An Aquaponics Project in the Bahamas

Aquaponics as a Solution for Sustainable Food Production in South Eleuthera, The Bahamas: A Demonstration Project

By Colleen O'Brien

The Cape Eleuthera Institute (CEI) was launched in February 2003 by the Cape Eleuthera Foundation to provide research opportunities for Island School students and to model sustainable systems for developing world places. Collaborating with government, scientists, students and the local community, CEI aims to be an inspiration that promotes responsible development and careful stewardship of resources within The Bahamas and in similar places throughout the world.

The campus features many innovative designs which are sensitive to local culture and minimize our ecological footprint. One of the hallmarks of the new Institute facility is the solar-powered Wege Center for Sustainable Fisheries. This building houses hatchery facilities and wet labs for the development of sustainable aquaculture, including offshore cage culture, bonefish studies and sponge, conch and lobster grow-out, as well as the aquaponics fish tanks. The solar panels on the Wege Center generate electricity for the entire facility and represent the first and largest grid-inter tie system in The Bahamas.

Aquaponics program coordinator, Colleen O'Brien, harvests basil from the raceways.

Natural resources have been the foundation of economic development in The Bahamas for many years. Eleuthera was once the breadbasket for The Bahamas, providing produce and meats to many of the family islands.

Unfortunately, changes in market demands, along with intensive growing practices that reduced the land's ability to sustain agriculture at a commercial scale, reduced the capacity of food production below sustainable levels.

Currently, the future of food security in The Bahamas is in jeopardy, and CEI endeavors to find a solution. Given

the prevailing physical environmental conditions and lessons learned from past agricultural methods employed in The Bahamas, novel methods of food production that are low-cost, environmentally-friendly and sustainable need to be used.

CEI began research in aquaponic systems because it offers one potential solution to the need for sustainable food production in The Bahamas. The design and implementation of our demonstration system will aim to reduce the costs of food production while diminishing negative impacts on the local environment.

Closing waste streams in a recirculating aquaponic system virtually eliminates environmental pollution commonly generated by traditional aquaculture. In addition, utilizing dissolved and particulate wastes produced by fish can result in secondary levels of food production beyond that produced by growing fish alone; it turns a waste stream into a valuable resource.

Top: *The new raceways are housed in a separate shade house with a retractable roof. The shade cloth on the sides protects the plants from wind. The roof protects the plants from solar intensity damage during the summer.* ***Middle:*** *Fish length and weight measurements are taken weekly by the students. These data are used to track the health of our system.* ***Bottom:*** *An Island School student records water quality measurements.*

Unlike conventional agriculture, there is no dependency on synthetic and expensive fertilizers, nor is there any requirement for soil as a growth media; all traits that make aquaponics a favorable alternative method for food production in areas such as The Bahamas where imports are expensive and fertile soil scarce.

The CEI aquaponic system utilizes freshwater from rainwater catchments. The use of rainwater will ultimately make any aquaponic system more cost effective and environmentally-friendly.

The fish used in this system are Nile tilapia (*Oreochromis niloticus*), and are currently stocked at a density of 88 fish/m^3. They are raised in two circular 750 gallon tanks and grown under ambient temperature and light conditions to help minimize operating costs. The Tilapia are fed 536 grams (per tank) over 12 hours, via an automated feeder, a complete diet of floating pellets containing 35% protein.

From the two fish tanks, water gravity-flows to a settlement tank, continuing to a biofilter and on to plant raceways. The 140 gallon settlement tank removes larger solid particles that sink to the bottom of the water column. These larger particulates are manually removed from the tank twice daily and this waste is used as fertilizer in traditional garden plots.

From the settlement tank, the water flows into a 27 gallon biofilter that is filled with inert plastic bioribbon which the nitrogen-converting bacteria affix to.

Aeration is provided to help maintain safe dissolved oxygen levels. Each fish tank and the biofilter have an air blower connected to an airstone, and the fish tanks are also equipped with an air lift.

