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URBAN AG PRODUCTS

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URBAN AG PRODUCTS

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Urban Ag Products actively seeks to become a connector for niche agricultural industries, **bringing together growers with growers, growers with manufacturers, growers with suppliers and growers with consumers**.

Urban Ag Products is an ***educator*** providing content through a variety of different media. Through its educational efforts, including its online quarterly magazine and blog, Urban Ag Products seeks to provide its users with a basic understanding of the industry and to **keep them informed** of the ***latest technologies***.

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Energy efficiency has become one of the cornerstones of global energy policies, essential in order to meet the growing energy demand while protecting natural resources and the quality of life. In this context, cogeneration plays a topical role, allowing up to 30% primary energy savings and ensuring measurable objective benefits in various application areas that we want to explore through this channel.

The COGENERATION CHANNEL is the brainchild of Gruppo AB, a global leader in the field of cogeneration, whose aim is to promote increased information and scientific and technical debate on an international level.

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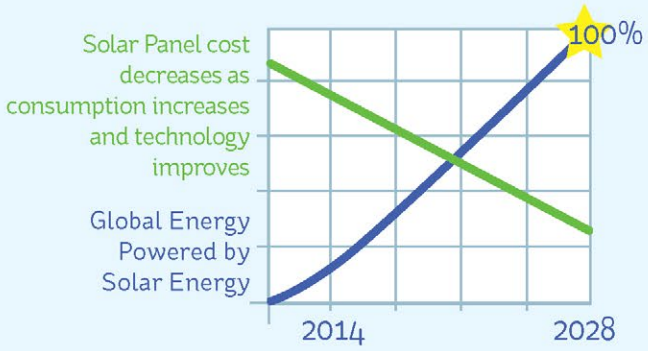

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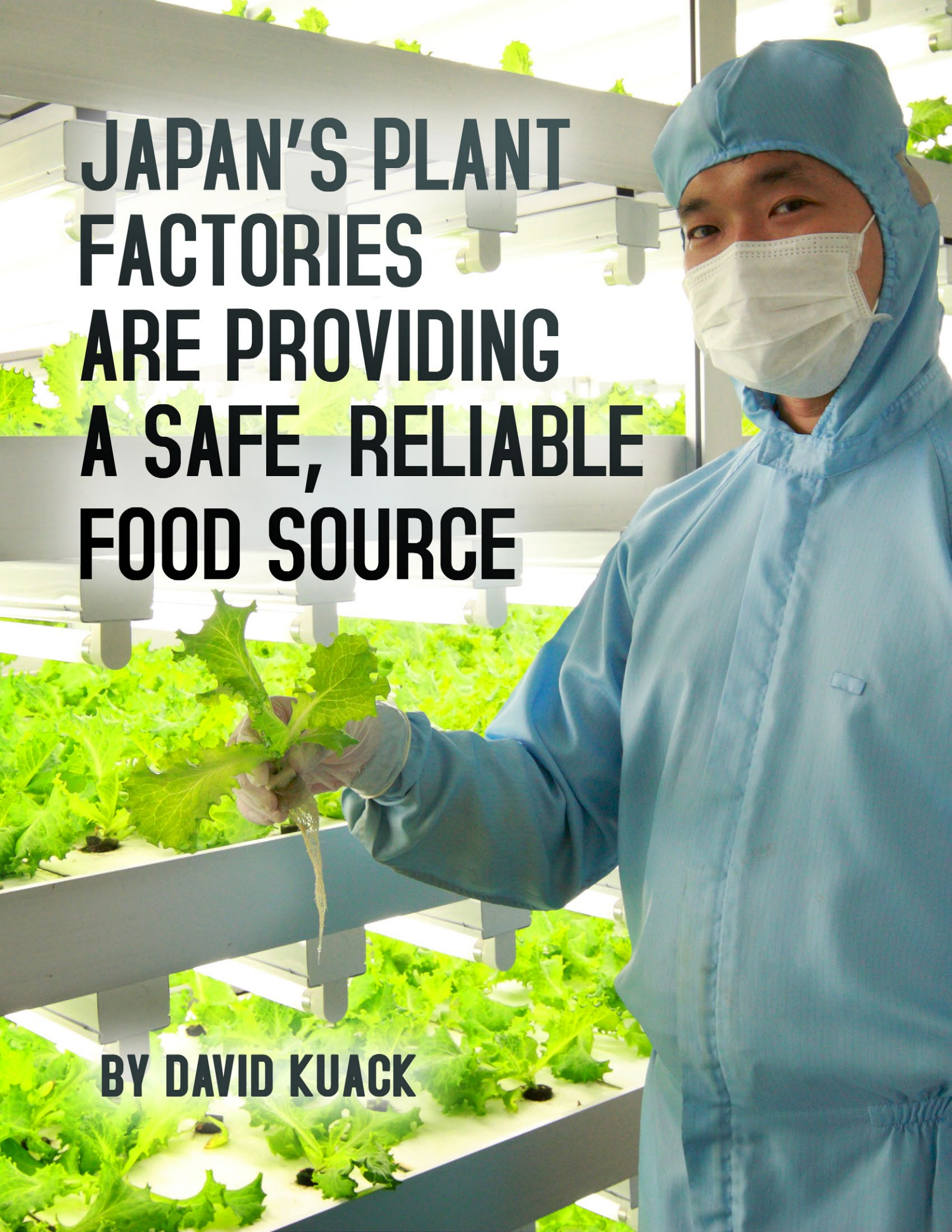

