

# Friendly Aquaponics, Inc.

## 2010 Commercial Aquaponics Training

You'll learn what we learned at the excellent University of the Virgin Islands 2007 Aquaponics Short Course, which cost over \$4,000 with travel, lodging, rental car, and food. This was for ONE participant. In addition, you'll learn everything we learned this past two years building and operating five aquaponics systems, a tilapia hatchery and nursery, a Health Department Certified vegetable processing facility, and most recently, a taro aquaponics system that enables anyone to grow wetland taro. See below for complete training outline.

We will show you how we got our aquaponics farm USDA Organic Certified AND Food Safety Certified (no small feats!)

We built our systems for less than one half what systems built to the UVI specifications would have cost in Hawaii. This saved us about \$100,000 in our three systems. We'll show you how to value engineer your system to save you up to \$30,000 over what it would cost to build to the UVI design.

Because of the way we value-engineered our systems for electrical economy, ours use half of the electricity the UVI systems use. This saves us \$6,800 per year on three systems. Forever. You will learn how to do this. In addition, you will learn about our newer Low-Density systems (LD) that use one-fifth of THAT amount of electricity (or ONE-TENTH the electricity the UVI systems do) for the same vegetable production.

We will show you how to build a tilapia hatchery for under \$2,000. We spent over \$40,000 on our own hatchery before discovering how to build this simple, elegant hatchery system!

This Commercial Aquaponics Training includes four full days of classroom instruction with daily trips to our farm for hands-on experience with aquaponic systems. Training site is North Hawaii Education and Resource Center (NHERC), in Honoka'a on the island of Hawaii (Big Island).

The Commercial Aquaponics Training written material includes: a step-by-step "Construction Manual" that makes it easy for anyone to build a system; a set of detailed CAD drawings, piping and wiring schematics; a materials and equipment list with pricing and sources to make procuring system components easy; an "Aquaponics Course Manual" covering all aspects of aquaponics, including day-to-day operation of the system, and an operations manual with checklist covering the day-to-day operations of a commercial aquaponics system. The plans include complete plans and materials lists for three different sizes of aquaponics systems: a 32-raft system (1,024 square feet), an 8-raft system 256 square feet), and a 2-raft system (64 square feet), so you can easily build a small, inexpensive system to gain experience and confidence with aquaponics, then graduate to the larger systems.

This year we have added a fifth day to the training. Friday the 23rd will feature a workshop on methane-producing biodigesters given by David House (author of "The BioGas Handbook"). This workshop will cover building, operating, and using the methane from a biodigester (for purposes of heating, powering engines and generators, and more) with working biodigesters demonstrating biogas principles, and a methane-powered electric generator producing our aquaponics farm's electricity during the hands-on session in the afternoon. The Friday methane workshop is an additional \$175 for aquaponics workshop participants, but can also be attended separately at a cost of \$250 for the day and class materials.

For an additional fee, you can have plans custom drawn for your site (including engineered plans for electrical, mechanical, and civil engineering, if your project is a large one) with a detailed, customized materials list specific to your project. We are happy to make site visits.

**Dates and Times:** April 19-22, 2010, 8am-5pm daily.

**Location:** The Commercial Aquaponics Training will take place at the North Hawaii Education and Resource Center (NHERC), in Honoka'a. There will also be daily trips to our farm in Honoka'a, with hours of hands-on learning. (If you are coming from off-island, please email for local vacation rentals/hotels. We can also coordinate car-pooling between those with rent-a-cars and those without).

## **Your Personal Trainers for the Commercial Aquaponics Training:**

**Susanne Friend**, the owner of the company (with degrees in biology and chemistry) is your personal trainer for questions and issues regarding organic certification, plant and fish diseases, sales and marketing, value-added processing, fish hatchery and nursery design and operation, water and aeration questions, and water quality questions.

**Tim Mann (technical staff)** has been doing architectural and civil engineering design and drafting since 1990, and was an authorized AutoCad dealer for 7 years during that period. Tim handles comprehensive system design and site-specific aquaponics questions as well as technical issues having to do with tank, piping, aeration, pumping, and electrical design. Tim also supplies civil, structural, electrical, and mechanical engineering services through the consultants he works with, at very reasonable package prices for those projects needing code-compliant plans and certifications for their local building departments.

## **Introduction**

You will build the aquaponics systems that change the way the world grows its food, so that everyone has enough to eat. To do that, you need to understand systems.

I had a sail making business that depended on my 92-year-old, cast-iron Singer sewing machine. One day it froze up in the middle of a seam, when I had a deadline and was already feeling less than totally relaxed and confident that I would get the job done. I didn't know how to fix it, so I sat and stewed.

Then I decided to take the whole thing apart.

I disemboweled the machine. I took it completely apart. I figured out how it worked; how the different parts related to one another; where it was adjustable. It took some time: I spent four hours doing this. Then I found the teeny piece of thread in the guts of the machine that had made it freeze up. The next time the machine froze, it took only five minutes to fix. Now I can fix and adjust any sewing machine because I understand how they work. Understanding the system gave me the keys to the kingdom.