The Tilapia fish tanks, the settlement tank, and the biofilter are all housed in the Wege Center for Sustainable Fisheries – the world's first solar-powered hatchery and wet lab center.

Following particulate settlement and biofiltration, water moves into six hydroponic raceways that measure 12 feet long by two and a half feet wide, with an average depth of four inches, and hold approximately 75 gallons each. We also have two raceways that are 12 feet long by two feet wide and five inches deep. The water flows through each raceway, and is returned into a common collection sump, where the only pump in the entire system, a fountain pump, lifts the water back into the fish tanks. The sump has a 140 gallon capacity, but is kept at one-third of its total volume so that the sump can accommodate the draining of an entire raceway. If the water level drops below our desired level, a float valve in the sump automatically opens a freshwater faucet.

The plants we grow in the aquaponic raceways include herbs, such as basil and cilantro, and several varieties of lettuce and greens, such as Butter crunch Bibb, Kyona Mizuna, Red Russian kale, Red Giant mustard and Tatsoi.

We have experimented with growing sweet bell peppers and Habanero peppers, but have had varying success since we did not provide nutrient supplementation for those fruiting vegetables. The lettuce and greens are grown in the six wider raceways, while the herbs are grown in one of the narrower raceways.

The final raceway is used for experimenting with different varieties of vegetables and local medicinal plants. The seeds are germinated in rockwool, which are then placed into plastic net pots that sit in holes drilled in sheets of expanded polystyrene that float on the water in each raceway. The spacing of the holes in the polystyrene boards varies depending on what we are growing; we are currently conducting trials on the correlation of plant spacing and harvest weights.

Students from The Island School worked to design and construct the pilot aquaponic system. Tilapia were imported in early October 2005, when the system first went online. Since then, the system has been managed by students of The Island School and research staff at CEI. The aquaponic system is used as a training tool for permaculture and marine science courses offered by CEI, but it is the students from The Island School that are responsible for monitoring and refining the system. Following each semester, students generate re-

search papers that are sent to The Bahamas Department of Fisheries and The College of The Bahamas for further dissemination. Students present the results of their work to local community members, government officials and professional research scientists during Island School Research Symposia held at the end of each semester.

If proven successful through our demonstration project, students and staff aim to highlight the potential for aquaponics as a low-cost, environmentally-friendly way to produce food for restaurants and resorts on Eleuthera.

Throughout the design and implementation process, water quality monitoring was conducted to ensure optimum conditions for fish and plant growth. The Island School students learn both the plant and fish requirements and develop an understanding of how symbiotic relationships can be formed in novel ways that produce a myriad of benefits. Students also have the satisfaction of providing their fellow students and community members with fresh fish and produce.

The fish are normally harvested once each semester, and the lettuce and herbs are harvested continually. And perhaps most importantly, students are involved in meaningful research that attempts to find the most economical and sustainable methods of food production for this remote Bahamian island.

Many students have recognized the many benefits of aquaponics on Eleuthera. Antonia Pryor, a student from the inaugural semester of the CEI aquaponics project said she thought it "was just a fun project at the beginning of the term, but then I realized how important it is in some places where the soil is infertile and the fish population is depleted. If done on a commercial scale, it can feed a lot of people."

Christopher Courtemanche, a student from the fall semester 2006, and a native to Eleuthera, has recognized that aquaponics "not only brings in income, but also to helps reduce the market demand in the islands for nearly endangered fish (such as the Nassau grouper), and supplies crops,

CEI all-greens salad mix on day 18 since seeding.

reducing the need for their import." Courtemanche has plans to set up a small scale aquaponic system at his home and will continue to be involved in the CEI aquaponics program so he can transfer the knowledge to his own system.

The CEI aquaponics project is still very much in its infancy, but with each new step of refinement and expansion, the system improves. In another two years' time, our goal is to have a viable crop and fish harvesting schedule that provides consistent and wholesome food for our community, and is a system that local farmers and entrepreneurs can replicate throughout The Bahamas. Developing innovating methods of food production, such as with aquaponics, allows communities - and entire countries - to embark on a path towards greater food security and economic gains.

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