JAPAN'S PLANT FACTORIES ARE PROVIDING A SAFE, RELIABLE FOOD SOURCE

BY DAVID KUACK

Japan's plant factories are expanding to meet the increasing demand for safe, pesticide-free, locally-grown food.

Japan has more plant factories (PFs) than any other country. The largest number of plant factories are located in Okinawa Prefecture near Taiwan. The rapid commercialization and financial subsidization by the Japanese government of PFs, which began in 2010, are helping to drive interest in their development.

Another reason for the increase in PFs in Japan is that the country has been importing a large amount of fresh, sliced salad vegetables from China. The Japanese are concerned about the amount of pesticides being used for Chinese vegetable production and looking for alternative sources of fresh vegetables and herbs.

Hort Americas spoke with Dr. Toyoki Kozai, professor emeritus at Chiba University and chief director of Japan Plant Factory Association, about Japan's expanding plant factory industry. Chiba University researchers are studying various aspects of indoor farming. A PF on the university campus, which is operated by a private company, is selling around 3,000 heads of lettuce daily to a variety of customers, including Japanese grocery store chain Tokyo Stores.

How large is the average plant factory in Japan and can you describe what type of equipment is used in one of these operations?

As of March 2014 there were about 170 plant factories (PFs) in Japan. Of these, 70 are producing more than 1,000 lettuce heads (50-100 grams per head) or other leafy greens daily. The number of PFs producing more than 10,000 heads of lettuce daily is estimated to be around 10.

The number of Japanese plant factories producing more than 10,000 heads of lettuce daily is estimated to be around 10.

Photos courtesy of Dr. Toyoki Kozai.

The average floor area of a PF with 10-15 tiers for producing 10,000 lettuce heads daily is 1,500 square meters. The main components of a PF are:

1. A thermally well-insulated and airtight warehouse-like structure with no windows.

2. Tiers/shelves with a light source and culture beds.

3. A carbon dioxide supply unit.

4. Nutrient supply units.

5. Air conditioners.

6. An environment control unit.

7. Other equipment includes nutrient solution sterilization units, air circulation units and seeders.

Are most of Japan's plant factories located in renovated buildings (i.e. old warehouses, abandoned factories, etc.) or are the buildings housing these operations constructed specifically for use as plant factories?

Sixty percent of the PFs in Japan are located in new buildings.

Why has Japan been one of the leaders in the development of plant factories?

Citizens' concerns for and interest in health, pesticide-free products, freshness and high-tech are high. There are many researchers who have been doing research on PFs for more than 10 years. The Japanese government started subsidizing R&D and doing extension related to PFs in 2010.

Are most of the Japan's plant factories operated by private companies and/or corporations or are there some operated as family farms?

Thirty percent of PFs are operated by families with five to 15 part-time workers. Half of these PFs are for vegetable production. Ten percent of the PFs are operated by agricultural unions or similar organizations. The rest are operated by private companies.

What are the most common crops grown in the plant factories?

Primarily green leaf lettuce, romaine lettuce, frill lettuce, spinach, basil and arugula.

Are there any limits (i.e. space restrictions, plant size, light requirements, etc.) to the types of crops that can be grown in plant factories?

Plant height is 30-40 centimeters or less, grow well at a photosynthetic photon flux (PPF) of 150-250 micro-mol per meter squared per second (*u*mol/m2/s) and at high planting density. Plants can be harvested within two months after seeding and respond well to controlled environments.

How are most of the crops grown in plant factories marketed to consumers?

