ENVIRONMENTAL
Fact Sheet
NEW HAMPSHIRE DEPARTMENT OF Environmental Services
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Water Efficiency: Agricultural Irrigation

Agricultural irrigation uses considerable volumes of water, and is one of the largest groups of consumptive water uses in the state. The water efficiency practices listed in this fact sheet describe how to reduce excess water use through implementation of efficient irrigation technology, effective irrigation scheduling, and soil moisture determination and retention. These practices are designed to minimize water losses from evaporation, deep percolation and runoff.

Irrigation Technology and Methods

Commercial agriculture in New Hampshire uses two primary methods of applying water to crops: micro-irrigation and sprinkler irrigation.

Micro-irrigation is the most efficient watering method. This method employs low-flow technology to deliver water directly to plant roots at rates that prevent deep percolation and runoff losses. In conjunction with proper irrigation scheduling and soil management techniques, this equipment delivers just enough water for plant use. Typical micro-irrigation devices include:

- Drip emitters: small irrigation heads that deliver water at a drip or trickle directly at the plant base.
- Soaker hoses: hoses with tiny openings that allow water to ooze from the hose. These hoses are placed at the base of plants and are suitable for row crops.
- Bubblers: similar to drip emitters, but deliver water at slightly higher rates. These emitters are used primarily for trees, shrubs and closely planted flowerbeds.
- Micro-sprayers: similar to overhead sprinklers in miniature, they deliver a fine mist and can be controlled by either the size of the spray head or by a system controller.

Sprinkler irrigation employs overhead irrigation spray nozzles and a large diameter piping system to apply irrigation water to crops. Using big water guns results in excessive evaporation and deep percolation losses. Their use should be minimized or eliminated from irrigation operations. Evaluate the following irrigation conservation practices and incorporate the most efficient and cost effective into your irrigation designs.

Water Efficiency Practices for Field and Orchard Grown Crops

The majority of agricultural irrigation water in the state is applied to row crops. Water efficiency practices that reduce overhead sprinkler operation can save water and energy costs for vegetable and small fruit farmers. Orchard-grown crops often use very little, if any, applied water, but micro-irrigation methods are easily adapted for orchard-grown crops. The following water efficiency practices can save water in both applications.

- Space sprinkler heads so that excessive overlap does not occur.

- Choose nozzles that allow for spray pattern adjustments so that water will be applied only to plants, avoiding irrigation between rows.
- Choose low flow, high-pressure nozzles for those crops that can tolerate a higher pressure spray.
- Replace overhead oscillating, center pivot, and walking sprinklers with low-energy precision-application (LEPA) or fixed-head types. Moving sprinkler heads broadcast water in all directions, maximizing losses due to wind, evaporation and runoff. LEPA sprinklers work on a center pivot and employ drag hoses and drag socks to position sprinkler heads and apply water near the ground surface. Fixed-head sprinklers can be adjusted to apply water to just the plants and not between the rows.
- Replace sprinkler type irrigation with micro-irrigation wherever possible. Micro-irrigation can be enhanced by using it under plastic mulch.
- Retrofit or replace oversized water pumps. Oversized pumps may apply water faster than the soil's infiltration rate, resulting in water loss and soil erosion. The need to maintain the proper pumping pressure leads to over-irrigation if the application rate cannot be controlled.

Irrigation Management for Water Efficiency
Incorporating a crop demand-dependent irrigation schedule saves water without affecting crop yields. In order to efficiently apply water to the root zone, estimate the water demand based on soil type, precipitation, crop needs and soil moisture retention. The process for developing an irrigation schedule is described below. For an in-depth discussion of irrigation scheduling based on crop water use, refer to the Nebraska Cooperative Extension article, "Irrigation Scheduling: Checkbook Method" at www.ianrpubs.unl.edu/epublic/live/ec709/build/ec709.pdf.

- Determine your soil type. Soil characteristics help determine effective irrigation application rates, durations and frequencies. For instance, sandy soils may require more frequent but shorter-duration applications.
- Determine weekly precipitation amounts. Install a rain gauge in a central location. Although local radio and TV weather services can give you general precipitation rates for the week, site-specific information is more accurate.
- Determine each crop's water quantity needs. Contact your county cooperative extension service for irrigation demand information for individual crops. A listing of contacts for county extensions in New Hamsphire can be found at www.extension.unh.edu.
- Monitor soil moisture to determine whether irrigation is necessary. If the soil moisture content is adequate for the crop's water quantity needs, no additional water application is required. Soil moisture can be measured with tensiometers, electrical resistance blocks ("gypsum," "ceramic" or "moisture" blocks) or neutron probes.
- Measure the output from your irrigation devices. Use flow meters or gauged water pans to measure the output of sprinklers and drip irrigation heads.
- Combine the five pieces of information above to determine a week-by-week irrigation schedule. Update the schedule as weather and soil moisture conditions change.
- Recheck soil moisture 1-2 days after irrigation to determine depth of applied water and uniformity. If water penetration is too deep, too shallow, or spotty adjust your irrigation schedule to correct it.

