

FOOD FOR THOUGHT

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Carla MacQuarrie and her husband, Pete, started Future Aqua Farms in 1998 with a greenhouse on the outskirts of Halifax and unique ideas about combining agriculture and aquaculture.

Future Aqua Farms has produced both plants and fish in an environmentally sustainable way by imitating the cycling of nutrients in a natural ecosystem. Fish waste is used to nourish plant life, which in turn provides clean water for the fish. In a normal fish-farming situation, fish effluent water is disposed of and replaced by clean water, creating water waste and pollution. Future Farms' system, on the other hand, is highly efficient, and has only a minimal impact on the surrounding environment.

Theoretically, any species of freshwater fish could be grown with any species of plant. But MacQuarrie chose to focus on tilapia fish, with lettuce, spinach and arugula as the plants. www.futureaquafarms.com

Small Company, Large Vision

Carla MacQuarrie completed an aquaculture engineering degree in Halifax in 1997, and began work as a consultant in the design of aquaculture facilities. She quickly realised two things: first, the industry was going to have to change its social and environmental impacts in order to survive. Second, sustainable aquaculture was not a contradiction in terms. She founded Future Aqua Farms Limited with her husband, Pete in 1998, setting up a greenhouse in the outskirts of Halifax.

MacQuarrie quickly rattles off the strong vision of Future Aqua Farms: "We thought that the way we were doing things would show that aquaculture can be done in a sustainable manner." Despite hardships and changes in the company, this vision never changed. It encapsulates the goals of the company, both to demonstrate sustainable aquaculture and to drive this change through the industry.

A Different Design Concept

Future Aqua Farms grows fish differently. The company actively imitates the cycling of nutrients in a natural ecosystem. The entire operation takes place in a greenhouse, where there are three groups of organisms passing along nutrients using water as a medium.

Fish are stored in 650-800 gallon tanks. These fish, like all animals, produce wastes, including nitrogen (in the toxic form ammonia), along with several other nutrients from digested and uneaten fish feed. The water containing the fish waste is pumped through gravel or porous foam growing beds, where the large amount of surface area encourages bacteria growth. These bacteria convert the nitrogen from ammonia to nitrites to nitrates, which as any good farmer knows, are the most useful source of nitrogen for plant uptake. Plants absorb the nitrates and remaining nutrients, turning them into plant biomass. As plants absorb the nutrients and grow, the water is purified and pumped back into

fish tanks. Theoretically, any species of freshwater fish could be grown with any species of plant. Future Aqua Farms has chosen to concentrate on tilapia as the fish, with basil, spinach and arugula as the plants.

The entire system needs very little. Water is almost 100% recycled, so maintaining the system requires virtually no water. Energy is required to heat and pump the water; however some energy is obtained from solar heating in the greenhouse, and the total energy used is much less than ordinary aquaculture facilities. The water cannot function as a nutrient carrier if it is contaminated by herbicides (this would harm the plants), pesticides (this would harm the fish), or antibiotics (this would kill the bacteria), so all pest control is done naturally. As an example, plant pests are controlled with

ladybugs. The farmed fish cannot interact with any wild fish, so an uncontaminated system remains disease free. As an added bonus, no fish can escape to interact with local ecosystems or genetic diversity, a common concern environmentalists have with more conventional farms. The only input required is fish food for the tilapia, and occasional amounts of calcium phosphate to buffer pH levels of the water.

A Changing Industry

Aquaculture is an ancient practice, going back at least 2000 years in China. However, high intensity aquaculture of carnivorous fish (like salmon) is a recent invention. The industry has come under increasing scrutiny over the waste produced from these farms, and health concerns about toxins in the fish produced on farms. These two issues are changing the industry: governments are increasing regulation on the effluent, and consumers, especially on the west coast, are expressing a taste and health preference for wild fish.

Carla is in touch with these market drivers. "Effluent is a big issue right now. As regulations become more stringent, farms will have to look at reducing effluent content to 0. Our method not only eliminates all harmful compounds in a farms outputs, it provides an additional profitable product from waste."