Aquaponics is a revolution in food production and food freedom comparable to what the world saw with the advent of personal computing. The difference is, this revolution will affect how we grow and create food for ourselves and others. We don't know where it will lead, but we do know that producing our own quality food, instead of just hoping giant agribusiness companies will do it, is a GOOD idea. When you understand how aquaponics systems work, you will have the tools with which to start the revolution.

Finally, thank you from the bottom of our hearts for supporting us in our commitment to this new and exciting method of food production. We will do everything in our power to make sure you get more than your money's worth from this training.

- **PLEASE NOTE:** Our farm's three commercial-scale systems for raising fish and vegetables are based on the University of the Virgin Islands (UVI) systems with modifications of ours that make them as high-yield as possible while still having reasonable construction and operating costs. They operate with a high fish loading of 1.5 lbs of fish per square foot of raft area in the system (we'll refer to this as High Density, or HD, throughout this course).

Since our last Commercial Training (in October '08), we built and operated our 256 square foot Family/Off-Grid System. It is as simple and economical an aquaponics system as we know of. It maintains the same production levels of vegetables as our commercial systems (HD), and reasonable production levels of fish. Because its stocking range is a fish loading of 0.3 lbs of fish per square foot of raft area in the system, we call it an LD system, for Low Density. If stocked at this density level, it functions affordably at low levels of electrical consumption as an off-grid system with the addition of wind or solar power.

After operating this LD system for ten months, we consider the technology to be solid and are including it in this manual. To be conservative, you may consider it EXPERIMENTAL. However, the four new 36-raft systems we are installing now are based on this LD technology.

We are continuing research in this area in an effort to design systems that produce more, at a lower cost to build and operate. This course contains information about these LD systems, as well as the well-proven HD systems we have been operating for 22 months now that are based on the University of the Virgin Island's (UVI) design. If you decide to build one of these newer LD systems, please stay in touch with us as we will freely share ongoing results and developments in this research project to make sure you have the best information possible.

# Table of Contents

**Introduction** Page 5

## **I. Aquaponics In Our World**

A. How To Have Fun And Make Money With Aquaponics Page 6

1. Features
2. Benefits
3. Energy Implications
4. Quick Summary of Aquaponics' Applications
5. Glossary of Terms and Definitions

B. Short Overview Of Aquaponics Page 11

1. General Principles
2. Different Kinds Of Systems Available; Pros and Cons
3. How Do You Find The Aquaponics System That's Right For You?

## **II. Technology, System Processes, and Water Chemistry Page 15**

A. Friendly Aquaponics Technology

1. How We Got Started
2. Things To NOT Do
3. Our Philosophy and Systems: Low Density and High Density (LD and HD)
4. Value Engineering: Reducing Costs Using Alternatives
5. Electrical Requirements and Alternate Energy
6. Dealing With Climate: Greenhouses, Fish Houses, and Insulation

B. System Proportions, Sequences, Processes, and Scaling Page 30

1. LD/Off-Grid Systems
2. HD Systems
3. In the Hydroponic Troughs
4. Nutrient Levels and Requirements, LD and HD
5. How To Scale A System Larger Or Smaller

C. System Water Chemistry Page 39

1. City Water, Ag Water, and Bad Water
2. Measurement Methods
3. High and Low Limits
4. Temperature's Effects on Operation, Aeration, and Nutrients
5. Additions
6. Sludge Use And Precautions
7. System Overflow For Irrigation, Discharge Requirements

### **III. System Startup, Operation, and Maintenance Page 42**

#### **A. System Startup**

1. Verify Water Quality And Fill Up
2. Get Fish: You Need The Fertilizer
3. Do Nothing: The Three-Month Startup
4. Inoculate: The Five-Day Startup
5. Helping Your Fish Survive The Nitrite Spike

#### **B. Daily Page 45**

1. Feeding/Observation
2. Sampling/Measurements/Record Keeping
3. Checking/Cleaning

#### **C. Weekly Page 47**

1. Harvesting Fish/Restocking/Carrying Capacity of Systems
2. Harvesting Vegetables/Replanting
3. Nutrient Adjustment/Cleaning the Net Tank (in HD Systems)

#### **D. Monthly Or Longer Page 50**

1. Maintenance/Repairs

#### **E. System Catastrophes And Recovery Techniques Page 50**

1. Water Loss Or Water Circulation Loss
2. Air Supply Loss
3. Power Loss

### **IV. Vegetables Page 52**

#### **A. Plant Selection**

1. General Types, What Grows Well
2. Screen House or Special Techniques Required
3. Not-So-Well and Why
4. Planting Trials Results
5. Climates' Effect on System Operation
6. Future Trials Planned