The produce is sold to diverse markets. Forty percent to large- and medium-size supermarkets, 30 percent to restaurant chain stores, 20 percent to meal delivery service companies and the rest to department stores, convenience stores and Internet shopping.

Is there any type of marketing on television, radio, online, newspaper, etc., done for the crops grown in the plant factories?

Most marketing is done on PF websites for ordering via the Internet. The PFs also do many interviews for articles and TV news without spending money for advertisement. PF sales personnel visit supermarkets, restaurants and department stores frequently.

In regards to the production system set ups currently being used in plant factories, where could the greatest improvements be made?

Automation for transplanting, harvesting, packing and cost and production management systems.

Japan's plant factories are used for the production of leafy greens, herbaceous medicinal plants, herbs and miniature root crops such as micro carrots and turnips.

What are the benefits/advantages of plant factories over greenhouse production and traditional field crop production?

Ten- to 100-fold annual productivity per unit land area regardless of weather, clean and no need to wash before cooking and a long lifetime. Consumers are now interested in its nutrition for humans, taste, functional and medicinal components in leaves, beauty color and mouth feeling

What are the benefits/advantages of greenhouse production and traditional field crop production over plant factories?

PFs produce vegetables with high quality (small, delicate looking and flavorful) which cannot be produced in greenhouses or in the fields. The PF vegetables are 1/3 to 1/100 the size of greenhouse- or field-grown vegetables. PFs enable consumers living alone to eat fresh vegetables daily.

Do you think that plant factories will be able to overcome their current limitations to compete with greenhouse and field production? If so, how many years do you think it will take for the production costs to be comparable?

PFs are useful only for the production of leafy greens, herbaceous medicinal plants, herbs, and miniature root crops such as micro carrots and turnips. These root crops must have edible tasty leaves.

PF vegetables are not replacements for greenhouse- and field-grown vegetables. They are new products and create a new market. It will take about 10 years in Japan, less than 10 years in China.

What aspects of plant factory production are being studied at Chiba University?

Research includes:

* The production of low potassium lettuce for persons who have kidney-related problems.

* Development of production and cost management systems.

* Lighting system using LEDs.

* Reduction in electricity costs.

* The physiological disorder of tip burn.

For more: Dr. Toyoki Kozai, Japan Plant Factory Association, Chiba University, Center for Environment, Health and Field Sciences, Kashiwa-no-ha, Kashiwa, Chiba, 277-0882, Japan; kozai@faculty.chiba-u.jp.

Additional articles on Japan's plant factories are available at:

http://www.japan-acad.go.jp/en/publishing/pja_b/contents/89/89_10.html; http://www.meti.go.jp/english/policy/sme_chiiki/plantfactory/about.html

David Kuack is a freelance technical writer in Fort Worth, Texas; dkuack@gmail.com.

Japan's plant factories produce high quality vegetables (small, delicate looking and flavorful) which cannot be produced in greenhouses or in outdoor fields.

JUNE 5, 2014, CHIBA UNIVERSITY FACILITY IS ONE OF JAPAN'S LARGEST PLANT FACTORIES

Chiba University Plant Factory is Japan's largest plant factory research facility. Seven consortia, made up of private companies and organizations, and educational and research institutions, have established five tomato factories using sunlight and two lettuce factories using artificial light. The hydroponic facility can produce 10,000 heads of lettuce a day. The factory consists of a 1,260-square-meter floor area and has vertical shelves with 11 stages. It is equipped with both LED and fluorescent lights that help to provide optimal environmental conditions. Lettuce crops are ready for shipment in about 35 days.

Shimamura Shigeharu is the CEO of MIRAI Co., the company that operates the plant factory. The company recently opened a 2,300-square-meter vegetable factory equipped with LEDs in Tagao, Japan, one of the cities that was damaged by the 2011 earthquake and tsunami. This factory will produce 10,000 heads of lettuce and other vegetables a day that will be sold to local supermarkets.

Plants grown in Japan's plant factories reach a height of 30-40 centimeters or less, grow well at a photosynthetic photon flux of 150-250 micro-mol per meter squared per second and grow well at high planting density. Plants can be harvested within two months after seeding.

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It takes commitment to grow organically

BY DAVID KUACK

Photo courtesy of Peace Tree Farm

Switching from an inorganic to organic fertilizer is not a simple process. Growers have to be willing to put in the time and effort to ensure the changeover is successful.

