformed channels may be used.

Outside the high tunnel structure, establish permanent vegetation on ground surfaces as needed to reduce erosion, in accordance with the Delaware conservation practice standard for Critical Area Planting (342). When conditions preclude the use of vegetation, Mulching (484) may be used to provide surface cover.

For organic operations, it is the responsibility of the producer to make sure that all permissible activities, designs, materials used, and material specifications are consistent with the USDA Agricultural Marketing Service National Organic Program, National Standards on Organic Agricultural Production and Handling.

Note: Specific programs may dictate criteria in addition to, or more restrictive than, those specified in this standard.

CONSIDERATIONS

When locating the structure, consider ease of access for stocking and removal of plant materials and other management activities. Consider a minimum clearance of 10 to 20 feet between side-by-side high tunnel installations for cover installation and snow removal.

Consider potential shading of the high tunnel by nearby structures or trees. When feasible, locate the high tunnel at a distance of two times the height of the other structures or trees.

Consider a high tunnel that includes shade cloth to provide protection from the sun and extend the growing season for cool-season crops.

Consider setting end posts in concrete, the use of heavier 12 to14 gauge steel, and a double layer of plastic to improve the integrity of the structure. If available, consider installing a manufacturer's supplemental kit to provide additional structural support.

Consider seasonal ice, snow, and wind conditions when selecting a high tunnel kit. Consider working with vendors in the same general geographical area, because they should be familiar with local conditions that must be addressed. High tunnels are typically available with 4 to 6-foot bow spacing and in two styles: "Gothic arch" (peaked roof) and "Quonset hut" (rounded). In the mid-Atlantic region, Gothic-style high tunnels with a bow spacing of 4 feet are recommended because experience has shown that they shed snow more effectively and are less likely to collapse under a heavy snow/ice load. Also, with their vertical side walls and peaked roofs, Gothic-style tunnels usually provide more interior space and better ventilation.

Consider the availability of a reliable source of water near the structure, and what method(s) will be used for watering the crops (e.g., hand watering, drip irrigation, or sprinkler irrigation).

Consider managing the high tunnel system to maintain or improve soil health by following a soil management system that creates a favorable habitat for soil microbes by:

1. Minimizing soil disturbance (physical, chemical, and biological);

2. Using plant diversity in the rotation to increase diversity below ground;

3. Keeping the soil covered with residue and growing plants year-round as much as possible.

Consider periodically leaving the high tunnel uncovered for at least one growing season to allow rain, wind, sun, and cold temperatures to reduce build-up of disease organisms in the soil. Consider growing cover crops on the site during the uncovered period.

Consider the need for appropriate supporting practices to address resource concerns associated with runoff from the structure, irrigation water management, nutrient management, and integrated pest management.

This practice has the potential to affect National Register listed cultural resources or eligible (significant) cultural resources. These may include archeological, historic, or traditional cultural properties. Care should be taken to avoid adverse impacts to these resources. Follow NRCS state policy for considering cultural resources during planning.

PLANS AND SPECIFICATIONS

Plans and specifications for this practice shall be prepared in accordance with the previously listed criteria. Plans and specifications shall contain sufficient detail to ensure successful implementation of this practice, and may be recorded in narrative form, on Implementation Requirements (IR) worksheets, on fact sheets, or other approved forms.

The appropriate fact sheet(s) and completed 325 IR worksheet can serve as the plan and specifications for this practice. The following items shall be addressed, as appropriate:

1. Purpose of the high tunnel;

2. Planned crops and growing season(s);

3. Location and layout of the practice;

4. Planned length and width of the structure, specifications for the cover, plus all necessary appurtenances as appropriate for the complete system;

5. Site preparation and construction sequence, including associated erosion control, runoff, permanent vegetative, and other practices, as appropriate;

6. Include the following statements:

    a. It is the responsibility of the landowner or operator to contact Miss Utility at 1-800-257-7777 (or dial 811) at least 2 business days in advance of construction to locate and mark underground utilities; and,

    b. Assemble the high tunnel according to manufacturer's instructions;

7. Recommendations for minimizing damage to the structure by removing the tunnel cover prior to significant snowfall or other potentially damaging weather conditions, if applicable.

OPERATION AND MAINTENANCE

An Operation and Management (O&M) plan shall be prepared and is the responsibility of the client to implement. The appropriate fact sheet(s) and/or IR worksheet may serve as the management plan, as well as supporting documentation, and shall be reviewed with and provided to the client.

At a minimum, the following components shall be addressed in the O&M plan, as applicable:

1. Periodically inspect the high tunnel structure and cover. Promptly repair, reinstall, or replace components as needed;

2. Follow the manufacturer's instructions for proper operation and maintenance of each component of the high tunnel;

3. Shade cloth may be used in place of, or in addition to, the impervious plastic cover to provide protection from the sun and lengthen the growing season for cool-season crops;

4. Apply soil amendments periodically, based on soil test results, to meet desired yield goals and promote plant growth. The use of commercial fertilizer and other forms of plant nutrients must be in compliance with Delaware nutrient management regulations;

5. Outside of the high tunnel, maintain permanent vegetation or other soil cover as needed to control erosion. Inspect runoff control measures after every significant rainfall event. Repair promptly, as needed;

6. Avoid damage to the structure from equipment operated in and around the high tunnel;

7. Remove and store the plastic cover after the growing season and before heavy snow/ice to avoid damage to the structure. Re-install the cover prior to use in the spring;

8. If the high tunnel will be used year-round, manage the structure in a manner that limits wind, snow, and/or ice damage. Promptly remove heavy snow and ice from the high tunnel to prevent structural failure;

9. Producers are responsible for repairing any damage to the high tunnel, such as that caused by operating equipment, wind, ice and/or snow for the 5-year lifespan of the practice;

10. The high tunnel cannot be used to provide shelter or housing for any livestock or to store supplies or equipment.

SUPPORTING DATA AND DOCUMENTATION

The following is a list of the minimum data and documentation to be recorded in the case file:

1. Location of the practice on the conservation plan map;

2. Assistance notes. The notes shall include dates of site visits, name or initials of the person who made the visit, specifics as to alternatives discussed, decisions made, and by whom;

3. Completed IR worksheet, and copy of the appropriate fact sheet(s) or other specifications and management plans;

4. Document on assistance notes initial discussion about the landowner's responsibility to notify Miss Utility, and any information from the landowner about the existence and location of known utilities;

5. Document on assistance notes assurances from the landowner that Miss Utility has been notified, including staking by the utilities.

REFERENCES

1. Butler, Brian, and Lisa Bauer. 2013. *High Tunnel Production: The Basics for Success and Three Case Studies on Profitability*. Maryland Cooperative Extension, Factsheet FS-957. http://extension.umd.edu/sites/default/files/_docs/articles/FS-957%20High%20Tunnel%20production.pdf

2. Cornell University, Department of Horticulture. *Cornell High Tunnels*. http://www.hort.cornell.edu/hightunnel/index.html

3. Nennich, Terrance T., Sr., and Suzanne Wold-Burkness. 2013. *Minnesota High Tunnel Production Manual for Commercial Growers*. Second Edition, University of Minnesota Extension. http://www.extension.umn.edu/garden/fruit-vegetable/mn-high-tunnel-production-manual

4. USDA, Natural Resources Conservation Service. *Community Garden Guide Season Extension - High Tunnel*. http://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/mipmcar9778.pdf

5. White, L., and M. Orzolek, 2003. *High Tunnel Production Manual.* Penn State University College of Agriculture, Department of Horticulture. http://extension.psu.edu/plants/plasticulture/technologies/high-tunnels/high-tunnel-manual