Additional Practices for Irrigation Water Efficiency
The following miscellaneous water efficiency practices and techniques will help further reduce water use.

- Employ mulches wherever possible.
- Develop an irrigation maintenance program. Routinely inspect all water lines, valves and pumps for leaks. Keep replacement and repair parts on hand. Inspect sprinkler nozzles to ensure they are

operating properly and are distributing the water uniformly. Evaluate irrigation system pressures to better control application rates.

- Collect stormwater and irrigation runoff in a series of ditches or drains that return the excess water to a storage pond.
- Incorporate moisture retentive polymers in the soil. Though traditionally used in container plantings, these polymers are presently being tested by some growers and golf courses to cut down on irrigation demands.
- Water early in the morning to reduce evaporation losses.
- Practice conservation tillage. Conservation tillage encompasses minimal or no tilling and leaves at least 30 percent of the previous season's crop residue in the field. Although conservation tillage was originally devised to prevent soil erosion, a side benefit is increased soil water storage capabilities.
- Till the land along the topographic contours to reduce runoff.
- Incorporate organic matter such as compost into the soil. Organic matter retains moisture and is especially effective in sand and clay soils.
- Incorporate cover crops for winter and fallow times to improve the soil and reduce water and soil losses caused by runoff. When tilled under, cover crops also add organic matter to the soil.
- Practice deficit irrigation where feasible. This method involves stressing plants by reducing water applications. Be aware that this practice typically reduces crop yields and may lower the quality of some products. However, the water savings may be more valuable than the crop losses.
- Use computer software to aid irrigation scheduling.
- Use pressure regulators for uniform water distribution throughout irrigation systems.
- Use timers, automatic shut off valves, rain sensors and other such devices to help ensure overwatering does not occur.
- Limit the volume of water used for frost protection for late maturing crops such as pumpkins.
- Investigate alternative irrigation water sources, such as treated municipal wastewater treatment plant effluent, treated industrial effluent, on-site gray water systems, and holding tanks for rainwater or greenhouse irrigation water. State and federal regulations that restrict the reuse of water from certain sources should be investigated and permits obtained where applicable.

Water Conservation for Greenhouse, Nursery Stock, and Potted Plant Irrigation

Water-efficient methods for irrigating greenhouse plants include hand watering, micro irrigation and sub-irrigation techniques. Micro irrigation and sub-irrigation techniques minimize losses through accurate application and recycling designs.

Micro-irrigation techniques are capable of applying water accurately at rates that do not result in runoff or overflow waste. See the section of this fact sheet titled "Irrigation Technology and Methods" for a more complete description of micro-irrigation.

Sub-irrigation techniques (i.e., ebb-and-flow and trough systems) allow the plant soil to absorb water through capillary action. This is a closed loop irrigation system that stores water in tanks or cisterns connected by piping to greenhouse growing benches. Excess irrigation water is collected and returned to the storage device. Originally developed for hydroponics (a system for growing plants in water only) use, an ebb-and-flow system pumps water to plants sitting in shallow bench trays and then drains it back into the storage tanks. The entire operation can be computerized for regularly scheduled waterings. Liquid fertilizer is also delivered to the plants via the system.

For Additional Information

Please contact the Drinking Water and Groundwater Bureau at (603) 271-2513 or dwgbinfo@des.nh.gov or visit our website at http://des.nh.gov/organization/divisions/water/dwgb/index.htm. All of the bureau's fact sheets are online at http://des.nh.gov/organization/commissioner/pip/factsheets/dwgb/index.htm. More information about the DES Water Conservation Program can be found at http://des.nh.gov/organization/divisions/water/dwgb/water_conservation/index.htm.

Resources

New Hampshire Department of Agriculture, Markets, and Food. *Best Management Practices for Agriculture in New Hampshire* www.nh.gov/agric/divisions/markets/documents/bmp.pdf

University of Nebraska irrigation publications. Irrigation management and scheduling information. www.lancaster.unl.edu/ag/crops/irrigate.shtml

Colorado State University Cooperative Extension. Discussion of crop water use and growth stages. www.ext.colostate.edu/pubs/crops/04715.html

References

New England Interstate Water Pollution Control Commission (NEIWPCC); *MRI Water Conservation Technical Bulletin #2, Water Conservation Best Management Practices for Agricultural Irrigation;*, NEIWPCC, Lowell, MA; 1996.

Vickers, Amy; *Handbook of Water Use and Conservation;* WaterPlow Press, Amherst, MA; 2001; pp 330-365, 337-383.

Note: This fact sheet is accurate as of March 2013. The availability of additional information after this date may render this information inaccurate or incomplete.