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Aquaculture Hydroponics Aquaculture Hydroponics

AQUAPONICS Journal®

The Voice of the Aquaponics Industry

Issue #62 1st qtr, 2013

Aquaponics in Indonesia, Underground and Veggies in Space! This issue demonstrates the global applications and growth of the aquaponics industry!

Aquaponics is the combination of aquaculture (fish farming) and hydroponics (growing plants without soil).

Editor's Note:
This issue of the Aquaponics Journal represents global advancements in aquaponics, with coverage on aquaponics from Indonesia, Australia, Afghanistan, the US and beyond. As we move into 2013, we are seeing a marked increase in the awareness of aquaponics and in the number and diversity of discussions related to aquaponics in the news, social media and at conferences and educational forums and events.

Here in Wisconsin, the International Aquaponics Conference: Aquaponics and Global Food Security, is being planned for June 19-21, 2013. The conference will take place at the University of Wisconsin-Stevens Point and it will include the first meeting of the International Aquaponic Society, a foundation dedicated to aquaponics research and education.

The International Aquaponics conference has a fantastic line-up of speakers who will cover topics ranging from Controlled Environment Agriculture to Aquaponics and Food Safety. In addition to the diverse group of speakers with expertise in aquaponics, the conference will welcome a special guest speaker, Joel Salatin, who is know for his contributions to the local food movement and sustainable agriculture methods. Read more about it on page 4.

Best wishes for success in aquaponics,
Rebecca

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On the cover:

Harvesting fish from the simplified aquaponic system in Bangka Belitung, Indonesia. See related story on page 30.

Industry News

International Aquaponics Conference, June 19-21, 2013

Stevens Point, WI, USA— The University of Wisconsin-Stevens Point will host its first international gathering of aquaponics experts on June 19-21.

"The International Aquaponics Conference: Aquaponics and Global Food Security" will bring together individuals with the goal of making an impact on food quality, security and sustainability using aquaponic methods, in which fish and plants are grown together in a symbiotic environment. Industry experts will share experience and knowledge in a fun and informative conference setting, providing participants a wealth of information on the rapidly growing aquaponics industry.

Those who should attend include current and prospective aquaponics growers, educators, ministers of agriculture, government representatives and those who manage agriculture, food and health regulations.

Conference highlights include:

- the latest in aquaponic technology, methods and applications;
- information from industry experts about aquaponics and how it is feeding people around the world;
- discussions on its use in commercial, education, mission and integrated systems as well as food safety, fish feeds and regulations;
- a poster contest and prizes for student aquaponics research;
- demonstrations by local chefs on a variety of ways to prepare aquaponically grown fish and vegetables, with samples of the culinary creations;
- tours of a 5,000-square-foot aquaponic greenhouse;
- a Wisconsin-style picnic featuring samples of the state's finest cheese, bratwurst and beverages; and
- the launch and first meeting of the International Aquaponic Society, a UWSP Foundation organization dedicated to aquaponics research and education.

The conference will include the latest in aquaponic technology, methods, applications and regulations; a student research poster contest; demonstrations by chefs on preparing aquaponically grown products; tours of an aquaponic greenhouse; a Wisconsin-themed picnic; and the first meeting of the International Aquaponic Society.
For more information and registration, visit www.uwsp.edu/AquaponicsConference or contact UW-Stevens Point Continuing Education at 1-800-898-9472 or 715-346-3838.

The International Aquaponic Society, in partnership with the University of Wisconsin Stevens Point, is dedicated to aquaponics research, education and science-based, economically-viable aquaponic systems. The society is supported, in part, through a UWSP Foundation fund.

Industry News

WI Gov. Walker Signs New Aquaculture Bill Into Law

Madison, WI, USA—On Monday April 2, 2012, Governor Walker signed the Aquaculture Bill, officially called 2011 Wisconsin Act 207. In addition to having a significant impact on lessening regulations, this bill also has the distinction of being one of the most supported, uncontested bills in recent legislative sessions. It had broad bipartisan co-sponsorship and passed the full legislature unanimously.

Wisconsin Governor, Scott Walker, center, signing the new aquaculture bill into law, along with representatives from the state and the Wisconsin Aquaculture Association.

This bill has significant features for Wisconsin aquaculture relating to Natural Water Body permits, record confidentiality, import permits, sales records, and permits and fees impacting some commercial farms:

1. Natural Water Body Permit does not expire (this is no longer a recurrent renewal date) unless the department determines that there has been a substantial change in circumstances. There will also be no public hearings or no notice given to any person other than the applicant before issuing a natural waterbody permit.
2. There will be confidentiality of records relating to information kept by the Wisconsin Veterinary Diagnostic Laboratory (WVDL) relating to identification of fish farms or testing results except if the laboratory determines it is necessary to protect public health, safety or welfare.
3. In general, you can now import fish or fish eggs into Wisconsin without an import permit, if they are from a fish farm, are going to a registered Wisconsin fish farm, and have a fish health certificate. There will still be import permits for fish or fish eggs that are going directly into waters of the state including activities for the Department of Natural Resources.
4. Fish farms are still required to keep records on purchases, sales and production of fish and fish eggs, but now records will not be required for sales of fish to an individual for the individual's personal use (these fish or fish eggs cannot be introduced into a public water body).
5. Fish farms (and State Hatcheries) that previously were required to have a Wisconsin Pollutant Discharge Elimination System *(WPDES)* permit will now be issued permits in accordance with Concentrated Aquatic Animal Production Facilities (CAAPF) as listed by the Federal Government in 40 CFR 451.10-541.11. Of important notice, these permits are best management based, and the requirements cannot be more stringent than the federal rules; additionally, no fees can be charged as previously done under the wastewater discharge environmental section.

This legislation, along with the pending changes to DATCP's Animal Health Rules (due out this June), will provide a more positive business climate for aquaculture in the state by encouraging existing farms to invest in expansion and spurring growth in new start up farms; this will contribute to more aquaculture production, increase jobs and the state's economy.

For more specifics on Act 207, go to http://docs.legis.wisconsin.gov/2011/related/acts/207 or call one of the Aquaculture Extension Specialists (Ron Johnson 715-373-2990, or Jim Held 920-648-2902).

Industry News

Aquaponics Project Launched at Cylburn Arboretum

Johns Hopkins University, Baltimore, MD, USA — The Johns Hopkins Center for a Livable Future formally launched its new Aquaponics Project at Baltimore's Cylburn Arboretum with a grand opening ceremony held in October, 2012.

The Aquaponics Project is raising about 400 tilapia and producing several hundred pounds of organic produce, all within a 1,200-square-foot greenhouse. The fish and produce are expected to be sold at local farmers markets and through area fish markets. Surplus output will be donated to local emergency food providers.

David Love, of the Center for a Livable Future, at Cylburn Arboretum, home of the Aquaponics Project.

The Center for a Livable Future developed this plan to demonstrate the potential of recirculating aquaculture for water-efficient and ecologically sound fish production. The project fits into CLF's larger goals of highlighting potentially sustainable alternatives to our dominant methods of food production and could become a model for local entrepreneurs and backyard hobbyists.

Aquaponics combines aquaculture (fish farming) and hydroponics (soil-less plant production), a process in which the fish waste becomes fertilizer for the growing plants. The system produces two income streams: from fish and from vegetables/greens.

CLF renovated an unused greenhouse at Cylburn, temporarily donated by Baltimore City's Department of Recreation and Parks, and outfitted it with Nelson and Pade, Inc.'s Clear Flow Aquaponic Systems®, which include two 150-square-foot hydroponic grow beds and four 210-gallon fish tanks. Tilapia were introduced into the tanks in June and are expected to begin reaching market weight by January. The grow beds are producing a variety of vegetables and herbs, including lettuce, kale, celery, basil, eggplant, and okra.

The project is open to the public on Wednesdays from 10 a.m. to noon, or by appointment (contact farm manager Laura Genello at lgenello@jhsph.edu).

Courtesy John Hopkins University, Office of Communications

Industry News

USDA Finalizes New Micro Loan Program

MEMPHIS, TN, USA—Jan 15, 2013- Agriculture Secretary Tom Vilsack today announced a new microloan program from the U.S. Department of Agriculture (USDA) designed to help small and family operations, beginning and socially disadvantaged farmers secure loans under $35,000. The new microloan program is aimed at bolstering the progress of producers through their start-up years by providing needed resources and helping to increase equity so that farmers may eventually graduate to commercial credit and expand their operations. The microloan program will also provide a less burdensome, more simplified application process in comparison to traditional farm loans.

"I have met several small and beginning farmers, returning veterans and disadvantaged producers interested in careers in farming who too often must rely on credit cards or personal loans with high interest rates to finance their start-up operations," said Vilsack. "By further expanding access to credit to those just starting to put down roots in farming, USDA continues to help grow a new generation of farmers, while ensuring the strength of an American agriculture sector that drives our economy, creates jobs, and provides the most secure and affordable food supply in the world."