The goal of any fertility program, regardless of whether it is with organic or traditional inorganic fertilizers, is to ensure that all of the essential plant nutrients are present in appropriate amounts. Kansas State University horticulture professor Kim Williams said whether the nutrients are injected into the irrigation water or preplanted in the growing medium, ensuring that proper levels of all essential nutrients are provided to the plants "can be surprisingly tricky."

"When we say adequate amounts or think about nutrient balances, how much of each nutrient should be present was originally based on how much of each nutrient ends up in the plant," she said. "For example, nitrogen and potassium both make up about 4 percent of the dry weight of most plants. Therefore they are typically provided in relatively high quantities in fertilizer programs. That's why there are general purpose formulations like 20-10-20 and 15-2-15. Thinking about nutrient balances in terms of conventional fertilizers, those ratios are applying about the same amount of potassium and nitrogen, which is quite common. There are some exceptions. There are some crops, including cyclamen and Rieger begonia (Begonia x hiemalis), that grow better with higher potassium levels than nitrogen. But in general, for conventional fertilizers, the ratio of one part nitrogen to one part potassium generally holds. This is a challenge for growers trying to use organic fertilizers because most of these fertilizers don't provide combinations of essential nutrients in the same ratios that growers are accustomed to with inorganic nutrient formulations."

Knowing what you've got

Williams said for commercial organic fertilizers it's common to see nutrient formulations that don't contain equal amounts of nitrogen and potassium.

"Sometimes phosphorus can be very high," she said. "Sometimes potassium needs to be supplemented depending on the nutrient source. Research was conducted at Kansas State with a soybean seed extract fertilizer with a formulation of 10-4-3. When applications were made based on the typical nitrogen range no disorders developed from having a potassium imbalance that would be expected to be seen with conventional fertilizers."

Williams said whether growers use organic or inorganic fertilizers the place to start is to make sure that all the nutrients are present and in adequate amounts—not too much or too little.

"In the past growers using general all-purpose fertilizers may have tended to over fertilize with nitrogen and potassium in order to deliver enough micronutrients like iron," she said. "They may have thought an improvement in growth was coming from the additional amounts of N-P-K when in fact it was coming from additional amounts of micronutrients.

"I worked with a grower who was using a soluble organic fertilizer to feed her crops, but she reported symptoms of iron deficiency developed on her petunias and calibrachoa towards the end of the production season. I thought the problem was related to upwards pH drift associated with the high alkalinity well water she was using for irrigation. For a couple years we worked on optimizing the root medium pH. After visiting her operation and doing some in-house nutrient testing, we discovered the problem didn't have anything to do with pH. It was a result of the organic fertilizer she was using not having enough iron to meet the plants' needs. When she added an iron supplement, the plants quickly re-greened and there was an improvement in growth."

Williams said growers need to make sure that all of the essential nutrients are in the fertilizer they are using and that they are going to be available in adequate amounts. Their availability can be affected by pH and other root medium characteristics.

Product improvements

Williams said another challenge facing growers using organic fertilizers is ensuring that they are receiving a consistent product from batch to batch.

"Being able to rely on a fertilizer to give the same results from one batch to the next is critical," she said. "This is especially true for growers who invest the time and effort trying to understand how a fertilizer is going to deliver nutrients to their crops and how it integrates into their production systems.

"Many fertilizer companies are working to manufacture consistent products by tightening up their standards for what the nutrient analyses of the raw input products have to be. This hasn't always been the case in the past. For example, the nutrient content

Whether growers use organic or inorganic fertilizers, the place to start is to make sure that all the nutrients are present and in adequate amounts.

Top photo courtesy of High Meadows Farm

of one batch of fish emulsion could be widely different to the next. There are now companies producing organic fertilizers that start with either animal or plant inputs that have done a good job of tightening up their protocols so that they are delivering consistent products from one batch to another. There is a difference between a company that is using whatever raw products are coming out of a food processing facility, drying it, grinding it up and packaging it. That's taking a waste product and using it as fertilizer. It is not actually engineering a fertilizer in the sense that the manufacturer is carefully monitoring and controlling the raw inputs that go into it so that the end-product performs in a consistent way for growers."

Water quality

Williams said there are a lot of aspects of water quality that come into play in terms of interacting with any fertilizer.

"With organic fertilizers a grower is often adding a high salt load to the solution," she said. "That can be an issue if a grower already has high levels of salt in his water supply, whether that is coming from alkalinity in the form of calcium, magnesium, sodium carbonate or other water contaminants. It is more difficult to use organic fertilizers because you don't have as much wiggle room in terms of extra salts before the total salt level affects plant growth."

