

Aquaponics: Thoughts about inherent problems

Aquaponics is a combination of aquaculture and hydroponics, based on the concept of using fish waste as a fertilizer for plants and letting the plants clean the recirculating water for the fish.

Concerns:

1. Aquaculture operations must be carefully managed to create optimum and disease-free conditions for the fish and, if there are disease outbreaks, profitability is unlikely.
2. Hydroponic operations must be carefully managed to create optimum and disease-free conditions for the plant rhizosphere and, if that does not happen, profitability is unlikely.
3. Calculations based on the Cornell system of deep flow hydroponics have suggested the cost of plant nutrients in a head of lettuce, for example, is less than a penny per head. This suggests little economic benefit to using fish waste as fertilizer for the plants. (See associated calculations in separate file.)
4. Plants can not "clean" the water for the fish. If that were the case, the plants at the end of the line would be growing in a very nutrient-poor environment, compromising their growth rate. This suggests little benefit to the fish.
5. At Cornell we have experienced root disease problems when we have used a nutrient solution containing too much organic material - slime mold explosions, specifically.
6. Fish waste does not contain all the nutrients in the proper molar ratios needed by plants for good growth. This means the nutrient solution will need supplementing of certain nutrients for the plants to grow well. Either that, or the fish waste will be "cleaned" very little of its nitrate (and other plant nutrients) load, for there will always be some nutrient that is limiting and nutrient uptake ceases when that limit is reached and the plants cease to grow.
7. Fish waste is not balanced to provide plant fertilizer having the proper molar ratios, so additional systems must be included to remove the remaining components of fish waste - unless the waste is dumped into the environment (such as into a constructed wetland.)
8. Recirculating water in fish tanks has a pH that is basic - around 7.2 - due to the inherent characteristics of fish waste. Plants grow best in a nutrient solution with a pH of 5.8 to 6.0. This is not compatible with fish waste, suggesting acid must be added for better plant growth, and acid is not free.
9. Scale (relative sizes) is a problem. We have calculated that a **very** small aquaculture operation (100,000 lb/year) produces enough nitrogen waste to support 30 acres of lettuce production if all other nutrients are available in sufficient quantity.
10. With these issues, both the aquaculture production system and the hydroponic system must be operated with a number of compromises. Because neither is a highly robust technology, and the slightest glitch can be very costly, this suggests that trying to integrate two difficult systems with compromises in each is unlikely to be profitable.

"As a general rule, hybrid systems tend not to work well. Invariably they make compromises in both modes of operations."

M. Lewis, President, American Institute of Aeronautics and Astronautics