The new microloans, said Vilsack, represent how USDA continues to make year-over-year gains in expanding credit opportunities for minority, socially-disadvantaged and young and beginning farmers and ranchers across the United States. The final rule establishing the microloan program will be published in the Jan. 17 issue of the Federal Register. The interest rate for USDA's new microloan product changes monthly and is currently 1.25 percent.

Administered through USDA's Farm Service Agency (FSA) Operating Loan Program, the new microloan program offers credit options and solutions to a variety of producers. FSA has a long history of providing agricultural credit to the nation's farmers and ranchers through its Operating Loan Program. In assessing its programs, FSA evaluated the needs of smaller farm operations and any unintended barriers to obtaining financing. For beginning farmers and ranchers, for instance, the new microloan program offers a simplified loan application process. In addition, for those who want to grow niche crops to sell directly to ethnic markets and farmers markets, the microloan program offers a path to obtain financing. For past FSA Rural Youth Loan recipients, the microloan program provides a bridge to successfully transition to larger-scale operations.

Since 2009, USDA has made a record amount of farm loans through FSA—more than 128,000 loans totaling nearly $18 billion. USDA has increased the number of loans to beginning farmers and ranchers from 11,000 loans in 2008 to 15,000 loans in 2011. More than 40 percent of USDA's farm loans now go to beginning farmers. In addition, USDA has increased its lending to socially-disadvantaged producers by nearly 50 percent since 2008.

Producers can apply for a maximum of $35,000 to pay for initial start-up expenses such as hoop houses to extend the growing season, essential tools, irrigation, delivery vehicles, and annual expenses such as seed, fertilizer, utilities, land rents, marketing, and distribution expenses. As their financing needs increase, applicants can apply for an operating loan up to the maximum amount of $300,000 or obtain financing from a commercial lender under FSA's Guaranteed Loan Program.

USDA farm loans can be used to purchase land, livestock, equipment, feed, seed, and supplies, or be to construct buildings or make farm improvements. Small farmers often rely on credit cards or personal loans, which carry high interest rates and have less flexible payment schedules, to finance their operations. Expanding access to credit, USDA's microloan will provide a simple and flexible loan process for small operations.

Producers interested in applying for a microloan may contact their local Farm Service Agency office.

The Obama Administration, with Agriculture Secretary Vilsack's leadership, has worked tirelessly to strengthen rural America, maintain a strong farm safety net, and create opportunities for America's farmers and ranchers. U.S. agriculture is currently experiencing one of its most productive periods in American history thanks to the productivity, resiliency, and resourcefulness of our producers.

USDA is an equal opportunity provider and employer. To file a complaint of discrimination, write: USDA, Office of the Assistant Secretary for Civil Rights, Office of Adjudication, 1400 Independence Ave., SW, Washington, DC 20250-9410 or call (866) 632-9992 (Toll-free Customer Service), (800) 877-8339 (Local or Federal relay), (866) 377-8642 (Relay voice users).

Industry News

Industry News

New Multi-Ion Meter From Clean Grow

Nutrient management is even more critical for the management of aquaponics systems than either aquaculture or hydroponics alone. Vital nutrients for plant growth can be toxic to aquaculture and the perfect balance is essential to avoid loss of plants or fish. In aquaculture, effluents accumulate in the water which increases the toxicity for fish. This water is led to a hydroponics system where the by-products from the aquaculture are filtered out by the plants as vital nutrients, after which the cleansed water is recirculated back to the fish in a symbiotic relationship – a relationship which can easily be disturbed. Problems such as an electrical failure or a pipe blockage can lead to a complete loss of fish stock.

A revolutionary new device manufactured by CleanGrow in Ireland is ideal for nutrient management in aquaponics systems. This device is a probe incorporating up to six sensors for synchronised real-time measurement of the concentration of six different ions / nutrients including calcium, chloride, potassium, sodium, ammonium and nitrate. The sensors can measure the nutrients in a broad concentration, pH and temperature range.

Typically aquaponics users send their water samples to a laboratory to be analysed where it may take a few days to receive back data. CleanGrow's multi ion probe can save a lot of time and money and enhance overall productivity by catching problems before it is too late.

The meter is about as easy to use as a pH meter and follows a simple calibration process followed by sample measurement, all in less than five minutes. Data can be stored on the handheld meter and easily transferred to a PC using CleanGrow's MeterLink software whereby further analysis can be undertaken.

The sensors are fabricated using carbon nanotube technology which allows the manufacture of six very small sensors in one probe of 16 mm diameter. The probe requires virtually no maintenance as it is all solid state; it can be stored dry and does not require any filling solution.

CleanGrow launched the product at the Horti-Fair trade show in Holland and were the only non-Dutch company to get into the final ten for Product / Innovation of the Year and achieved fourth place overall. CleanGrow have now set up a number of distributors around the world and their kit is currently being used in a number of universities, research laboratories and with an increasing number of growers and companies in the UK, USA, Asia and Europe.

More information on CleanGrow and their products can be found at http://www.cleangrow.com/.

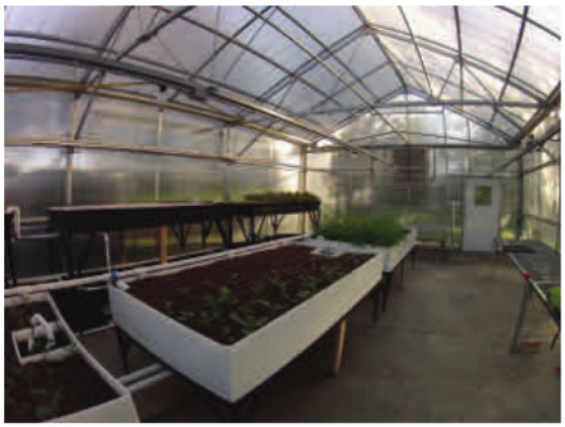
California Teen Launches Aquaponics Program at Del Oro High School

By Rebecca Nelson

Aquaponics has become a passion and platform for learning for Pierre Beauchamp, a 17 year old student at Del Oro High School in Loomis, California. It all began when Pierre, then 13 years old, along with his parents, Jerome and Mary, and two sisters, attended a short course on hydroponics at the University of Nevada-Reno. The course inspired the family to build an 800 square foot greenhouse at their home.

Initially, hydroponic systems were installed and the family enjoyed seeing the rapid plant growth and the productive water-based culture. During this time, Pierre was inspired to build additional hydroponic systems and enjoyed the challenge of designing and engineering the systems. But, the reliance on mined and manufactured fertilizers made them continue to look for other solutions.

After a few years of hydroponic growing, Pierre learned about aquaponics and was anxious to give it a try. He converted one of the hydroponic systems to aquaponics, added fish and watched it grow. He was impressed with how well it all worked, without the need for fertilizers or daily tweaking of the fertilizer recipe.



A variety of vegetables growing in the aquaponic system designed by Pierre Beauchamp at Del Oro High School, Loomis, CA

Over past four years, Pierre has designed and built seven aquaponic systems in the family's greenhouse, experimenting with different designs, concepts and methods. The aquaponic systems have provided an abundance of fresh vegetables and fish for his family and friends and, in operating the systems, Pierre has gained knowledge and a great appreciation for the science and engineering involved in aquaponics. He realized that an aquaponic system could be a great learning tool for a school and, in noticing the Del Oro High School greenhouse being under-utilized most of the year, he hatched a plan to introduce aquaponics to his High School, FFA and community.

Agriculture Teacher and FFA Advisor, Regina Dvorak, shares, "When Pierre approached me about giving up half the greenhouse growing space to build the aquaponics project, I was honest about the need to maintain some space for the student plant propagation projects, the need for involvement in our local chapter of the National FFA Organization and the current limitations of energy supply, but he was undaunted."

The aquaponic system is comprised of a 200 gallon stock tank for the fish (bottom left), media beds filled with expanded clay for filtration and plant growth (right) and raft tanks (left) for additional plant growth.

Pierre, along with Dvorak, went to the school board and presented the concept of setting up an aquaponic system in the greenhouse. Pierre was able to show the school board the concept and design he put together, as well as show photos of the systems he had built at home. Pierre's mission for Del Oro High's aquaponics project is to create an economically sustainable program in which the FFA will reap the benefits.

The fresh vegetables grown in the proposed system would be used in the school cafeteria and also sold in a CSA (Community Supported Agriculture) program and at local farmer's markets. The aquaponic system that Pierre designed has a water capacity of 1000 gallons and can produce 350 heads of lettuce every 6 weeks, 300 bunches parsley every 3 months and 100 lbs of catfish each year.

