Growing hydroponic strawberries in the desert

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Hydroponically grown strawberries stay clean hanging three feet above the ground in the UA's strawberry project greenhouse. Credit: Chieri Kubota

Growing up in Tokyo, Chieri Kubota savored fresh strawberries brimming with flavor in the winter. Only when she went to college and studied agriculture did she learn that fresh strawberries in winter are "an unusual cycle against nature," she said.

Today Kubota is trying to perfect that off-season cycle and grow strawberries hydroponically in a greenhouse in the University of Arizona Controlled Environment Agriculture Center, which is part of the College of Agriculture and Life Sciences. Her goal is to introduce sustainable strawberry cultivation to local greenhouse growers and provide sweet luscious berries for restaurants, high-end grocers and farmers markets.

She knows it can be done. "I'm from Japan. We grow strawberries in greenhouses in winter." Some are grown hydroponically.

Kubota is a widely published professor in the UA School of Plant Sciences and the Department of Agricultural and Biosystems Engineering. She completed a doctorate from Chiba University in Japan, did post-doctoral research training at Clemson University in South Carolina and Laval University in Canada, then joined the faculty of her alma mater. She came to the UA in 2002 to work with hydroponic tomatoes and explore the potential of adding sustainable strawberries to local greenhouse production.

In the United States the majority of strawberries are grown in California. The plant varieties – or cultivars – are bred for that climate. In the desert, even in a greenhouse, it's a challenge to approximate that mild misty coastal climate.

Kubota's co-principal investigator on the project is research specialist Mark Kroggel, who has a Master of Science degree in horticultural science. Kroggel designed an under-the-bench fog system that releases humidity at night so the strawberries are dewy moist by dawn. It's turned on for five minutes at time, three times an hour, for three hours. This is "technology to make the plants happier," Kubota said.

Focus on Flavor, Not Shelf Life

"We want water flowing into the plant all the way to the tip," Kroggel said.

If water doesn't reach the tips of the leaves at night, they get tip burn. Those lovely green petals around the base of the strawberry – called the calyx – also can turn "an undesirable crispy brown that affects marketability."

"He's the grower," Kubota said. "I'm more the 'idea- theoretical-based person.' So I think – and he makes it happen."

They experiment to identify optimal growing conditions for sustainable off-season hydroponic strawberries. "We want the strawberries to grow slower in the right conditions so they accumulate sugar in the fruit," she said.

"Flavor is very important. We want to see flavor over shelf life," Kubota said – because these berries don't have to travel very far. They'll be sold locally.

Strawberries ripen in the UA strawberry project greenhouse. Credit: Chieri Kubota

The California cultivars are bred for yield, shelf life and disease resistance, she said. Flavor is maybe fourth on the priority list.

Strawberries are harder to grow hydroponically than tomatoes or lettuce.

"Most traditional greenhouse crops are quite predictable," Kroggel said. "Not strawberries."

At this point they're a low-yield, high-maintenance crop.

The humid strawberry greenhouse is bathed in bright diffused light.

Plants are growing in special styrofoam troughs from Japan that maintain a healthy temperature. The troughs are suspended by chains in long rows at waist height. Bright red berries peek out from lush green leaves.

"This type of production is rarely done in the U.S.," Kroggel said.

New Varieties to Share with Growers

In Japan, which produces some 259 million pounds of strawberries annually, new flavorful varieties are patented like drugs.

"We recently got some off-patent plants from Japan, but their condition was not so good," Kubota said. "Now we're in the tissue-culture stage to get better plants, healthier plants. Next year we hope to plant them in the greenhouse. This is not a high-yield variety – but it is really flavorful," she said. "These are relatively old varieties that we hope we can propagate and share with growers."

There is an astonishing lack of information available about growing greenhouse strawberries – one reason this UA research is so valuable.

Research specialist Mark Kroggel (left) and graduate student Michael Whalen work on strawberry plants in the UA greenhouse. Credit: Chieri Kubota

The literature includes one book from New Zealand called "Hydroponic Strawberry Production," by Lynette Morgan and a thick tome of several hundred pages written in Japanese. There's one UA library book from 1932. There's not much more than that.

Recently a collaborator in Oregon came across a strawberry crate label from 1943 that read "Arizona made, packed and distributed." Then Kubota met a Japanese-American woman who said her family had grown strawberries in Phoenix. That led her to do more research and discover that Arizona grew strawberries in the winter back in the 1890s.

C. B. Hewitt of Pasadena, Calif. wrote in a letter to the editor of the

Pacific Rural Press in 1897:

"While visiting Phoenix, Arizona, during January, 1893, I noticed some fine large, bright red, glossy strawberries in the market and upon inquiring was told that they were originated a few miles out from the city and were called the Arizona Everbearing. I at once drove out to see the patch and was surprised to see the quantity of fine ripe fruit...

"I purchased 2,000 of the plants from the original grower and planted them out in Pasadena. ... The Arizona ... is the most prolific and luscious berry yet produced on the Pacific Coast ... continuing to bear enormous sized bright red berries that fairly melt in the mouth for at least eight and sometimes nine months of the year."

Sadly the Arizona Everbearing Strawberry is no more. Yet it inspires Kubota and Kroggel to know that there once was strawberry cultivation in Arizona and – with their high-tech hydroponics research – it could happen again, in a much more sustainable way.

Right now they're growing three California varieties. This winter – their sixth year – the greenhouse plants have the potential to be very productive.

"We may have to pick every single day," Kroggel said.

Provided by University of Arizona