Greenhouse manager Martha Edens examines the root system of a strawberry plant nourished by trout farm wastewater circulated in a hydroponic trough. (K5769-12)

Trading Wastewater for Crops

Now ARS scientists at the Appalachian Fruit Research Station in Kearneysville, West Virginia, are using trout farm wastewater to grow strawberries in the greenhouse, cleaning the water in the process. And, they're converting the waste solids they remove into potting mix.

"We're using wastewater produced from raising rainbow trout in recirculated spring water," explains D. Michael Glenn, an ARS soil scientist at Kearneysville. Glenn oversees the joint project with the Freshwater Institute that is part of the Conservation Fund. The fund is a nonprofit organization working with private and public partners to protect and conserve land and water resources. [See "Aquaculture Springs Up in West Virginia," *Agricultural Research,* March 1993, pp. 4-8.]

"Wastewater from fish farming may pollute streams and rivers by adding excess nutrients such as nitrogen, phosphorus, and organic matter," Glenn says.

And phosphorus is the most critical, because it triggers processes that lead to the degradation of water quality. So scientists have searched for ways to reduce the phosphorus load in wastewater.

Glenn says that plants can take up more phosphorus than they need and store it without any ill effect. This makes them a good scavenger of excess phosphorus in the environment.

But whereas hydroponically grown plants can take up other nutrients directly from tranquil water, their roots must have an opportunity to "bump into" phosphorus molecules.

The Kearneysville scientists had to devise a special system to facilitate that uptake.

At a glance, the green, leafy, 6-foot structure in the greenhouse at Shepherdstown looks like a tree. A closer look reveals plastic elbows sprouting individual, vigorously growing strawberry plants.

This is Kearneysville horticulturist Fumiomi Takeda's way of growing strawberries hydroponically, using fish effluent as fertilizer.

"With this system, we can increase greenhouse production about 10 times because we grow the strawberries vertically, or stacked," he explains.

Takeda drilled 24 holes in a 4-inch- diameter, 6-foot plastic pipe. He put plastic elbows in the holes, turned the pipe upright, and filled it with Perlite, a growth medium that supports developing plants. Each hole holds a strawberry plant, its roots reaching into the Perlite and its foliage growing out of the elbow.

"We drip in the effluent, cleaned of solids, at the top of the tubing, letting it trickle down the roots of all 24 plants," says Takeda. "The plant roots extract essential nutrients, like phosphorus, from the effluent so that the water coming out of the bottom of the tube is much cleaner. Plants will grow in this system for about 6 months. The fruit is harvested during the latter 3 months."

The growing season for field strawberries in California is 9 to 12 months; in Florida, about 6 months.

So in 4 square feet of greenhouse space, he grows 24 strawberry plants, where conventional growing practic- would allow only 2.

Takeda is also growing strawberries in troughs similar to rain gutters, starting with "plug" plants.

He plants runner tips in small containers of potting mix. After they develop roots, he transplants them into 4-inch-square, flow-through basket "pots" made of plastic netting that allows the effluent to flow through and the roots to grow out of the pots. The baskets contain about a pint of Perlite.

At Shepherdstown, the gutters are constructed at a slight slant and baskets of plants are placed in the gutters, 12 inches apart, so the roots are exposed to the flowing wastewater. The plants are fed by the nutrients in the water.

Growing strawberries in filtered wastewater and rockwool, a growth medium commonly used by the nursery industry, has also produced good results, Takeda says. "Rockwool has a high water-holding capacity and good aeration properties, which means the roots will get plenty of oxygen."

"Each of these systems using fish effluent produces good-size fruit that tastes just as good as strawberries grown in the field," Takeda says. "However, we have noticed nutrient deficiency symptoms—specifically manganese, iron, and boron—in the plants. Fish wastewater contains no iron. But we're adding supplemental micronutrients, which should eliminate this problem.

SCOTT BAUER

Strawberry plants thrive in hydroponic columns that save both growing space and production costs. Martha Edens checks the health of these plants receiving their nutrients from aquaculture effluent. (K5767-4)

"Also, since these systems are being operated in the greenhouse, we didn't have adequate pollination for the flowers. Strawberry plants need bees or other insects for this. So, we placed a hive of bumblebees, known to be good pollinators, in the greenhouse. They're doing a great job."

So far no fungal problems have appeared, and a few thrips are the only insect encountered. Conventionally grown plants produce about a pound of strawberries per plant. In the summer months, the experimental plants produced about three-fourths of a pound per plant, but the added micronutrients and the growing scheme during the cooler months should bring production up to a pound or more.

"We're hoping that greenhouse growers will fill the market gap between October and December with these strawberries. California strawberries end in October and Florida starts shipping around Christmas time," Takeda says

Even the solids, cleaned from the wastewater used to grow the strawberries, become valuable byproducts. Consisting of feces and uneaten fish food, the solids will eventually break down and can further enrich the soil as fertilizer. However, Glenn also has another use for them.

"We add straw, another waste product, to the solids, making a potting substitute," he says. He has tested this material as a replacement for rockwool.

Glenn says there was no difference in quality or yield between lettuce grown in rockwool and that grown in the new compost. "We're now thinking about adding some disease-suppressing microorganisms to the new potting mixture."—By **Doris Stanley**, ARS.

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