Dovorak explains, "That was the catalyst for all the rest to come. One board member personally donated $500 to get Pierre started. Once word of the project spread, we discovered how impressed people were with the idea of raising food for the school and its potential for learning on many levels. It only took a few months to raise enough funds to start putting the plans into action, so Pierre came up with a budget for supplies and began the process of finding and ordering these materials. Pierre drew up plans and worked with several students in the school welding shop to design and fabricate the tables that would hold the 6 grow beds."

"We have had several community members step forward to offer their expertise and have involved interested students every step of the way from learning about electricity, pumps and water quality to the reality of metal construction and the physics of volume and pressure. After 6 months of gathering supplies and building the foundation of the system, Pierre began actual construction of the project during the late nights of July and August. We had water flowing when school began in the fall and were planting seeds not long thereafter."

Since the goal was to sell the fresh vegetables to the school cafeteria, the school was required by the county to apply for a permit and develop a food safely plan. Once this was completed, the aquaponics project was ready to supply greens for the cafeteria salad bar once a week and to sell to local families.

The project is bringing together students, educators and the community as people learn about it and want to be involved. Jeff Tooker, Assistant Superintendent of Schools, Placer Unified School District, comments, "There is a lot of excitement at Del Oro High School right now with the aquaponics project. It is galvanizing this community. There are so many cross over skills, from science and math, the agriculture program is going to be very exciting. This could potentially be a great pilot program for other schools around the country."

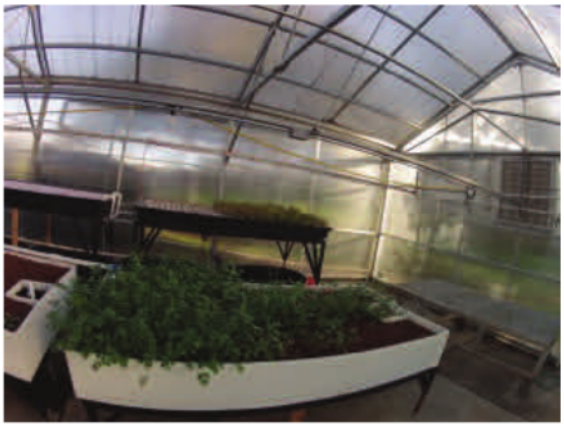
Although Dan Gayaldo, the Principal of Del Oro High School, was skeptical of the proposal at first, he is now very enthusiastic and sees the progression from a concept to an active food production system to be a fantastic learning tool for Pierre and other students. He explains, "It is something they can see, they can learn how the process works. It is hands on which gets people of all ages engaged. I can just feel the synergy that is growing in our community and on our campus."

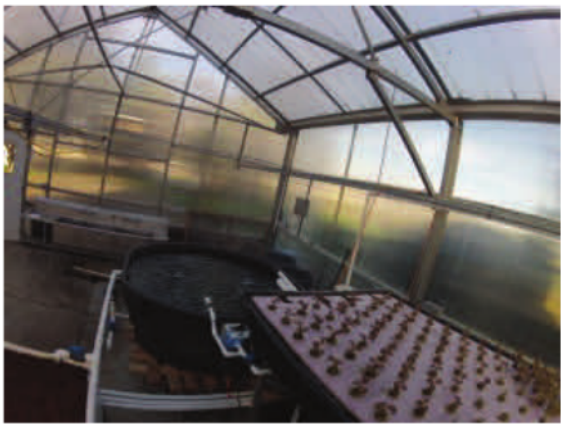
The system is stocked with 200 catfish that reside in a 300 gallon stock tank. The water is pumped from this fish tank into beds that hold expanded clay. Additional plant production is achieved by floating rafts on the surface of water in the raft tanks. Plants are grown on these rafts, with the roots dangling into the water.

This past summer, Pierre was awarded the 2012 Sea World / Busch Gardens Environmental Excellence Award in the "educator" division, the first time in the 13 year history of the award that a "student" was awarded the "educators" award. Pierre was invited to the National Science Teachers Association conference in Indianapolis to accept the award.

Shortly after that, Regina Dovorak, nominated Pierre for the Global Green International-Citizen Entrepreneur Award, and he received the 2nd place award. As a result, Pierre was invited to the International Eco-Summit Conference in Rio De Janeiro Brazil as a U.S. student delegate.

Regina Dovorak comments, "Pierre is a remarkable young man who is intelligent, learns quickly and is genuinely concerned about the future of our natural resources. He is capable of seeing how the intricate parts of a system work as well as how the overall purpose of a system can be achieved or improved. He has impressed his teachers and his peers yet remains humble about his accomplishments. I am proud to be his advisor/teacher and am looking forward to his successes to come, for he is just getting started."





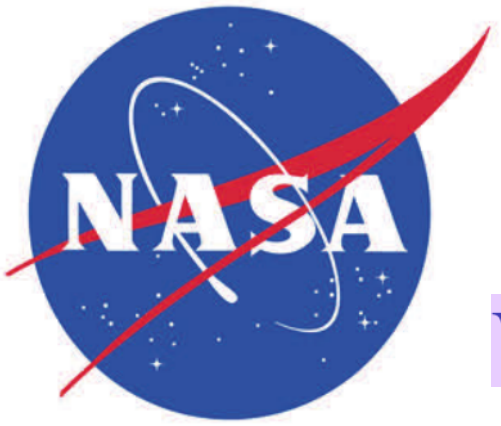
Top: Parsley growing in the media beds (foreground). Lettuce growing ni the ratf tanks (back ground.

Bottom: the water flows back to the fish tank after passing through the raft tanks, in which plant roots dangle into the water, drawing out

Pierre is interested in physics, technology, science and engineering and he is currently working on designing small aquaponic systems that can be used in schools and by gardeners interested in sustainably raising fresh fish and vegetables. Then next phase of the project is to establish a "how to" manual that includes lessons across curricular areas and begin implementing those very ideas on campus. Pierre comments, "What is good for me is to take what I've learned and apply it somewhere else."

Dovorak adds, "So far, the system has proved to be fascinating to students and visitors who come to see it and has become educationally valuable to the agriculture education and FFA program at Del Oro High School. I am excited about the exposure and growth that this project has created and, more importantly, the potential it holds to teach young people the value of and need for sustainable food production systems."

For more information, visit deloroaquaponics.com, the website that Pierre and his classmates have developed to showcase their efforts.



NASA's VEGGIE Program Will Put Fresh Vegetables in Space

International Space Station—With all the prepackaged gardening kits on the market, an exceptionally green thumb isn't necessary to grow your own tasty fresh vegetables here on Earth. The same may hold true for U.S. astronauts living and working aboard the International Space Station when they receive a newly developed Vegetable Production System, called VEGGIE for short, set to launch aboard SpaceX's Dragon capsule on NASA's third Commercial Resupply Services mission next year.

"Our hope is that even though VEGGIE is not a highly complex plant growth apparatus, it will allow the crew to rapidly grow vegetables using a fairly simple nutrient and water delivery approach," said Howard Levine, Ph.D. and chief scientist, NASA's Kennedy Space Center International Space Station Research Office.

Gioia Massa, a postdoctoral fellow in the Surface Systems Group of Kennedy's Engineering Directorate, has been working with the International Space Station Research Office to validate the VEGGIE hardware here on Earth before it takes flight next year. "VEGGIE could be used to produce faster-growing species of plants, such as lettuce or radishes, bok choy or Chinese cabbage, or even bitter leafy greens" Massa said. "Crops like tomatoes, peas or beans in which you'd have to have a flower and set fruit would take a little longer than a 28-day cycle."

It may not sound like a big deal to us Earthlings who can just run out to our local produce stand or supermarket when we have a hankering for a salad, but when you're living 200 miles above the surface of the planet, truly fresh food only comes a few times a year. "When the resupply ships get up there, the fresh produce gets eaten almost immediately," Massa said.

Weighing in at about 15 pounds and taking up the space of a stove-top microwave oven, the stowable and deployable VEGGIE system was built by Orbital Technologies Corporation, or ORBITEC, in Madison, Wis. The company designed the system to enable low-maintenance experiments, giving astronauts the opportunity to garden recreationally.

"Based upon anecdotal evidence, crews report that having plants around was very comforting and helped them feel less out of touch with Earth," Massa said. "You could also think of plants as pets. The crew just likes to nurture them."

In simple terms, the VEGGIE system works like this: Clear Teflon bellows that can be adjusted for plants as they grow are attached to a metal frame housing the system's power and light switches. A rooting pillow made of Teflon-coated Kevlar and Nomex will contain the planting media, such as soil or claylike particles, along with fertilizer pellets. Seeds either will be preloaded in the pillows on Earth or inserted by astronauts in space. To water the plants, crew members will use a reservoir located beneath the pillows and a root mat to effectively add moisture through an automatic wicking process.

VEGGIE is set to join other plant growth facilities that vary in size and complexity, such as the Lada greenhouse unit and the ABRS, short for Advanced Biological Research System. VEGGIE is the simplest of the three designs, but has the largest surface area for planting and is expected to produce data on a more regular basis. Levine noted that the ability to grow plants in microgravity has really evolved throughout the past decade.

