Fish Increase Greenhouse Profits

An aquaculture study in North Carolina shows that fish and vegetables can be good companion crops.

Top: The larger plants on the right benefited from circulated fish tank water.

Bottom: These vegetables were grown in a bed of sand lined with polyethylene to recapture tank water.

By Doug Sanders and Mark McMurtry

RAISING a fish dinner complete with salad, entree, and vegetable in a single greenhouse sounds a little strange, but raising such a meal from only a "fish chow" sounds like science fiction. The fantasy is further expanded when one hears that such a system requires only a few gallons of new water each day. This story will be retold more frequently if results of work at North Carolina State University continue to meet with success.

We have been growing blue tilapia (*Oreochromis aureus*), a west African river fish, in tanks in our greenhouse. The water must be aerated and the waste and harmful nitrite must be removed for the fish to gain weight. We are using the waste and water to fertilize and irrigate vegetables.

The vegetables are grown in a bed of sand so water and waste can be circulated frequently. The sand provides a well-aerated medium which will drain readily and must be watered often. Thus excess waste does not accumulate in fish tanks between cycles. The sand and vegetables provide excellent filtration for the aquacultural water.

During a three-month period, fish were held in a 25-cubic-yard tank. They were fed 306 pounds of a commercial fish chow. In total, they gained

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Table 1: Yields of fish and vegetables in three months.

	Fish (pounds per cubic yard)	Beans (pounds per square foot)	Cucumbers (pounds per square yard)	Tomatoes (pounds per square yard)
Aqua-integrated greenhouse	9.4	4.6	29.1	36.8
Conventional greenhouse	—	1.4	12.1	32.4

150 pounds from an initial 81 pounds. The fish were mixed male and female and were not stocked closely (34 per cubic yard). If the population had been all male and were stocked more densely, the yield would have been two to four times greater.

During the three-month period crops of tomato, cucumber, and green beans were grown as only a part of the experiment. The yields of these crops and a comparison to a conventional soil culture are reported in Table 1.

The sand beds for vegetable production and fish waste filtration are a critical part of this integrated system. This filter was made by first removing the soil below the bed and then grading the bottom to a predetermined slope. Then 6-mil polyethylene was laid down to capture drainage water for return to the fish tank. A coarse builder's sand was used to fill the bed area. After the surface was leveled, micro furrows were cut for the water to flow down the bed. Each bed was 5 x 25 feet and contained three to five micro channels. The beds were watered for 30 minutes every three hours during daytime hours. The sand was saturated in the first five minutes. As water drained from the bed it was returned by gravity to the fish tank where it passed through an aerator.

This reciprocating biofilter benefits both nitrifying bacteria and plant roots by providing: 1) uniform distribution of nutrient-laden water within the filtration medium/root zone during the flooding cycle and 2) excellent root aeration through a total exchange of the media atmosphere during each drainage period. Uniform crop development and water quality performance of this system can be attributed in part to the reciprocating water movement.

The system provides economical yields of vegetables and fish. The fish system is profitable on its own and when the vegetable component is added profits are further increased. The system needs further work to determine how best to optimize economic output. This could be done either by increasing fish to vegetable area or vice versa, depending on value of the products and biological constraints of tank stocking density and filter area. These fine points aside, one can have his salad and "filet de lemon" grown together. □