A New Look at NFT Aquaponics

By Wilson Lennard, PhD

Introduction:
In the second half of 2008 I spoke at the Australasian Aquaculture 2008 conference in Brisbane, Australia. There was a full session on aquaponics with about 8 speakers. This meant that aquaponics was well represented at the conference, which in turn, drew people from all over the world to the conference.

One of those people was Ashley Berrysmith. Ashley is an Auckland, New Zealand-based businessman who has a large fresh-cut processing operation, New Zealand Fresh Cuts (NZFC). NZFC grows, processes, packs and distributes bagged, fresh-cut baby leaf greens to New Zealand and Asian supermarkets. He approached me with a very exciting aquaponics project to be based in New Zealand and asked if I wanted to be involved. As I was not working in aquaponics at the time, I jumped at the opportunity to return to my true professional passion.

Ashley is very keen to educate the world in the use of more sustainable farming practices. He is doing this via the establishment of the Berrysmith Foundation; a not-for-profit foundation to encourage the use of sustainable farming practices around the world. Ashley's idea is to educate by example, and therefore he is keen to adopt the most sustainable practices for the production for his salad products. For Ashley, the logical starting point was aquaponics.

The first major project for the Berrysmith Foundation (BF) has been the establishment of a pilot-scale commercial aquaponic system in New Zealand. The uniqueness of the approach is that we have set up a greenhouse that houses an aquaponic system right along side a conventional, standard hydroponic system. With this approach, we are able to directly compare a number of production parameters, and as many plant species as we like, within the two systems. This way, we can collect data to build a technical and economic case for the viability of aquaponics as a legitimate and successful way to farm both fish and plants.

The Systems:
The trial greenhouse has been set up at another highly successful New Zealand based business; Tasman Bay Herbs (TBH), owned and operated by Yoka De Houwer and Don Grant. TBH successfully grows, markets and sells a variety of fresh cut herbs for the NZ domestic market. The growing system TBH uses is the very popular Nutrient Film Technique (NFT), a standard hydroponic approach to culturing plants. TBH has approximately 1,600 m^2 (15,000 sq ft) of plant growing area within their twin skinned greenhouse in which they grow herbs such as Basil, Coriander (Cilantro), Parsley, Dill and Mint, along with a popular Salad mix and Rocket (Arugula).

The trial greenhouse has been divided into two mains sections; the plant growing portion (approximately 160 m^2) and an insulated fish/nutrient room (approximately 50 m^2). The greenhouse section is divided into two halves; the standard hydroponic half and the aquaponic half. Therefore, the Eastern half of the greenhouse is aquaponic plant production (4 NFT benches), and the Western half is standard hydroponic production (again, 4 NFT benches). Because TBH utilises the NFT method for plant culture, the majority of the greenhouse area consists of NFT culturing channels (both the hydroponic and aquaponic sides). In addition, there are two 2m^2 semi-deep flow beds and two 2m^2 Ebb & Flow tables for seedling production. Therefore, all growing systems are replicated for both hydroponic and aquaponic growing techniques.

The nutrient room consists of, as mentioned, a structure which has been divided off as a separate room and insulated. This room contains the nutrient sump and dosing unit for the hydroponic system and a fish system for aquaponic nutrient provision. While the greenhouse has been designed to run hydroponics and aquaponics half and half, the fish system has been designed to a size that will enable the entire greenhouse to act as an aquaponic system if required. In addition, the plumbing of the greenhouse has been designed so that it may also be run entirely as a standard hydroponic greenhouse if required.

The Design Approach:
As opposed to most current commercial aquaponic system models which utilise the highly successful and practical Deep Flow or Raft Culture plant culture approach, this system utilises the NFT plant culture approach. NFT has been adopted as the predominant plant culture method for several reasons:

1. NFT is what is used at TBH and therefore, the hydroponic expertise available via Yoka and Don may be fully utilized.
2. NFT is one of the most often used hydroponic culturing approaches for commercial hydroponic plant culture and in my mind therefore, needs to be explored fully for its potential to aquaponic adaptation.
3. I have developed a commercial aquaponic system design philosophy and approach which allows me to adapt ANY hydroponic culturing method to aquaponics, so this project has allowed me to test my theories with the NFT technique.

NFT as the hydroponic component has been utilised in aquaponic systems before with varying success. However, NFT appears not to be favored among many aquaponic researchers and operators for various reasons. I have heard and been directly told several reasons why NFT is an inferior or less preferred hydroponic component for aquaponic systems, including:

1. Deep Flow affords more water volume in the system, which makes it easier to operate and allows for “more room for mistakes,” while NFT has far lower water volumes.
2. NFT requires additional or more refined filtering components. Usually increased solids filtration and the addition of a separate biofilter, which increases expense.
3. NFT uses small diameter feed lines (4 – 5 mm black poly tubes as used for drip irrigation systems) and these block too easily and increase maintenance.

