

## Perspective

# Aquaponics Education in the Community College Setting

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## Abstract

As the human population has exceeded 7 billion, consumption of animal products is at an all time high. Most of our commercial fish stocks are overexploited, recovering, or depleted, so we have turned to aquaculture to produce fish and other seafood for human consumption. Currently, about half of all seafood marketed for human consumption is a product of aquaculture. The idea of combining aquaculture and hydroponics has increased in popularity. This method, called aquaponics, uses the water from fish pools to grow plants in a controlled environment. The waste from the fish is converted to nutrients for the plants. The plants filter the water for the fish. Aquaponics is a sustainable way to produce fish proteins and fruits or vegetables for human consumption. As a science professor teaching a non-majors science course entitled Conservation and the Environment at Herkimer College in Herkimer, NY, I felt it was my responsibility to make my students more interested and aware of their environment. One way I did this was by assigning an aquaponics project among other aquaponics activities. Aquaponics appealed to a wide variety of students because it is based on science, but also has important business and economic value. Students generally not interested in careers in science were educated on an innovative type of farming. Education is the key to awareness and action. Educating community college students on aquaponics is one step in helping to keep our fish populations plentiful and our world healthy and sustainable.

## Keywords

- Aquaponics
- Aquaculture
- Hydroponics
- Education
- Community college

## THE SIGNIFICANCE OF AQUAPONICS

As our global population steadily increases towards 7.5 billion, it is becoming more pertinent to ensure a varied and reliable food supply that can support the growing number of humans. It is necessary for agricultural output of crops to keep up with the increased demand for food, animal feed and alternative fuel sources [1]. Recently and with increased affluence came an increase in meat consumption, including marine organisms such as fish. In many developed countries, seafood is promoted as a healthy alternative to red meat or other sources of protein from animal products. Omega-3 fatty acids found in fish protein are critical for neurological development and health [2]. As a result, the fishing industry has become larger and more efficient, catch has increased, and wild fish populations are having trouble repopulating naturally and in a timely fashion.

Based on data from the United Nations Food and Agriculture Administration, calculations show that 60% of major commercial marine fish stocks are overexploited, recovering, or depleted [3]. Prolonged and intense overexploitation of wild fish populations has delayed population rebuilding and increased uncertainty in predicting recovery times [4]. It is possible to change harvesting strategies to help with rebuilding and reduce the uncertainty in recovery times. However, if fishing and harvesting strategies do

not change, it will be extremely difficult for many of our currently depleted wild fish stocks to recover.

To ensure a constant supply of fish and other seafood despite many collapsing wild fish populations, we have turned to aquaculture. In 2011, the same year the global human population reached 7 billion, nearly half of all seafood consumed by humans was a product of aquaculture [1]. Currently, production via the use of aquaculture is increasing at a rate of about 6% per year [5]. Obviously aquaculture has its benefits, considering the amount of fish and seafood produced in this manner. However, there are several problems associated with aquaculture. Aquaculture facilities produce only seafood, which is just one part of a balanced diet. If fish are grown on an aquaculture farm, they must be fed on a daily basis. In a wild population, fish find their own food. Spread of disease and waste disposal must be highly regulated on aquaculture farms due to high fish density and low genetic diversity. Antibiotic use is essential to prevent the spread of bacterial infections in aquaculture systems. Antibacterial agents are used to prevent or combat pathogens and their overuse can cause adverse effects on human, animal and environmental health [6].

Aquaponics is a relatively new approach to agriculture that combines the techniques of aquaculture and hydroponics [7]. This type of farming is becoming more popular and gaining

attention as an important and potentially more sustainable method of food production [8]. Usually aquaponics farms raise tilapia or similar fish along with leafy green vegetables. The idea is to build a facility such that the water from the fish pools can be circulated through the roots of the plant products, combining fish farming with plant growth. There is much efficiency associated with aquaponics. Because the water is cycled through the system, water use is minimal. The ammonia and nitrite from the fish waste is converted to nitrate, acting as a natural fertilizer for the plants. The plants absorb the nutrients from the water, filtering it for the fish [9]. An efficiently designed aquaponics farm can be thought of as its own ecosystem.

There are some drawbacks to aquaponics farming. For example, you would need a facility to house both fish pools and plant beds in close proximity to one another. Conditions such as light, temperature, and sanitation need to be highly regulated. Diseases or pests can quickly become an area of concern; however soil-borne diseases should not be a problem. Aquaponics farms require fish feeding, close monitoring of bacterial populations and water quality, and water maintenance.

Many commercial aquaponics farms are comparable to small farms in terms of size and gross sales revenue [10]. As with traditional farming or gardening, it is possible to purchase or build residential aquaponics facilities. With the increased interest in organic foods and knowledge of food sources prior to ingestion, it makes sense that residential aquaponics can become a popular and sustainable way of producing fish proteins and fruits and vegetables at home.