Image above: Crops tested in VEGGIE plant pillows include lettuce, Swiss chard, radishes, Chinese cabbage and peas. Image credit: NASA

"What's interesting is that plants breathe, just like humans," Levine said. "Initially, biologists tried to grow plants in sealed compartments but that didn't work because without continuous airflow bringing carbon dioxide and oxygen to plants for respiration, they won't thrive."

An added benefit of the VEGGIE system is that it requires only about 115 watts to operate, less than half the energy it takes to power a desktop computer and monitor. The blue, red and green light-emitting diodes, or LEDs, are bright enough for crops to grow, but energy efficient enough for a place where power is at a premium.

"We really only need the red and the blue LEDs for good photosynthesis, but we have the option of turning the green LEDs on, which will make the overall light look white, making the plants look green rather than purple," Massa said.

Once the facility reaches the station, astronauts will unpack it and install it into one of the station's EXPRESS racks. Then, they'll report back to Kennedy's International Space Station Research Office about the setup and work that goes into planting, maintaining and harvesting the crops, as well as the effort that goes into pillow disposal and sanitation.

Mary Hummerick, a microbiologist at Kennedy, will be awaiting swab samples and frozen plant tissues to return from space so she can analyze them for bacteria and microorganisms that could adversely affect the crew. If those numbers are acceptable, NASA could give the go-ahead for crews to start eating what they grow.

NASA is looking into other ways to use the VEGGIE facility once its operation is validated on the first flight to the station. "You could have bio-behavioral studies on the effect of growing edible plants compared to ornamental plants with flowers, nutritional studies, psychological studies, or you could grow herbs like mint and basil," Massa said.

The agency recently released a NASA Research Announcement asking for those types of proposals from peer-reviewed researchers to join in with their own VEGGIE experiments. Prospective researchers also will have to detail their plans for involving students in K-12 classrooms and how their experiments would help teach kids about science, technology, math and engineering, or STEM.

"There's definitely an outreach component to VEGGIE and we're looking at reaching the up-and-coming generation with STEM activities," said Levine. "We're leaving it up to the researchers to propose how to engage and enthuse a significant number of students with their experiments."

While a successful run of VEGGIE would open innumerable possibilities for future experiments, the near-term goal will be seeing whether the hardware performs as expected on the station come next year.

Breakthrough in Aquaculture Feed Research Shows Promise of Soy-Based Feeds

The U.S. Soybean Export Council (USSEC) announced today feed trial research results that attain a major goal for sustainable marine fish aquaculture: producing farmed marine fish with a wild fish in/farmed fish out (FIFO) ratio of less than 1:1.

The amount of fishmeal and fish oil from wild-caught sources used in farmed fish feed has been a concern for the long-term sustainability and scalability of aquaculture. Marine species, such as salmon, tuna, and yellowtail are higher up the food chain, and require diets comprised mostly of proteins and oils. These are usually in the form of fishmeal and fish oil derived from smaller fish lower on the food chain, such as anchovies and menhaden.

However, these wild fisheries cannot be scaled up to meet the feed demands of a growing global aquaculture industry. Much innovative research has taken place in the past decade to find alternative sources of proteins and oils in an effort to increase the sustainability of aquaculture and reduce pressure on wild forage fisheries.

Over the past five years, U.S. soybean farmers have sponsored a series of feed trials for farmed marine fish to test the use of soy ingredients as a replacement for fishmeal and fish oil. Recent trials conducted by Kampachi Farms in Hawaii, collaborating with the University of Nebraska, have produced farmed carnivorous fish with a FIFO ratio of 0.89:1.

"We're very excited with this research and the promise it holds for the future of aquaculture," said Michael Cremer, USSEC's Technical Director for Global Aquaculture. "Soybeans are particularly rich in nutrients that produce healthy and safe farmed fish, and unlike wild resources, can scale up to help aquaculture meet increased demand for seafood."

An eight-month feed trial in 2011 tested an experimental diet of 40% soy protein concentrate (SPC) and a 50:50 blend of fish oil and high Omega-3 soy oil against a standard commercial feed traditionally used to raise kampachi (a sashimi-grade Hawaiian yellowtail). With taurine (a non-essential amino acid) added to the SPC diet, the kampachi showed improved growth rates. Also, in controlled taste tests, consumers could not detect any difference from fish raised on a conventional diet.

"Attaining a FIFO of under 1:1 has been the holy grail of marine fish feed research for some time," said


Soy Bean plants

Neil Anthony Sims, President of Kampachi Farms. "We show here that we can produce premium, sashimi-grade fish with a net increase in marine proteins: that is, we produce more fish than our fish eat. This represents a significant step forward for the economics and the ecological efficiencies of marine fish culture. This research is truly the marriage of America's heartland with her blue horizons." This year, Kampachi Farms will run trials to test refined diets with the SPC and soy oil, as well as incorporating a strain of microalgae into these experimental feeds as a natural source of taurine and EPA/DHA (the heart-healthy Omega-3 fatty acids found in fish oil). Future research will also include a market analysis of the cost effectiveness of these diets. For more information, visit www.soyaqua.org .

About USSEC - The U.S. Soybean Export Council connects U.S. soybean farmers with opportunities to improve human nutrition, livestock production and aquaculture. This mission is accomplished with a science-based technical foundation and a global network of partnerships including soybean farmers, exporters, agribusiness and agricultural organizations, researchers and government agencies. USSEC operates internationally and works with aquaculture programs in different nations to help ensure sustainability and profitability for industry producers. USSEC programs are partially funded by the United Soybean Board (USB).

About USB: USB is made up of 69 farmer-directors who oversee the investments of the soybean checkoff on behalf of all U.S. soybean farmers. Checkoff funds are invested in the areas of animal utilization, human utilization, industrial utilization, industry relations, market access and supply. As stipulated in the Soybean Promotion, Research and Consumer Information Act, USDA's Agricultural Marketing Service has oversight responsibilities for USB and the soybean checkoff.

About Kampachi Farms -Kampachi Farms is a Kona-based mariculture company focused on expanding the sustainable production of the ocean's finest fish. Through innovative research and application of the best available science, Kampachi Farms aims to further develop offshore technologies, alternative marine fish diets, and new species for culture to help drive the expansion of responsible mariculture in the U.S., and the world.

SOURCE U.S. Soybean Export Council

Aquaponics at the Survival Condo

Nelson and Pade, Inc., the world's largest and most experienced provider of aquaponic systems and technology, has designed, built and installed a unique underground aquaponic system at the Survival Condo in Glasco, Kansas. The Clear Flow Aquaponic Systems® will be used to grow fish and vegetables in a sustainable, soilless environment.

The Nelson and Pade Team, unloading the aquaponics systems in preparation for the installation.

The Clear Flow Aquaponic Systems® will produce a continuous supply of fresh fish and a variety of vegetables including lettuce, herbs, tomatoes, beans, peas, peppers, cucumbers and more. Aquaponics is an integrated system in which the fish waste provides the fertilizer for the plants and the plants help to purify the water for the fish. It is a soilless farming method that does not require the use of pesticides, herbicides or chemical fertilizers. Full spectrum LED grow lights will be used to provide adequate levels of light for the plants. The lights will turn on and off automatically, to mimic natural sunlight.

Assembly of the fish and filter tanks that will provide fresh fish and vegetables to the residents of the Survival Condo.

The Survival Condo is an engineering marvel designed for comfortable long-term survival in a former Atlas missile silo. It offers spacious condos with many amenities including luxury living space and a community swimming pool, dog walking park, rock climbing wall, theater, general store and an aquaponic farm, among other features, all of which are underground and encompassed by walls that are 2.5 – 9 feet thick. The aquaponic systems

fill two floors of what was formerly the control center and will provide a continuous supply of fresh, all natural fish and vegetables to the condo owners.

The Atlas missile silo, which was built in the 1950's as part of the US and the Soviet Union's "mutual assured destruction" doctrine, will now provide protection and safety in the face of a natural or man-made catastrophe. The Atlas missile program was decommissioned in the 1960's. The missiles were then removed from the silos and used in the US space program and to launch satellites. The silos were abandoned and some of them were later sold.

Larry Hall, Developer of the Survival Condo, Rebecca Nelson and John Pade, Nelson and Pade, Inc. (left-right). Inside the aquaponics bays at the Survival Condo in

One of the silos in rural Kansas was purchased by Larry Hall, the founder and developer of the Survival Condo. Five years ago, Mr. Hall conceived the idea to use the underground infrastructure to provide shelter and has been working tirelessly to design, engineer and build the 7 floors of condos, all circular in design inside the Atlas silo, and to integrate components to provide energy, security, air filtration and food. The total occupancy will be 50-60 people, all of which will live in and participate in the operation of the facility when in lock-down status.

