LAND IMPROVEMENT CONTRACTORS OF ONTARIO

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MANAGING SOIL MOISTURE

How sub-surface drainage benefits crops and the environment

The objective of cropland sub-surface drainage is the management of air and moisture in the crop root zone while conserving as much useable water as possible.

Healthy, productive soil is typically made up of 45 per cent mineral material (sand, silt or clay), five per cent organic matter (more is better), 25 per cent air and 25 per cent water (soil moisture). Pore space available for air and capillary water may be reduced by soil compaction from equipment activity on wet soil, soil structure degradation from too much tillage and poor crop choices, and in the humid Great Lakes Region, excessive soil water fills the space needed for air.

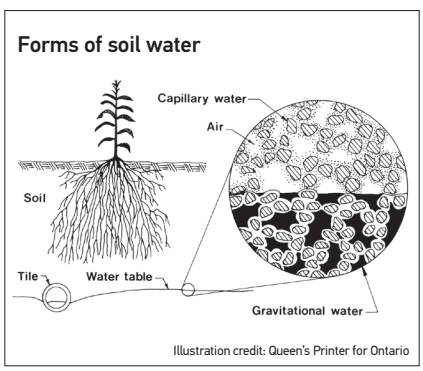
To achieve good air-water balance, sub-surface drainage can be used to remove free or gravitational water from the crop root zone. This is water that fills soil macropores such as earthworm holes and cracks. As the water is removed air enters the soil. Gravitational water cannot be used by most crops and because of soil conditions that contribute to the water surplus it has very limited potential for groundwater recharge.

In spite of sub-surface drainage, the soil continues to hold capillary water. This is the water, i.e., moisture, that can be used by crops and makes up the 25 per cent water that healthy soil needs. It is held cohesively in a layer around soil particles and in small spaces called micropores in the capillary zone – the soil between the water table and the soil surface. The capillary zone becomes the crop root zone. Water can move up from the water table to replenish moisture in the crop root zone. The amount of movement is determined mostly by soil type and the continuity of connected pores. Tillage can damage these pores.

Hydroscopic water also remains after sub-surface drainage. It forms a thin, tight layer on soil particles and cannot be removed by drainage or by crops.

The air and water balance is important to grow healthy crops. Adequate air is needed to allow soil to warm up quickly for early plant growth. It also makes possible large, deep root systems that can reach sufficient capillary water in dry weather and permits the necessary oxygen-carbon dioxide exchange. Various forms of soil life such as earthworms and mycorrhizae (fungi) can flourish only if they have access to air. Soil life is important for nutrient retrieval by plants, for organic matter breakdown and for maintaining healthy soil structure.

The depth of drain pipe installation establishes the water table elevation through periods of excess soil moisture, such as periods of heavy rainfall and during cooler seasons when evaporation from the soil and transpiration of moisture from plants is less than the precipitation that adds to soil moisture. Shallow sub-surface drains placed close together provide the most uniform drainage and minimizes the volume of soil drained aiding water conservation. This kind of installation requires precision equipment and skilled operators. Drainage design is important.



In addition to improving soil health and reducing food production costs, sub-surface drainage reduces the runoff of sediment and nutrient, e.g., total phosphorus. It results in the filtration of water as it moves to drain pipes. Because water can enter air-filled pores during rainfall events, this extends the time required for water to leave cropland and often results in more uniformity of stream flows.

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Further sources of information

- **Best Management Practices – Cropland Drainage,** Ontario Ministry of Agriculture, Food and Rural Affairs: http://www.omafra.gov.on.ca/english/environment/bmp/series.htm#22
- **Handbook of Drainage Principals – Publication 73,** Ontario Ministry of Agriculture, Food and Rural Affairs: www.drainage.org

The Land Improvement Contractors of Ontario (LICO) is an association of professional drainage contractors and suppliers of drainage pipe and equipment. The focus of their business is soil moisture management to enhance crop production in Ontario.