People who know me understand that I am always “up for a good argument.” Therefore, when statements like those above are put forward, I am keen to test these things for myself. I set about designing the aquaponic system using my Symbioponics™ design approach. This approach is based on completely balancing fish nu-

Photos on right:
1. *Finished greenhouse*
2. *Completed fish system*
3. *Solids filter manifold*
4. *Hydroponic System Sump & plumbing*

trient output with plant nutrient uptake, so that the system works as efficiently as possible and there is no possibility of positive or negative nutrient accumulation within the system. Aquaponic fish to plant ratios have not been well researched to date, with only my good friend and colleague Dr Jim Rakocy (of the University of the Virgin Islands) and myself (as far as I am aware anyway) developing commercial fish to plant ratio models. As many people know, the commercial aquaponics world is rightly dominated by Dr. Rakocy's model, which has been around and completely successful far longer than anyone else's, including mine. I want to make it very clear here, my management approach to aquaponics is almost identical to what is currently utilized by many commercial aquaponic designs, including Rakocy's. The major technical difference in my approach is that I always utilise a separate biofilter and fine solids filtration in my designs; no matter what hydroponic component. In addition, I also utilise 100% solids mineralisation with ultimate return of all nutrients bound in the solid fish waste component to the system. This approach allows what I think are several advantages:

1. Both components (fish and plants) may be decoupled from each other whenever required and can/do operate independently of each other if required. I believe this is important in a commercial situation because it allows fish or plant production to continue when and if there are any problems with the other component.
2. The fish component is not dependent on the plant component for biofiltration requirements and therefore, any hydroponic component configuration, including NFT (which usually has too little surface area to often meet the system biofiltration needs) may be adapted to the aquaponic system.
3. I can "retrofit" existing aquaculture and hydroponic facilities to be aquaponic while utilizing the existing equipment, therefore making the conversion to aquaponics more economically viable.

So, I designed an aquaponic system that utilizes NFT as the primary and dominant plant culturing component for the project trials.

First aquaponic crop of Tasman Bay Herbs spring lettuce mix.

Current Outcomes:

The systems (both hydroponic and aquaponic) have been up and running now for approximately 13 weeks. The hydroponic component has had a very good workout and shakedown by being used for the entire month of December to assist TBH with its pre-Christmas rush for product for the market. We have produced large quantities of fresh herbs over a 5 week period. All herbs have grown very well and have met all the growth rate and quality requirements of Yoka and Don at TBH, and were successfully integrated into the TBH production line.

The aquaponic system has had fish (Grass Carp – chosen because it is a vegetable eater and one of the core interests in the trial is to try and produce a fish feed made from the green waste produced from the system) in it for over 3 months now, but few plants, because my management approach is to build a background of fish waste nutrient in the system for several weeks before adding plants to the system. This means as soon as plants go in, there is sufficient quantity and mixture of nutrients in the system to produce good plant production results. Therefore, we have not utiliszd the entire aquaponic plant growing area available but have tested two major crops (the TBH Salad blend and Dill) with excellent results (150 bunches of Salad mix and 300 bunches of Dill). The Salad blend grew from seed to harvest size in 5 weeks, as did the Dill.

Of course, the purpose of any trial is to test hypotheses and to gain information. While we are just at the beginning of all of the plant growth trials we wish to run in the greenhouse over the next 12 months, I have been able to discern several important outcomes to date.

1. While not scientifically measured (with associated statistical analysis) the plants in the aquaponics are growing as well as the plants in the standard hydroponics.
2. The plants tested (TBH Salad blend and Dill) have thus far met all TBH quality requirements based on

aroma and flavor.

3. Because of the lowered system volume when compared with Deep Flow culture, NFT aquaponics builds system nutrient levels much faster.
4. NFT systems (whether hydroponic or aquaponic) grow plants very well and very quickly.
5. NFT is an easy system to use and operate as the plants grow at a good working height.
6. NFT aquaponic feed lines appear to not block any more frequently than NFT hydroponic feed lines, however, more time is required to get a fuller understanding of this phenomenon. The blocking of feed lines, as stated above, is an often quoted draw back of NFT for aquaponics. However, seasoned hydroponic NFT operators will also tell you that hydroponic NFT feed lines block on a very regular basis and checking feed lines is one of the most important maintenance issues. In addition, usually two feed lines are used in case one blocks.
7. The Symbioponics™ method has predicted fish to plant ratios for zero nutrient accumulation (ie: nutrient can be managed to reach a certain level and then be maintained at that level indefinitely – meaning zero nutrient accumulation) very well and system nutrient levels and mixture are very easy to manage and control.

Top: Hydroponic dill and coriander
Bottom: Inside the greenhouse

The success of my approach in terms of design has been very pleasing and because I have also built the entire systems by myself, there is a high amount of personal satisfaction. As I said above, my approach to aquaponic design was developed so any fish or plant could be grown aquaponically with fine nutrient level control and no positive or negative nutrient accumulation. I believe this is vital to the long term efficient and successful operation of commercial aquaponic systems, because if the system is not balanced, nutrients will either build up in the system (too many fish scenario) and high nutrient levels can cause problems for both fish and plants, or nutrient levels will not ever build up enough (not enough fish scenario) and therefore, plants will not grow properly or quickly enough for commercial viability.

In conclusion, it has been very satisfying to be given the opportunity to design, build and test my approach to commercial aquaponics with a hydroponic component configuration I have never used before (NFT). I now await to see the outcomes of the numerous plant growth trials we plan to do with the system to show that aquaponics grows plants as quickly as, and to the same quality as, a standard hydroponic system. In addition, I am keen to see how the aquaponic system operates over an extended period of time; the true test of any aquaponic system!

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About the Author: *Wilson Lennard, PhD, has been studying aquaponics for the past 8 years. He is a PhD graduate from RMIT University in Australia. Wilson has practical experience and knowledge of commercial aquaponics and is the director of Aquaponic solutions. He can be reached by email at: willennard@gmail.com.*