John Pade, co-founder of Nelson and Pade, Inc. and designer of Clear Flow Aquaponic Systems®, comments, "Aquaponics is a viable and sustainable food production system. The installation of our system in a underground setting at the Survival Condo is a great example of the potential to use aquaponic technology to provide fresh fish and vegetables in nearly any environment."

Nelson and Pade, Inc., the leader of the aquaponics industry, offers complete aquaponic systems, consulting and extensive training programs. Clear Flow Aquaponic Systems® by Nelson and Pade, Inc. are very efficient and dependable and are available in all sizes for applications such as home food production, commercial ventures, education and social programs.

Nelson and Pade, Inc. has had individuals from 28 countries and 49 US states attend their Aquaponics and Controlled Environment Agriculture Course and they have co-developed the first-of-its-kind aquaponics course with the University of Wisconsin-Stevens Point. For more information on aquaponics and Nelson and Pade, Inc., visit: http://www.aquaponics.com or call 608-297-8708.

The Survival Condo has been featured on the Discovery Chanel, ABC News, Fox News and in many other media outlets including the New York Times and Popular Science. For more information, visit: http://www.survivalcondo.com

Effects of Different Plants on Nitrogen Content and Tilapia Growth

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Introduction

Tilapia (*Oreochromis niloticus*) has a high economic value and is an important commodity in freshwater trade in Indonesia. This because, it has a) a relatively high resistance to water quality and disease, b) has wide tolerance to environmental condition c) has an efficient ability to form high-quality protein from organic materials, domestic and agricultural waste, d) have the ability to grow well, and easily grown in intensive aquaculture systems (Sucipto, 2007).

Along with the rapid increase in the development rate of aquaculture, there are consequences that we must face, such as the shrinking of water resources, particularly in urban areas. In fact, water is one that can be used to support daily human activities, including aquaculture. Aquaponic technology is one alternative solution to be applied to solve the problem. In addition, using aquaponics will gave the fish farmer an extra income from the crops they plant (Nugroho and Sutrisno, 2008).

In intensive aquaculture the comparison of fish and water is generally more than the amount of fish and water in nature. Hence, ammonia production is high. These could be reduced using plants to absorb ammonia. Therefore, the objectives of this study are to assess the effectiveness of Water spinach (*Ipomoea aquatica*) and Mustard greens (*Brassica juncea)* on removing NH_3 and NO_3 production and fish growth.

Materials and Methods

Research was conducted in the Laboratory Animal Breeding and Reproduction and Laboratory Water and Aquatic Sciences and Marine Biotechnology, Faculty of Fisheries and Marine Sciences, University of Brawijaya.

The treatments in this experiment were using two different plants: water spinach (treatment A) and mustard greens

Figure 1. The beginning of experiment; with plants (left and middle) and without plants (right)

(treatment B) and one control/no plant (treatment C). All the treatments were repeated three times. Tilapia (*Oreochromis niloticus*), 29-35 g in size, were used as the protein producer. The fish were acclimated for one week before experiment. Pumice was used as the filter and substrates for the plant.

The experiment began with the following stages:
1. Planting mustard greens and water spinach of 8 plants each aquarium.
2. Stocking tilapia into the aquarium with a density of 25 fish/m^2
3. Daily feeding twice a day for 1 month
4. Measuring water quality parameters on ammonia, nitrate, and growth rate. These parameters were calculated every 10 days.

Fish growth was calculated as SGR (Specific Growth Rate) as follows:
$SGR = [(\ln W_2 - \ln W_1) / (t_2 - t_1)] \times 100$

Where: W_1 = initial weight
W_2 = weight at the end of the experiment
$t_2 - t_1$ = the experiment duration

Data collected were analysed using ANOVA.

Results and Discussions

Ammonia (NH_3)

The ammonia measured was Total Ammonia Nitrogen. No significant difference between treatments in ammonia concentration. The average Ammonia were in the normal range for Tilapia to live ranging from 0.1-0.49 ppm which were under the toxic level for larvae (1.007 ppm and fingerlings (7.39 ppm) respectively (Benli and Köksal, 2005). Excessive levels of ammonia in water can cause disturbance to the fish. One effect, the most significant is the damage to the gills, so that the consequences will be disrupted fish respiration (Limbong, 2005).

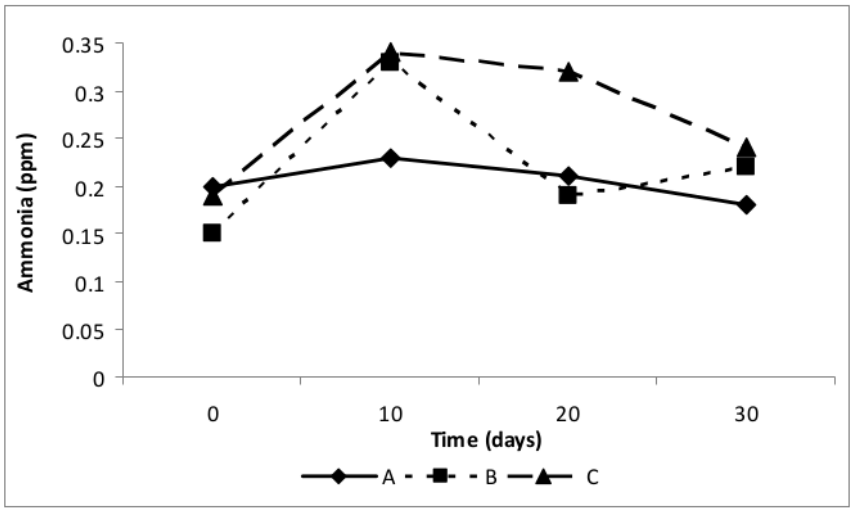

Figure 2. Ammonia ± SEM content during experiment

Water spinach is more efficient in removing ammonia than mustard greens (Figure 2). In treatment B, there was an increase in ammonia production due to high feces accumulation and inefficiency on ammonia absorption of mustard greens.

Nitrate (NO_3)

The figure shows that the administration of plant affects in nitrate content. Treatment A (water spinach) was significantly different from treatment C (control), but not significantly different with treatment B (mustard greens). However, treatment B (mustard greens) was not significantly different from treatment C (control). This is possibly because the number of water spinach leaves was more than mustard greens which will affect on higher photosynthesis rate. The process of photosynthesis requires sunlight, carbon dioxide, and water containing nutrients (nitrate) and chlorophyll. This shows that the water spinach is efficient in taking nutrients (nitrate) from the derived fish feed and feces.

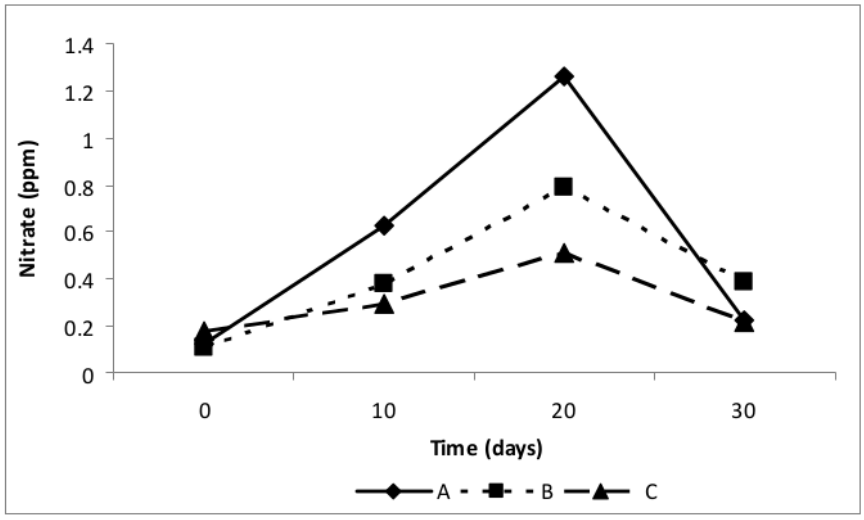

Figure 3. Nitrate ± SEM content during experiment

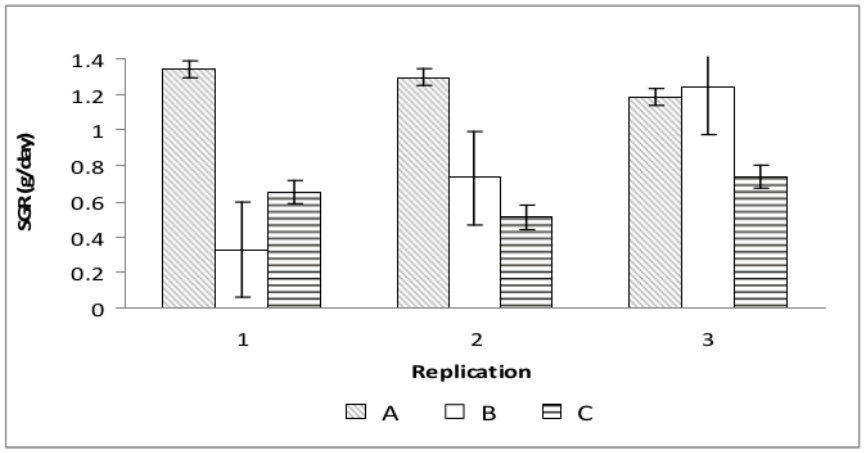

Figure 4. SGR ± SEM of Tilapia in the experiment

Nitrate produced through nitrification process in the filter tub used as a source of nutrients by plants. Rakocy, *et al.* (2006) explained that the high nitrate concentrations will promote leafy green vegetables. This is an essential part in an aquaponic system. The Nitrogen removal mechanism could be from plant uptake (Rogers, *et al.*, 1991) by absorbing nitrate in the tissues (Mckane, *et al.*, 2002; Miller and Bowman, 2002).