#### **B. Sprouting And Planting Systems Page 63**

1. Germination And Types Of Seeds
2. Conventional Sprouting On Greenhouse Tables
3. Sprouting In Aquaponics System Rafts
4. Sprouting Table System In Aquaponics' Sideflow
5. Planting Out
6. Raft Size/Hole Spacing And Cycling Tricks

### C. Harvesting and Processing Tips And Tricks Page 66

1. Cut-And-Come-Again
2. Remove And Sell Whole
3. Remove And Process
4. Pick Vegetables/Remove Unwanted Growth
5. Value-Added Processing

### D. How To Sell Vegetables Page 67

1. Do Your Homework: Sell It First Then Grow It
2. Direct-To-Consumer: Farmer's Markets And CSAs
3. To Wholesaler/Distributor
4. To Retailers
5. To Restaurants/Hotels
6. How Big? Size Your Operation Correctly For Your Market

## V. Fish And Aquatic Species Page 71

### A. Aquatic Species In Our Systems

1. Tilapia *tilapia* sp.
2. Chinese Catfish *Clarius fuscus*
3. Malaysian Giant River Prawn, Wild River Prawn
4. Mosquito Fish
5. Water Fleas/*Gammarus*
6. Species For Your Location (and NOT For Your Location)

### B. Temperature Ranges And Growth Page 77

1. The Relationship Between Feeding, Growth, and Temperature
2. Hotter Is Better For Fish
3. Cooler Is Better For Vegetables
4. What Is Your Ambient? Plan Your System And Market Accordingly
5. Fish Disease Problems

### C. Stocking And Grow-Out Strategies And Systems Page 79

1. Batch Stocking and Harvesting
2. Continuous Biomass Loading (CBM)
3. Where Do You Get The Fish To Stock With?
4. What If You Don't Have A Hatchery Nearby?
5. Some Interesting Things We Noticed About Tilapia

### D. Harvesting For Different Stocking Methods And Markets Page 83

1. Live Harvesting Versus Dead/Chill Harvesting
2. Purge Tank/ Saltwater Purge Tank
3. Harvesting Batch Stocked System
4. Harvesting Continuous Biomass Loading System

### F. How To Sell Fish Page 84

1. Whole Fish Direct-To-Consumer: Live-Haul Tank, Chilled
2. Specialty Ethnic Markets
3. To Wholesaler/Distributor
4. To Retailers/Hotels/Restaurants
5. Value-Added Possibilities And Requirements

## **VI. Regulations And Other Hoops Page 85**

### A. Statutory Requirements

1. County Building Department Regulations
2. National Resource Conservation Service (NRCS)
3. State Health Department Requirements For Wastewater
4. State Agriculture Department Plant Quarantine Branch Regulations
5. Processing Requirements For Vegetables
6. Processing Requirements For Fish

### B. Organic Certification / Food Safety Certification Page 89

1. What Are They? Benefits And Market Preference
2. Organic Certification
3. Food Safety Certification

### C. Business Information For The Aquaponics Operator Page 99

1. Small Business Help Available and General Advice
2. State Extension Agents: Agriculture, Aquaculture, State Fish Vet
3. How To Apply For Loans: If You Need It, You Can't Get It

## **VII. Current Research Page 104**

### A. Low-Density (Fish) Recirculating Aquaponics Systems

1. Application of a Simplified System to Back Yard Use
2. Off-Grid or Low-Energy-Use Aquaponics Systems

### B. Taro In Aquaponics Systems Page 105

1. Year's History Of Our Taro Research

### C. Alternate Fish Foods Page 106

1. Black Soldier Fly Larvae
2. Duckweed
3. *Hibiscus manihot*

## **VIII. Future Research And Development Page 107**

### A. Systems For Developing Nations

1. Modification Of Techniques To Use Cheap Materials

2. What Staple Plants And Aquatic Species Are Usable
3. Alternatives To Energy-Intensive First-World Techniques

B. Spin Off Industries/Businesses Page 108

1. Fish food/Animal food processing plant
2. Coco fiber collecting and processing
3. Hatcheries for Prawns, Tilapia, Catfish, Aholehole, Anae, Awa, Koi
4. Seed Farming For Aquaponics and Other Producers

**Addendum A:** Page 109

Small Business Resources in Hawaii; List of Services and Government Help

(If you are NOT in Hawaii, this list is still a good guide as to what State and Federal agencies exist that you can obtain assistance from).

**Addendum B:** Page 111

Aquaponics system monitoring and recording form that we use

**Addendum C:** Page 112

Aquaponics Spreadsheet Calculator Printed Version (Courtesy Marcus Spallek)

**Addendum D: DVD with Electronic Files:**

Aquaponics Spreadsheet Calculator (Courtesy Marcus Spallek)

Generic Aquaponics Business Plan

Aquaponics system monitoring and recording form that we use

Dr. Steven Summerfelt article on CMSGH

Dr. Nick Savidov article on cold-weather growing