Cornell profuses plants to treat sewage

ITHACA, NY — Cornell University researchers are using a host of plant species to do what conventional sewage treatment facilites do – take pollutants out of sewage – at much lower capital investments and operating costs.

Countless homes, industries, and commercial establishments, among other sources, all discharge wastewater into municipal sewers, creating untold amounts of sewage sludge around the clock.

Cornell's plant-based treatment system is capable of doing as good a job as the typical chemical treatment plant does, says William J. Jewell, an agricultural engineer in the New York State College of Agriculture and Life Sciences at Cornell.

The system, in essence, relies on plants grown in a modified hydroponic system known as the "nutrient film technique" that uses only sewage as a growing medium for the plants, and the resulting plant roots efficiently pick up all the pollutants from the wastewater.

"Instead of building concrete-and-steel monsters at tremedous costs, we can use this plant-based treatment system, which could cost half as much to do the same job," Jewell says.

Sewage contains many kinds of organic and inorganic pollutants, including nitrogen, phosphorus, potassium, calcium, iron, sodium, microorganisms, and heavy metals such as cadmium, lead, nickel, and copper.

The conventional treatment plant removes these pollutants from sewage before discharging the treated wastewater into the environment. It does this in a two- or three-step process. The first step, called primary treatment, removes much of the pollutants from sewage by settling out suspended materials. The second step eliminates dissolved pollutants. Sludge resulting from this two-step process may require further treatment.

The key component of Cornell's treatment system is living plants grown in sewage, requiring no soil. Plants are grown in water-tight troughs somewhat similar to gutters, and a thin "film" of wastewater is directed to flow through the plant roots.

Hence, Cornell's Jewell calls his system the "nutrient film technique." He says that plants grow well in such a system because sewage contains all the major nutrients necessary for plant growth. The result is massive root systems that pick up all the pollutants.

"The roots serve as a highly efficient filter," Jewell says. "Better yet, they are renewable because the plant continues to grow."

Based on a series of experiments conducted over the past several years at Cornell and other locations, including one at a sewage treatment facility in New Hampshire, Jewell says that his system is capable of producing high quality water from domestic sewage at rates faster than the typical treatment plant.

The system works efficiently, even in cold climates. In colder areas, the plants can be grown in low-cost plastic greenhouses. Therefore, this system can be adopted anywhere in the United States for year-round operation.

For a community of 10,000 people, for example, a five-acre system should be adequate, Jewell estimates. A community of this size produces one million gallons of sewage per day.

Thus far, Jewell has experimented with many kinds of plants, such as wetland plants, ornamentals, grasses, and even food crops. Among the species tested are cattails, bristly sedge, woolgrass, soft rush, bulrush, reed canary grass, phragmites, napier grass, roses, chrysanthemums, carnations, petunias, gernaiums, cucumbers, tomatoes, millet, and wheat. Whether the food crops grown in this system are fit for human consumption is yet to be determined.

Jewell's system consists of three treatment sections, each requiring different types of plants. The first section, called "primary treatment," is designed to trap most of the suspended solids, followed by the second section – "nutrient conversion and recovery" – where remaining suspended solids and most of the pollutants are removed. The third section, called "water polishing," puts the finishing touches to the wastewater by removing most of the remaining pollutants.

"It takes only a few hours to turn grossly polluted sewage into highly purified water," Jewell says. "The quality of water produced by this system exceeds that achieved by conventional sewage treatment facilities."

Since plants use sunlight for growth, among other requirements, the Cornell system relies on solar energy, and, therefore, the system is an energy-efficient as well as cost-effective alternative to the conventional system, Jewell says.

In addition to turning wastewater into clean water, the nutrient film technique has several other potentially important applications. As Jewell sees it, plants grown in this sytem can be harvested periodically for use in generating energy in the form of methane, better known as natural gas.

Since some ornamental crops such as roses, carnations, and chrysanthemums grow well in such a system, these crops could be produced on a large scale to be marketed or used in public parks and other recreational areas of a community.

In areas such as New York State's Long Island, where groundwater is contaminated with certain pollutants, the Cornell system could be used as a low-cost water supply treatment facility.

Other possibilities, says Jewell, include production of drinking water from salt water through this system, because plants give off large amounts of moisture through transpiration. All one has to do is condense and collect the moisture in a greenhouse. In this situation, salt-tolerant plant species must be used.

Jewell is planning to set up his system at the Ithaca municipal sewage treatment facility this spring under the sponsorship of the Gas Research Institute in Chicago and the New York State Energy Research and Development Authority. To be tested for the next two years, the system will handle 10,000 gallons of sewage per day.

Summing up his work, Cornell's Jewell says that the nutrient film technique "represents a real breakthrough in wastewater treatment."