Williams said in the case of conventional inorganic fertilizers they are relatively pure so when a grower uses potassium nitrate that is what primarily is applied.

"In general, the electrical conductivity (EC) for an organic fertilizer tends to be higher because there are so many other ions in the fertilizer," she said. "Some of these ions are plant essential and many of them aren't. Sodium is one of the ions that is sometimes found in too high levels in many organic fertilizers."

Williams said water quality becomes more critical the longer the production cycle is for a crop.

"Water quality is going to be much more critical for a grower producing tomatoes hydroponically," she said. "Trying to maintain plants over a period of months in a rockwool slab is going to require more water quality monitoring than short term crops like basil or greens.

Water quality is much more critical for a grower producing a long term crop like tomatoes than short term crops like basil or greens.

Left photo courtesy of High Meadows Farm | Right photo courtesy of Peace Tree Farm

Data collection

Williams said growers who are considering making a change from conventional inorganic fertilizers to organic fertilizers should start small and trial short-term crops.

"Growers should be prepared to spend more time doing nutrient and pH monitoring so that they have more information than just pH and EC," she said. "I would encourage growers as they are collecting this data to plot nutrient levels over time. Growers should essentially determine the nutrient release pattern from the addition of a given rate of the fertilizer at a given temperature. Monitoring and recording the temperature will allow growers to know what to expect regarding the release pattern when they expand the size of the crop."

Williams suggests that for the first 48 hours of using an organic fertilizer in a recirculating solution, growers should sample the fertilizer solution twice a day so that they can understand how the pH and EC are changing. "Our experience is that for the first couple of days there is tremendous shift in the pH and EC when organic fertilizers are applied because of the microbial activity," she said. "Growers should collect recirculating solution samples that can be sent off to an analytical lab to see what nutrients are available. For a hydroponic grower making the switch from conventional inorganic fertilizers to organic fertilizers, sending a sample in once a week for analysis isn't enough. This grower would need to do it more frequently until he really learns what to expect from a given organic nutrient source."

For more: Kim Williams, Kansas State University, Department of Horticulture, Forestry and Recreation Resources; (785) 532-1434; kwilliam@ksu.edu.

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GREENS & GILLS BRINGS LOCALLY-GROWN FISH & PRODUCE TO CHICAGO

FROM A PORK-PROCESSING FACILITY TO AN INDOOR AQUAPONICS OPERATION, GREENS & GILLS HAS TAKEN ADVANTAGE OF AN OLD USDA BUILDING'S UNIQUE FEATURES TO PRODUCE EDIBLES AND FISH.

By David Kuack

When co-owners David Ellis and Eric Roth began operating Greens & Gills LLC in an old USDA pork processing facility on the south side of Chicago in January 2013, some people may have scratched their heads wondering why they picked this particular building. The company is the first licensed aquaponic business in the city.

"The USDA operated the facility from 1926 to 2006," said Ellis, who is CEO and handles the company's sales and business development. "We literally had to make a growth chamber or an indoor greenhouse inside the building. We are only using 3,100 square feet of the entire 90,000-square-foot building. It is a small area because we are using vertical production and floating raft systems. There are other growers using other areas of the building."

Ellis said the building has some unique features that made it advantageous for the company's plant and fish production system.

"The walls of the building are 2 feet thick so we don't have to heat through the winter," he said. "The air intake passes through clean room filters and we have a positive pressure exhaust system that moves air to the outside. We have circulating fans that mix the air and a commercial dehumidifier.

"The floors are pitched to drain so that is an advantage with our water-based system. There aren't any concerns with removing any water. The walls are made of fiber-reinforced plastic, which prevents mold from growing and they can be sprayed down with hoses."

TESTING DIFFERENT CROPS, TECHNOLOGIES

Greens & Gills' biggest crops right now are basil and microgreens. Other crops that are grown include lettuce, kale, arugula, and bok choy.

"Our testing right now is more on technology and less on crops," Ellis said. "We have been testing different organic nutrients. We use the aquaponics water to fertilize the crops. The aquaponics water is our base, but we have bumped the EC up with additional organic nutrients. We are also testing the crop production with synthetic fertilizers to compare yields."

Ellis said they have tested various supplemental lamps including high intensity discharge (HID), fluorescent and LEDs.