## AQUAPONICS IN THE CLASSROOM

As an Associate Professor of Science at Herkimer College, I teach a course entitled Conservation and the Environment. It is a lecture-based course targeted for non-science majors as a science elective. When I began teaching the course I quickly discovered many of the students were taking the course because “they had to”. In other words, the only reason they were there was to fulfill graduation requirements. With all of the environmental problems we are experiencing or expect to experience in the near future, I wanted my students to get more out of my course than simply satisfying a graduation requirement. I wanted them to gain knowledge about their environment and take that knowledge with them. As most students taking the class were not science majors and had career aspirations other than those in the science field, I began focusing the content of the course on environmental issues that could affect the students in their own lives and the things they can do on an individual level to become more sustainable.

At the same time I was developing Conservation and the Environment, an aquaponics farm was being developed in a town about 40 miles from Herkimer, NY. The aquaponics farm gained much local publicity and sparked my interest. In my class, we covered an entire chapter on agriculture and the future of food. The textbook did a nice job of discussing aquaculture [11], but did not discuss in detail any innovative alternatives such as aquaponics. I decided to assign a project in which students were required to read about aquaponics on the Internet and more specifically read some of the local publicity regarding the

developing aquaponics farm in our region. Then I asked the students to write a reflection based on what they had learned.

During the class period in which students submitted their work, we had a short discussion on aquaponics and how they felt about it. It was wonderful to both read and hear the students’ opinions. They were truly interested. Many of them recognized, based on the course content, that we may not be able to continue farming and fishing as we have been and remain sustainable. Herkimer College offers a degree in Business, so several of the students were interested in the business aspect of aquaponics, using the local farm as an example. After the completion of this project, I really felt like I was able to get the students interested in science and to realize that they did not have to be scientists, fishermen or farmers to play a role in the sustainability of our earth’s natural resources.

In addition to the aquaponics project assigned in my Conservation and the Environment course, I was able to take a small group of students, some science majors and some non-science majors, to tour the local aquaponics facility. They were able to learn the process of aquaponics farming and see the set-up and the labor required to run an aquaponics facility firsthand. Around the perimeter of the warehouse in which the aquaponics farm was constructed, the owner had smaller set-ups that were more feasible for a residential or an institutional aquaponics farm. The smaller set-ups could fit in a room or basement in a typical home or a lab space at an institution. This gave the students real-life examples of how they can incorporate aquaponics into their own lives.

Although only a small number of students were able to visit the aquaponics farm, a colleague of mine was able to organize a seminar presented by the owner of the local aquaponics facility. About 50 students attended the seminar. Some were those in my Conservation and the Environment course, others were not. The seminar covered the science, business, and economics of running an aquaponics farm. This appealed to a variety of students.

## AQUAPONICS EDUCATION IS IMPORTANT AND BENEFICIAL TO ALL TYPES OF STUDENTS

Taken together or as individual experiences, we were able to educate many Herkimer College students on aquaponics. When asked about the in class project, students described it as “interesting”, “informative”, and “fun”. Students also said, “I gained a lot of knowledge from it” and “I never knew we could do that”. When asked about the aquaponics tour, students replied that it was “cool”, “really interesting” and said, “thank you for bringing us”.

What I consider one of my greatest accomplishments in terms of reaching out to students regarding aquaponics education is one particular student that I had in my fall 2012 Conservation and the Environment class. He came in as a student interested in environmental science, but not sure how he wanted to pursue it. The aquaponics project really intrigued him. He already had a sixty-gallon aquarium at home. Eventually he used that aquarium to build a small aquaponics set-up in his New York City apartment. He researched building instructions for a residential set-up, went out and purchased supplies, and over the winter break that year he set up a small aquaponics facility in his home.

His mother maintained the facility while he was away for the spring semester. Since then, the student transferred to the State University of New York College of Environmental Science and Forestry to pursue a career in environmental science.

Education is the key to shaping human behavior and developing citizens who willingly behave in desirable ways [12]. It is important to establish a sense of relationship when educating on issues such as environmental care and responsibility [13]. With the human population continuing to grow and more than half of our wild fish stocks overexploited, recovering, or depleted [3] and an increased need for agricultural crops not only for food, but also for animal feed and alternative fuel sources [1], it is desirable to educate college students on alternative farming methods such as aquaculture. In the community college setting, many students plan to graduate and enter directly into the workforce. Knowledge of aquaponics can help students become more sustainable on an individual level and help them to educate others in the future, including their own children. The goal of aquaponics education is to allow students to become interested and aware, regardless of their field of study, so that they may make better-informed decisions in the future and as a population we can become more sustainable.

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