Challenges and Opportunities

In the fall of 2003, hurricane Juan hit Halifax, and the power outages lasted for 8 days. Without electricity to heat the



water, or to pump ammonia-laden water out of fish tanks to bacteria beds, 95% of their fish died. The following January, the company lost the remainder of their fish when their furnace broke, and the fish froze. The company has since restarted as a hydroponic operation, adding nutrient salts in place of fish waste.

Unwilling to give up, Future Aqua Farms focused on their vision and looked for new strategic opportunities. They come up with two core competencies and strategies. The first was something they already did: training and exporting their 'aquaponic' model that combined plant growing and fish farming. Carla and her husband Pete have done consulting for Plover Mills and Fulton Farms for setting up aquaponic operations. In addition, they have done feasibility studies for what Carla sees as the future of aquaponics: setting up businesses in hot climates where water is scarce. Exporting their model to African or Caribbean countries might be an excellent market for their knowledge.

The second option involves the addition of greenhouses to existing aquaculture operations in North America. As regulations drive fish farms to reduce effluent content, the addition of a greenhouse which treats waste and provides another revenue stream could be very attractive. Carla sees greenhouses designed and tailored to other farms specific conditions, purifying the nutrients that differ according to water source and fish species cultured. Future Aqua farms

Biomimicry and eliminating the concept of waste

Academics, professionals and business owners are finding ways to design businesses to be profitable because they are socially and environmentally responsible, while this responsibility is central to the businesses existence.

Biomimicry is one tool for achieving these "eco-preneurial" businesses. Janine Benyus helped promote the idea with her 1997 book 'Biomimicry: Innovation Inspired by Nature'. Nature has had years of evolution to find elegant solutions to problems, solutions which can be imitated to form more environmental companies.

Eliminating the concept of waste entirely is part of this way of thinking. Nature doesn't waste – one creature outputs are another food. Future Aqua Farms embraced this thinking: instead of looking at fish waste as a problem, they saw an opportunity. They designed a system that used nutrients just like an ecosystem, growing plants hydroponically in water containing fish waste. Their first aquaculture operation found more profit in the plants produced from the 'waste' than from the fish themselves.

would be positioned to provide a unique and not easily imitated service to almost any land based freshwater fish farm.

Given the large and growing number of trout farms, this might be a large market.

Both of these options could represent large markets and both are consistent with the company's vision of demonstrating sustainable aquaculture as well as continuing to change the industry.

Growth Potential for the future

Fish is increasingly acknowledged to be a healthy food, high in desirable compounds like omega-3 fatty acids. This has been responsible for an increase in the amount of fish consumed, especially in North America. Global sales of wild and farmed fish grew from 88.8 million metric tons to 142.1 million metric tons between 1984 and 2001. Wild fisheries during this period grew 16.1%, while aquaculture production grew 475%.ⁱ However, a recent article in Science pegged farmed fish as unhealthy, reporting that eating it more than twice a month in western countries could cause cancerⁱⁱ. This is helping to drive a backlash against farmed fish – there are a significant number of NGO's, fishermen, conservationists and other stakeholders actively engaged in deterring the growth of the aquaculture industry. The shape and form of future aquaculture practices will be influenced by this, and unhealthy, environmentally destructive companies will either adopt better practices or fade away.

Creating the Future

Future Aqua Farms limited is undergoing changes. They are repositioning themselves to offer different products to different markets after the destruction caused by hurricane Juan. The outcome of their strategic choices remains to be seen, but there are two promising signs: the company is very in touch with consumer's demands on the aquaculture industry, and the company has a very strong vision based on these demands. The company is proving that environmental practices can be a source of profits rather than a cost, if you just find the right design.

ⁱ *Aquaculture Statistics*. The Department of Fisheries and Oceans Canada, 2003. Available at http://www.dfo-mpo.gc.ca/aquaculture/statistics_e.htm.

ⁱⁱ Hites, Ronald, Jeffery Foran, David Carpenter, M. Coreen Hamilton, Barbara Knuth, Steven Schwager. 'Global Assessment of Organic Contaminants in Farmed Salmon.' *Science*. Vol. 303, 2004.