"The lights we are using really depend on the crop we're growing,"

Co-owners David Ellis and Eric Roth began operating Greens & Gills LLC, the first licensed aquaponic business in Chicago in January 2013.
Photos courtesy of Greens & Gills

Ellis said. "The LED production modules are best for microgreens production. They don't have the intensity and power that the metal halide lights have. For growing basil or lettuces we've found the HID lights to be better suited for those crops."

One of the crops that Ellis is interested in trialing is tomatoes.

"I want to see if we are able to grow an indoor crop of tomatoes," he said. "There may not be a market for them or we may not be able to grow them in a cost competitive way because there is a lot of competition. "Because of the thickness of this building's walls, we don't have to heat through the winter. The heating costs for greenhouses in the Midwest can be quite high during the winter. Our HID grow lights may not be the most efficient, but they do generate heat. What if we could do a large scale tomato production in this type of facility? I want to be able to say that I know how to grow a tomato indoors."

Although Greens & Gills operates in a closed building, Ellis said they don't take any chances when it comes to pest control.

"There are other growers in our building and some of them do grow in soil," he said. "We have particular concerns with thrips, aphids and other soft-bodied insects. We haven't really had to deal with any type of pest issues so far except for some fungus gnats. But they are not damaging the crops. We start everything from seed so that is probably another reason why we haven't had any major pest problems. Every two weeks we bring in green lacewing larvae (Chrysoperla rufilabris) and other predators just to be sure that we are staying on top of any pest issues."

GREENS & GILLS OPERATES FOUR 300-GALLON TANKS FOR RAISING TILAPIA AND THE WATER IS USED TO FERTILIZE THE PLANTS.

FISH-TANK FERTILIZER

Greens & Gills operates four 300-gallon tanks for raising tilapia and the water is used to fertilize the plants.

"The fish provide an organic fertilizer," Ellis said. "Our hydroponically-grown plants do well with the nutritional makeup of the water. The nitrifying bacteria in the water are key to the success of an aquaponics system converting ammonia to nitrogen. It takes about 12 months for all of the microbes to reach peak levels."

Ellis said fish production is staggered between the tanks so that one tank is harvested every six weeks.

"By having the four tanks and staggering the fish production we're able to keep a constant nutrient level in the water. Growers who try to use fewer, larger tanks may have issues with maintaining the same nutrient level. Also, the size and number of fish is going to affect the nutritional levels. The system has to be sized properly and you have to have the right amount of fish in the water. We have done studies to determine the best levels of fish."

Ellis said the fish tank water is constantly monitored for pH and EC.

"Even though we do monitor EC, it's not really an accurate picture of what is in the water," he said. "The only way to know exactly what is in the water is to send it off for analyses and we do. You have

Customers who taste Greens & Gill's edibles, which are fertilized with water from its fish tanks, report the plants are more flavorful than similar crops that are just grown hydroponically.

to have proper levels of N, P, K and micronutrients. If the system is designed properly there should be balanced levels of macronutrients and micronutrients. The only thing we have to add is chelated iron."

Ellis said using the fish water as fertilizer has made a difference when it comes to plant favor.

"I've had chefs tell me that they have purchased hydroponically-grown produce that looked great, but kind of fell flat when it came to taste," he said. "I tell them about how we grow aquaponically and about the important role the microbes play in delivering the nutrients to the plants. After they taste our produce they tell me that it has a much better flavor than crops that are just grown hydroponically. We did not know this before we started the operation. It's something we have learned growing the crops and the response of people who have tried our products."

LOCAL VS. ORGANIC

Most of the plants and fish produced by Greens & Gills are sold within a 20-mile radius of the facility. Product is sold to restaurants, grocery stores and multiple local distributors.

"We are not certified organic growers, but we are set up for certification," Ellis said. "Right now the push for local seems to be more valuable at the consumer and chef level than being certified organic. When the timing is right we will become certified organic. We market everything as urban local and pesticide-free. Right now that is more meaningful than having a USDA certified organic label like some large ag business that there is really no way of knowing its production practices.

"Our buyers tend to be tougher on local farmers wanting to know what their practices are. We have spoken about installing cameras in our facility so that anyone can go online and watch what is going on here."

For more: Greens & Gills LLC, (773) 475-7501; david@greensandgills.com; http://www.greensandgills.com.

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Eat Green DFW is dedicated to helping entrepreneurs involved in the local food system in North Texas connect with the kinds of consumers who appreciate the value of locally raised or prepared food. If you are a farmer, rancher, artisanal food producer or gardener, we can help you develop better ways to reach consumers in North Texas while maximizing your profits. Through Eat Green DFW, we are dedicated to helping small, local food producers succeed.

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