Filters in the form of pumice planted vegetables, can reduce the content of N (nitrogen) for 45-75% of tank water. With the design of sedimentation tanks and biofilter, water spinach can provide a positive influence that is capable of reducing the nitrogen content of water from the filter of 30-35% (Nuryadi, 2008).

SGR (Specific Growth Rate)

The figure 4 shows that there is no significant difference between treatments. However, water spinach has higher growth rate effect on fish than mustard greens. This might be due to the high Nitrate and low Ammonia content. The water spinach having more leaves than mustard greens. The photosynthesis process requires sunlight, carbon dioxide, and water containing nutrients (nitrate) and chlorophyll. So, there is a taking process on nutrients (nitrate) derived from the remaining feed and fish feces.

Conclusion

The water spinach is more efficient in absorbing ammonia Nitrogen and produce more Nitrate Nitrogen than mustard green. However, it is still needs to assess the ammonia nitrogen removal efficiency rate and nitrogen absorbance process.

The growth rate of tilapia in aquaponics was not significantly different in all treatments, but the water spinach provides relatively higher growth than the mustard greens

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Clontarf Beach SHS Includes Aquaponics in Marine Science

By Geoff Wilson.

Fresh-water aquaponics teaching in Australia has taken a significant step forward with a new unit soon to be officially-opened at Clontarf, a bayside suburb just north of Brisbane. It was inspected recently by Australia's Prime Minister, Julia Gillard and local Federal Member for Petrie, Yvette D'Ath.

The aquaponics unit is part of the newly-built, A$1.97 million Science and Marine EcoCentre at Clontarf Beach State High School, funded by the Australian Government under its A$16.2 billion Building and Education Revolution (BER) program.

Proud principal founder of this important new start for aquaponics in Australian high school teaching, Adam Richmond, is the Marine EcoCentre Co-ordinator. He and his head of department, Ms Carie Tye, collaborated in the project. Ms Tye suggested a dedicated room for aquaculture- but Adam wisely expanded this to aquaponics – recognising the wider and superior teaching potential of combined aquaculture with horticulture – emulating "Mother Nature".

Adam said: "I had heard that aquaponics was an important teaching unit idea that well-incorporated aquaculture, and well-introduced sustainability into a teaching program. I love fish, and my old classroom had several aquaria in it. So I convinced Ms Tye about an aquaponics teaching unit alternative to mere aquaculture."

"We applied for BER funding for a marine education centre, because we had recently refurbished the school's science labs. The application won approval, and is now ready for both it's marine science teaching role and its better teaching of science and maths (plus other school subjects) via aquaponics."

The turn-key aquaponics unit at Clontarf Beach's new Science and Marine EcoCentre was supplied by aquaponics equipment specialist Murray Hallam, founder of Practical Aquaponics, at North Macleay, just south of Brisbane.

It comprises three fish tank units and three raised growing beds for plant-growing based on nutrients converted from fish wastes. It is a well-respected Hallam design that is both simple and most workable by students and hobbyists.

Adam Richmond (left) and one of his students, Lexus Hughes.

The fish species currently used at the Science and Marine Eco Centre at Clontarf is the high omega-3 oil Queensland fish, Jade Perch (*Scortum barcoo*). Formerly known as Barcoo Grunter, this fish is drawn from the Barcoo River system in north-central Queensland.

Jade Perch as a species is native to the harsh Lake Eyre and Bulloo-Bancannia catchments of inland Australia, where the natural habitat includes low-gradient rivers and creeks. Waters are generally highly-turbid, and have a wide temperature and conductivity range. Clontarf Beach High School is believed to the first teaching organisation to adopt Jade Perch as its principal fish species. Limited (but exciting) commercial experience suggests that Jade Perch is well suited to production in well-managed recirculation tank systems with effective biological filtration.

Jade Perch is most notable as being the world's fish with the highest natural omega-3 oil content in its flesh – more than 2,000 milligrams per 100 grams – compared with the average for other fish species of 50 to 100 milligrams. This huge human dietary advantage for both commercial and hobbyist growers of the fish, is expected to trigger significant expansion of its specialised culture in aquaponics.

Medical scientists now estimate that about 70% of the world's population is deficient in omega-3 oil in its diet. Jade Perch can thus be expected to be a widening teaching advantage for Adam Richmond and his developing team at Clontarf Beach State High School.

In the hydroponic growing of plants on fish wastes (converted to plant food by micro-organisms), Clontarf has three raised plant-growing beds that are testing different growing media. Common vegetables, such as lettuce, are now grown by students as they learn how to simply manage the three streams – fish production, microflora acting upon fish wastes, and growing of plants from the changed wastes. Water is recirculated constantly.

Two growing beds have expanded clay bead media bought for about $1,000 from Aquagardening, a hydroponic supply shop. Another growing bed has "salt-and-pepper" granite chips bought from Clontarf Landscaping for $110. The two kinds of plant-growing media will clearly show students that "traditonal soil" is not necessary in water-based urban agriculture if plants have simple root-support and are supplied with adequate water and nutrients.

Costs of maintenance, and fish and food purchases for the project, come from the science faculty budget of the school. The school's Home Economics Department has offered to supply herbs and spices for aquaponics growing, and this could pioneer some new teaching. Adam said he intended to have a saltwater tank too, and may yet grow mangroves or seaweed or marine worms. "That's another reason why I have an open space in the corner," he said.

One of the subjects offered at Clontarf Beach is Marine & Aquatic Practices (MAP)- which incorporates freshwater studies. Adam observed that most schools teaching aquaculture had freshwater systems only.

Asked about his plans for teaching marine and ecology science at Clontarf Beach Adam said : "I involve all my classes, but at this stage it has been a case of making sure that it will work. Year 11 Marine studies and MAP classes test water quality, and will observe fish husbandry. Year 12s currently make aquaria, and are involved with maintenance tasks.

"There is potential for Biology classes to use the plant and fish culture side of things for EEIs (extended experimental investigations) too. So, about 60 students are being taught this year, and the potential is to extend teaching to more than 200 students a year," he said. Current teaching staff in the Eco Centre is Adam and his colleague, Mr Matt Feeney.

"We have a third marine teacher coming on board next year," Adam explained. "Science studies at Clontarf Beach has a laboratory technician involved with the practical activities, and a teacher aide.

"The students maintain tanks, clean glass, feed fish, and to weed and plant the grow-beds. The lab assistant helps by feeding fish on holidays, as do the cleaners - but sometimes it does seem like it's just me", Adam said ruefully!

This is a common observation among initiators of aquaponics teaching units at high schools – and is a problem that needs to be better understood and addressed. Aquaponics teachers need to offload many routine tasks in the interests of teaching efficiency – and less take up of their week-end and other recreational time.

Adam's qualifications include a BSc in marine biology, a Diploma of Education (secondary teaching), a MEd (Science education), 13 years classroom teaching experience and a number of awards for excellence in teaching. Before full-time teaching he worked in garden centres, and has part-time experience in a fish and produce shop while studying at university.

"I keep fish recreationally, I like fishing and gardening, and am a member of marine and environmental groups, he said. This includes Aquaponics Network Australia, and organisation being set up to service information needs of high school science and maths teachers.

What is Adam aiming to achieve in education with the aquaponics unit ?

"I like the sustainability side- and respect for life. Kids can see that their food doesn't start at a suprmarket. The 'food miles' in providing lettuce to the school tuck shop are pretty low too.
At this stage, any additional educational impact is a bonus - but we have used the system for directly teaching nitrogen and carbon cycles,"he said.

What is the total educational program for the Clontarf Beach centre ?

"I don't think this has ever been determined," Adam replied. "I teach Science, Marine Studies and Marine and Aquatic Practices. The centre is just part of the wider school at this stage. An expanded aim may be something for us to work on," Adam said.

Certainly closer alliances with home economics and small business studies are indicated. But the significant advance in high school teaching of science and maths at Clontarf Beach has begun to attract the interest of fellow teachers.

