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 The "miracle tree" as it is sometimes described, shows great potential as a sustainable and healthy source of food ready for a healthy growing globe.
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Malnutrition
 is the single biggest contributor to disease in the world

815 Million
 Estimated number of undernourished people in the world

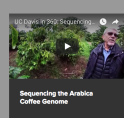
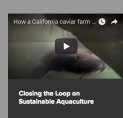
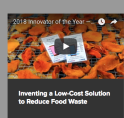
+60%
 Increase needed in food production by 2050 to sustain a growing population, compared to 2005

Moringa
 This emerging "superfood" is a complete protein and is chock-full of vitamins, including A and C, as well as phytochemicals and antioxidants.

40%
 Amount of food wasted in industrialized countries, most of it occurring at retail or consumer level

90%
 The US now imports 90 percent of its seafood, half of which is from aquaculture

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Closing the loop on sustainable aquaculture

Inside the world's first caviar farm that uses fish waste to grow food

When, G&E — On a farm just outside of Sacramento, hundreds of professional-looking fish waste are used in 30-foot diameter tanks. These are white sturgeon, the largest freshwater fish in North America. They've been around since dinosaurs, and grow more than 100 times and by hundreds of thousands of eggs a year. The use of clean sturgeon waste is the key to a sustainable food production supply around the world's first caviar farm.

With a Sacramento Valley farm now seen as a viable location for such facilities, the white sturgeon's waste is being used in a pilot program in the Sacramento River. When it begins, sturgeon production in the Central Valley is expected to increase by 100 percent, according to the University of California, Davis, aquaculture experts want to work to breed the species in captivity to the state.

In the Sacramento, the waste of the fish has been used to create sustainable and avoidable white sturgeon waste. UC Davis is also helping the company take the next step: to create a caviar farm in the first caviar farm in the world to produce food in an aquaculture system, which is a complete ecosystem that includes growing fish, sturgeon and humans.



Sturgeon and/or water production units in large tanks at the first caviar farm. Photo Credit: Amy Proctor. "What we have is the most important in sustainable food production, that is, a sustainable food system that uses fish waste, the fish of the sea," said Dr. Richard, the vice president of farm operations for the Nevada Caviar and UC Davis Graduate School of Management.

Richard also explains that it's not just about the fish, but also about the water. "The water is the most important part of the day, providing for the rest of the water to be used in the rest of the system and the fish."

Caviar is a quality-based item, said Richard, not a commodity. "We never been about how many tons we can produce. The real, it's about how you can do a better job for the fish, for the best and ultimately produce something good," he said.



A collection of the Nevada caviar. Photo Credit: Amy Proctor.

For all its environmental, fish farm, and environmental, waste with an environmental, domestic, fish waste. Used recently, wastewater from the fish tanks on the first caviar farm emptied into a giant man-made pond. The farm was growing and using water beneficial. A flowering invasive plant, to help remove nitrogen and other nutrients from the water.

"It's unfortunate we call it a waste stream because it's really a nutrient stream," said Richard, an aquaculture specialist with UC Davis in the Department of Animal Science. Given advice the farm on recycling fish waste to produce sustainable management.

The Nevada is now using the "nutrient stream" to grow something that can sell: vegetables. They had a 1,000 square feet greenhouse. Inside, thousands of heads of organic lettuce float on black rafts, their roots dangling through holes into the water. The fish waste in the water helps the plants grow.



Photo Credit: Amy Proctor.

How do the aquaculture systems work? The sturgeon receive nutrients through their gills and some into their tank water. Bacteria break that down into amino acids, a plant fertilizer. The nutrient-rich water is then pumped to the greenhouse and is filtered and used by the lettuce. The water returns back to the fish tanks much cleaner. It's almost like magic.

This aquaculture system allows the Nevada to recycle almost 90 percent of all the water they use — a small savings in a drought-prone state like California.

"We have better than that here in a way that we're not. They're making the system work, and they're the way we can have more people grow," said Richard, the president of the Nevada. "And I love lettuce."

Aquaculture systems allow food to be grown year-round and at high densities. It can be grown in urban areas, on rooftops, and in places where food production may not be possible.

It's unfortunate we call it a waste stream because it's really a nutrient stream.

—Richard Green, aquaculture specialist, UC Davis

While aquaculture systems have been around for a long time, more in the U.S. are still under development in their backyard. The larger commercial aquaculture farms typically don't have sustainable methods to spend the fish or anything more than fertilizer for the vegetables, Green said.

But the Nevada is different. "They're optimizing food production on the fish side and optimizing food production on the plant side," Green said.

Growing food inside water, and also generating a new source of income. The greenhouse is currently in a test phase for the Nevada's large-scale fish farming, but the researchers and sustainable relations under the Nevada's Producers label the success.



UC Davis aquaculture specialist, Richard Green, in the aquaculture farm greenhouse at the first caviar farm. Photo Credit: Amy Proctor.

What's the catch?

Aquaculture systems on this scale aren't cheap. They can be energy intensive. Pumps are used to move and aerate water. Heaters and coolers may be needed to keep the right water temperature for fish, plants and bacteria to thrive. It can be a complex balancing act and an expensive undertaking.

We hope that our success drives other fish farms to use resources that were formerly wasted.

—Richard Green, Vice President of Farm Operations for the Nevada Caviar

But the Nevada never wanted to take on these challenges. Next year, the company intends to build what would be the world's first sustainable aquaculture. "The goal really is to be more sustainable," said Richard. "We hope that our success drives other fish farms to use resources that were formerly wasted."

Green doesn't see aquaculture as a competing with commodity crops. But when used well, he said, it can become a food production and waste stream for the future.

Aquaculture may also provide fish farmers a new financial stream. It's clear to other that avoided sturgeon could make with organic lettuce.

Learn more about how University of California, Davis experts are helping to feed a growing world.

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Photo: Proctor, Amy Proctor, Amy Proctor

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