"I have had visits from Susan Kennedy Smith, science advisor of the Queensland Education Department, Peter Watts from St Patricks College, Grant Smith from Palm Beach Currumbin School, Ward Nicholas from Heatly SHS, Townsville (who is currently regional Science Advisor). The Prime Minister, Julia Gillard and Member for Petrie, Yvette D'Ath, have visited, as have Redcliffe Environment Forum members, and local primary school teachers. Also, I have had many email enquiries from teachers in other states of Australia," Adam said modestly.

Responses to his advanced thinking about improving science and maths teaching are now likely to escalate as this successful BER project is opened officially soon, and as word spreads. Clontarf Beach State High School (CBSHS) was opened 1964. It is a co-educational, public high school. Current Principal is Lisa Starmer. The school's enrolment is now around 1,250 students, where before it was just above 1,000.

The lower student attendance a few years ago had good reasons. In 2008 Clontarf Beach High School was in the news for being in the most disrepair – and suffering from asbestos problems.

Since then money has been spent on making the school safe for students and in upgrading classrooms. The school has built new tennis and futsal courts on the school oval and converted old tennis courts into a one-of-a-kind Marine Science EcoCentre that includes an aquaponics teaching unit.

This units's construction was funded by the Building the Education Revolution (BER) program, which is the single largest element of the Australian Government's $42 billion Nation Building - Economic Stimulus Plan, with around 24 000 projects being delivered in every community across Australia. Other aquaponics teaching units are likely to be similarly funded throughout Australia.

The $16.2 billion BER program aims to modernise schools through the delivery of necessary infrastructure and, by doing so, support local jobs and stimulate investment. The BER is now in its most dynamic phase with construction underway in thousands of schools across the country. In many locations, students, teachers and their communities are already enjoying the benefits of recently-completed projects delivering world-class, 21st century facilities for Australia.

This is despite there being severe political complaints about a percentage of poorly run and overly-costly projects. The less-publicised view is that despite some problems the BER program has been highly successful in transforming Australian education.

Top: One of the Queensland Red Claw fresh-water crustaceans that are part of the aquaculture of the aquaponics unit at Clontarf Beach State High School. Bottom: One of the six-month old Jade Perch fish (formerly known as Barcoo Grunter) now being grown at Clontarf Beach State High School.

The still-modest aquaponics unit at Clontarf Beach State High School is perceived to be the beginning of an important new trend in Australian education – to improve science and maths teaching within existing subjects. Aquaponics teaching is expected to have an important side-benefit for all its students – much-improved knowledge about sustainability of human progress and best utilisation of renewable resources close to where we live and work.

Many high school aquaponics enthusiasts have testified to me that at least 5% of students learning about aquaponics have been motivated to setting up simple units at home for production of healthy, fresh food. That is a most important new trend too.

Further information: http://www.clonbeacshs.eq.edu.au/

Geoff Wilson is director of Aquaponics Network Australia, an organisation for informing both high school science and maths teachers of the instructional benefits of integrated urban aquaponics. A retired journalist in agribusiness, he was a founding director of Qponics Limited, a Brisbane-based company that will use advanced aquaponics for production of omega-3 oil and high-value fish feed protein from algae. Email: wilson.geoff@optusnet.com.au

Aquaponics in Afghanistan

Bunker side garden serves as test bed for small-scale Afghan agriculture

By Army Journalist Dave Melancon

It is not the biggest farm in Afghanistan, but it is one of the newest and perhaps, one of the more experimental.

Tucked away next to a shaded break area and concrete bunker on the east side of the U.S. Army Corps of Engineers Afghanistan Engineer District -South compound on Kandahar Airfield, half of a 300-gallon plastic water tank sits on a shipping pallet. Mounted on another pallet, about a foot above the tank is the other half filled with golf ball-sized gravel. The lower tank is about 80 percent filled with water; and a system of recycled garden hoses and household plumbing keeps the water flowing from the lower tank onto the rocks in the upper.

Sticking through the stones are plants - lettuce, peppers, broccoli and rebar-staked tomato plants. A couple dozen tadpoles graze on the algae growing in the lower tank's sides and bottom. Penny Coulon, a district contracting officer representative, combined hydroponics and aquaculture to create the south district's first-ever aquaponics garden.

Coulon, who deployed to Afghanistan from the USACE Sacramento district, said she stumbled upon the idea for an aquaponics garden in Afghanistan while researching different gardening systems for her home garden. Aquaponics seemed ideal because of its simplicity, chemical-free fertilization, fewer weeds and insects and no bending requirement.

"I figured I could kill two birds with one stone," she said. "I can have the fish and I could have vegetables as well. Then, I thought, this could work here."
Aquaponics is an entire food production system combing aquaculture -raising of aquatic animals such as snails, frogs, fish, crayfish or prawns in tanks --with hydroponics, a water-based plant cultivation method. The animals - in this case native Afghan tadpoles - live in the water, food plants grow in the rock.

"The fish produce waste. You then pump that water to the plants," Coulon said. "The plants clean the water because they use the fish waste as their fertilizer. The clean water is then returned to the fish."

The system also conserves water, which is especially vital in Afghanistan, she added. "It's a closed-loop system so once you fill the tank you are truly not using any water except for evaporation because it keeps circulating through," she said.

The fish will come from a nearby lake later this spring. Until they arrive, Coulon is using tadpoles and vitamin B-12 as a plant fertilizer as a stop-gap measure. She said she will feed the fish with duckweed.

"The fish will make a whole system," she said. Wouldn't a nice fish dinner be good?"

Penny Coulon, a south district contracting officer representative, checks for wilting leaves on a recently sown patch of lettuce. She combined hydroponic gardening and aquaculture - raising of aquatic animals - to create the south district's first-ever aquaponics garden. (USACE photo by Dave Melancon.)

The fish, depending upon the species, will be ready to eat in about six months, so it may be a bit premature to start bringing out the recipes and spices, she warned. The garden has been going for only a few days but the plants are looking strong with little evidence of wilting, Coulon said.

"So far it's looking pretty good. I think the plants are taking. If they weren't they would begin to wilt," she said. "I'm feeling pretty positive that it will take off."

Store-bought Aquaponic systems can range in price from about $200 for a complete starter kit to several thousand dollars for larger, more elaborate systems, she said.

Many parts for Coulon's two systems were donated by Backyard Aquaponics, Inc. of Australia, she said. The Yenigun Construction Co., a Turkish building contractor with several projects under way on KAF, provided the rock and the tanks. Coulon brought the old the garden hose and PVC pipes and hardware from home.

John Caudill, of Watkinsville, Ga., Operations and Maintenance Section office engineer, helped build the systems, Coulon said. He will ensure the pumps keep running and the plants and tadpoles are thriving while she is on off-site assignments and leave.

If successful, one unit will remain on the USACE compound and a second will be taken to the Afghan bazaar school on KAF, Coulon said.

"Hopefully we can teach some kids about Aquaponics and for science classes," she said. "I'm excited about it. I hope it produces nice organic vegetables and will be easy to maintain," she said. "I'm hoping the Afghans can take this idea and run with it."

Modelling Of Aquaculture Development Based On Aquaponics In Bangka Belitung, Indonesia

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Abstract
One way to develop the aquaculture sector is though the use of a narrow yard to culture fishery commodities. It is intended to increase land productivity and to create self sufficiency for the people. Initiation of hydroponic technology combined with aquaculture technology is a simple and appropriate technologies that can be adopted by communities to create self sufficiency. Aquaponics is a *bio integrated farming system* between aquaculture and hydroponics and it is expected to motivate people because of the multiple benefits of combining aquaculture and hydroponics, resulting in two crops in the same production cycle.

Introduction
Aquaculture is one of the important chains in fisheries bio-industry development. Aquaculture is a production unit that can sustain availability of animal protein of fisheries commodity, both raw materials nor food for consumption. In the aquaculture sector development that focuses on the production and productivity requires the integration of components within the scoop of aquaculture, both aquaculture technology, feed, diseases, and others factor that support aquaculture sector development.

Aquaculture sector is often assumed as an activity that requires enormous capital, one of which is land. In fact, aquaculture activity can be developed to utilize only a small or narrow yard for optimized productivity. Aquaculture activity in the yard can be done by using an aquarium, concrete pond, and even a tarp pond that can be tailored to the needs and goal expected. Aquaculture in the narrow yard aims to improve function of idle yard into productive yard, especially in fisheries scoop. Some of the other benefits are to increase productivity, the esthetic value through exterior landscape that has exoticism, and psychological benefit as a refreshing of the saturation everyday activities. One way to optimize yard function can be done by combining aquaculture with hydroponic plants in aquaponic system.

In principle, aquaponics is an integrated technology between aquaculture and hydroponic technique. The aquaponics is designed as a manifestation of usage water recirculation system that contain excess nutrient of feed from fish pond to be flowed to hydroponic media that supplied repeatedly and continuously or periodically. The combination of aquaculture and hydroponic is seen as a simple farming technique, but can produce double product, namely fishery commodities and plants in the same production cycle. Development of aquaponic technology is seen as an appropriate medium for people that is ex-

pected can be change pattern of consumptive to productive and in the main goal to increase the independence of people, especially fisheries and vegetables needs. Department of Aquaculture, University of Bangka Belitung is disseminating aquaponics in two villages in Bangka Belitung archipelago province are Jada Bahrin village and Tempilang village. The dissemination is expected to be a row model for community based aquaponics to increase productivity

Home and Aquaculture

Aquaculture is defined as farming activities (maintenance and production) of freshwater organisms and marine water in the form of plants and animals in a controlled environment (U.S. Environmental Protection Agency, 2012). When explored further, aquaculture is defined as a maintenance activity, reproduction, and growth (growing) fish and non-fish in a controlled environment to produce a profit for the people who cultivate. In the context of characterizing differences in surface waters, the cultivation can be divided into freshwater, brackish and marine aquaculture.

Freshwater aquaculture is a potential partition to be developed. This is caused by variation of commodity cultivated and relatively easy to done. Basically, the freshwater aquaculture sector has tremendous potential to be developed. A way to develop the aquaculture sector is utilize non-productive yard. Non-productive yard can be used as the location of cultivation, both using a ground pond, making hatchery for indoor cultivation use aquarium, or even more simply and cheaply by using a tarp pond. This means that aquaculture activity in the yard is not a job that requires enormous capital and complicated. Aquaculture activities can be done in a simple in a narrow non-productive yard or land around the home

.

Some studies have been done to provide information related to the optimization of aquaculture in the yard by using a variety of container cultivation, including a tarp pond. Some of fishery commodities have been successfully developed in a tarp pond to increase animal protein sources such as fish and other fishery commodities and improve the welfare of society, especially the farmers. A number of fishery commodities which are usually developed for consumption such as tilapia (*Oreochromis* sp), catfish (*Clarias* sp), carp (*Cyprinus carpio*), etc and for ornamental fish like guppy fish or millionfish (*Poecilia reticulata*), molly fish (*Poecilia sphenops* or *Poecilia velifera*), platy fish (*Xiphophorus maculatus*), goldfish (*Carassius auratus*), and so on.

Aquaponics: Simple Appropriate Technology

Akauponik is a concept of bio integrated farming system which is a technology that combined the technique of aquaculture and hydroponic farming techniques (Diver, 2006). Aquaponics is designed to utilize water which the feed nutrients excess from aquaculture pond to be flowed into the plant hydroponic media continuously or periodically through the recirculation system. The nutrients contained in the water aquaculture are utilized as nutrients by plants to allow for the efficiency and effectiveness of the feed and nutrition of plants. Wahap *et al*., (2010) said the waste of water that produced by the fish served as nutrients for plants through the process of recirculation. In addition, a selection of appropriate fishing and agricultural commodities in aquaponic system can be used as a model for environmental regulation and sustainable food production.

The aquaponic technique is considered to be very precise in order to be implemented by the people, both on a small scale by utilizing yard and large scale production of a wider area. The other benefits of the aquaponic system are include multiple products, efficiency in water use due to the recirculation process, allowing recirculation of nutrients to feed recycles waste waters into nutrients for plants, healthy produce, and have aesthetic value. Martan (2008) said aquaponics is not only produce double, even producing multiple products through the selection of the right product to be developed in polyculture system.

Dissemination of Aquaponics in Bangka Belitung

Dissemination of aquaponics is a way to introduce a simple and appropriate technology for the community. It aims to enhance the independence and the welfare of society. Dissemination of aquaponics was done in two villages are Jada Bahrin village, Bangka regency and Tempilang village, West Bangka regency in Bangka Belitung archipelago province, Indonesia. Both villages are selected because they have the potential of agriculture and development of freshwater fisheries. In the implementation, development of aquaponics in Jada Bahrin village done by combining catfish (*Clarias* sp) with scallion (*Allium fistulosum*), kale (*Ipomoea aquatic*), and green mustard (*Brassica few*), while they developed aquaponics in the Tempilang by combining tilapia (*Oreochromis* sp) and celery (*Apium graveolens* L) were grown by using the rice husk (sekam padi in Indonesia) and sawdust. Both cultivation activities are carried out by a tarp pond that combined with hydroponic cultivation. Some of the equipments and the planting medium are used in aquaponics shown in Figure 1, the tarp pond preparation shown in Figure 2, and the aquaponics preparation shown in Figure 3.

In the modeling, the used recirculation process is drip irrigation that aims to bring water with nutrition for used as a plant nutrient and then water flows back into the container pond to enrich the oxygen content in the water so it can be used by fish. Nurhidayat (2009) said recirculation is a system that uses water continuously by circulated to be cleaned in a filter and then flowed back into cultivation pond. It means that the recirculation aims to harness the water by filtration so that it can be used repeatedly. Rakocy *et al.*, (1997) said recirculation is a re-use system. Recirculation process in the system can also be defined as *recirculating aquaculture systems* (RAS). The modeling of aquaponics with drip irrigation system in a tarp pond shown in Figure 4.

Figure 1. Equipment and Rice Husk Media for Aquaponics

Figure 2. Preparation of Tarp Pond

Figure 3: Preparation of Aquaponic System

Figure 4. Integrating the Aquaponics with Drip Irrigation In Tarp Pond

The primary goal of recirculation process in aquaponic is to reduce the waste waters generated from the feed that is not consumed or feces. The organic waste is discharged to the plant to be used as a nutrient. The organic waste used for growing crops or filtered by the media as a filter plant will produce water for fishery commodities has diminished waste. Thus, these two industries will be mutually beneficial through this recirculation system. Recirculation process can also be done by exploiting the role of decomposers bacterial, such as bacteria *Nitrosomonas* and *Nitrobacter* which acts remodel ammonia through nitrification and nitratasi as the following reaction:

$$NH_3 + H_2O \rightleftharpoons NH4^+ + OH^-$$

$$NH_4^+ + 1\frac{1}{2}O_2 \rightleftharpoons NO_2^+ + 2H^- + H_2O$$

(*Nitrosomonas*)

$$NO_2 + \frac{1}{2}O_2 \rightleftharpoons NO_3$$

(*Nitrobacter*)

Utilization of rice husk as planting medium has a lot to done, especially in hydroponic technology. As for the aquaponic, using rice husk as a planting medium has not been developed. Anisa (2011) said, rice husk known as mixed media well enough to drain the water so that the media still retain moisture. Rice husk also has the ability to purify water, prevent disease, and even its nitrogen content is believed can increase fertility of crops media.

Beside the rice husk, the other media was also added in developed aquaponic system is sawdust as activated carbon. Sawdust can be categorized as waste from wood craft with excellence in the filtration. Wardana (2010) said activated carbon is amorph carbon compounds which can be produced from mate-

rials containing carbon or charcoal that is treated in a special way to get more surface area. Activated carbon manufacturing process itself begins with the carbonization process, followed by activation. Activated carbon has the function as an adsorbent.

Aquaponics and Society

Aquaponics is one of appropriate technology that can be applied simply to society. Some modifications pond can be used in aquaponic system that adjusted to the abilities and needs. Utilization bucket or plastic tub, tarp pond, and a simple concrete pond can be used as a medium for developing systems at home. Aquaculture development based on aquaponic system can provide many advantages, such as fisheries and crop production simultaneously in a production cycle, efficiency in water used, the recirculation of nutrients so that it can be efficiency for fertilizer, healthy products, and aesthetics. In addition, the development of aquaponic can also be a way to develop a system in agriculture and fishery organic without using of chemicals because organic matter produced from aquaculture can be used as fertilizer.

The aquaponic development in the midst of society will create independence of society's economy. This is caused aquaponic system able to help people not to rely on to meet their needs, especially fishery and plant commodities. The good productivity can reduce consumptive and support productive spirit which economically valuable to improve welfare of society. It can be seen through aquaponic dissemination activities in the modeling of aquaculture development in the province of Bangka Belitung. This activity can increase motivation of people to develop aquaponic based aquaculture sector. Harvesting activities aquaponic products shown in Figure 5.

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Figure 5. Harvesting of Aquaponic Products

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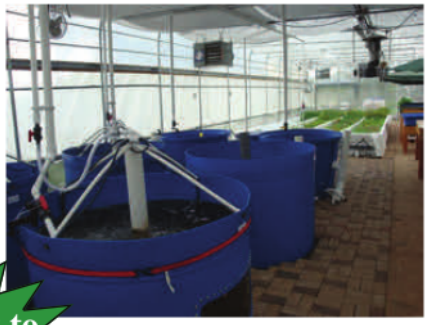

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