

Agtech:

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Reducing waste is another big source of savings. While the weather has gotten easier to predict, Larson said farmers would want to know if a storm was approaching to avoid overwatering plants. Other technologies are used to avoid the overuse of fertilizers and pesticides.

Finally, Larson said, farmers also face a shortage in workers to help plant and pick crops. Robots haven't yet taken over the harvest, but some greenhouses, where San Diego's vast crop of nursery plants are grown, have found ways to automate planting and soil mixing.

"We have a serious labor shortage, that's driving the desire to mechanize," he said. "We don't have a lot of solutions to that yet."

San Diego's tech startups are working to make the process of growing the food on our tables more efficient. From feed crops to organic produce, these companies see an opportunity to earn a stake in the farms of the future.



Patrick Henry



Mike Ritter

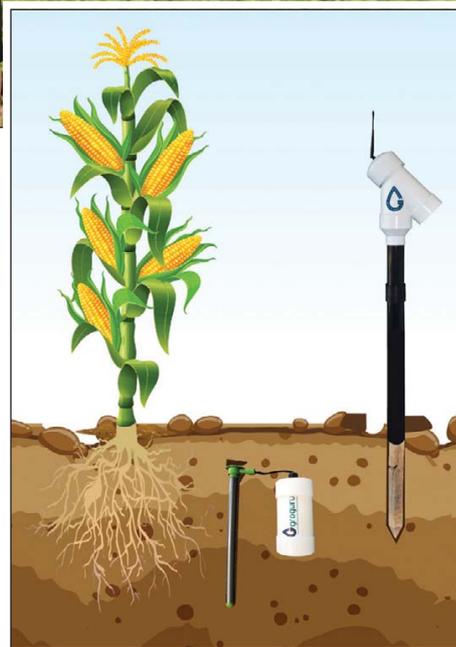


Photo courtesy of SlantRange

Above, SlantRange designs sensors and software that can be attached to drones to gather information about crops.

Image courtesy of GroGuru

Right, GroGuru's sensors are buried in the ground near the roots of plants, where they can provide growers with information on soil moisture and salinity.



Home Garden Beginnings

A former Qualcomm engineer, **Farooq Anjum's** startup is helping California farmers reduce water and fertilizer use.

GROGURU

CEO: Patrick Henry
AMOUNT OF FUNDING RAISED: \$325,000
REVENUE: About \$200,000 in 2018
NO. OF LOCAL EMPLOYEES: Nine
INVESTORS: Patrick Henry, Radicle Capital, Right Side Capital Management
HEADQUARTERS: University City
YEAR FOUNDED: 2014
COMPANY DESCRIPTION: GroGuru develops wireless sensors for commercial agriculture that can measure soil moisture and salinity.

He co-founded **GroGuru**, an agtech company that buries sensors in soil so they can measure its moisture and salinity. Farmers can use this information to determine if their crops are being overwatered, if the soil salinity is too high, or if the fertilizer is being washed into groundwater.

Anjum, who has a bit of a green thumb, had the idea while planting a garden at his new house. He wanted to use sensors to grow the best garden possible, but he didn't find any devices that worked well. So, he created his own.

At first, Anjum thought to sell the sensors to other home gardeners, but he quickly found commercial growers were much more interested in the product.

Taste Test

He said the solution can save farmers money — up to 20 percent in water savings — and lead to better crop yields. These factors can also affect the taste of the food, he said.

For example, in June, Anjum sampled some cherries at an orchard in Washington. "Those were some of the sweetest cherries I had tasted in my life," he said.

But a stop at a different farm in San Jose yielded different results.

"There was no taste," Anjum said. "The problem is they applied a lot of water. If you don't apply the right amount of water at the right time, that's what happens."

No Established Player

Anjum currently serves as chief technology officer of GroGuru. It was through a mutual friend at his most recent job, at **OnRamp Wireless**, that he met investor and GroGuru CEO **Patrick Henry**.

"The idea, I thought it was a good one," Henry said. "It just looks like a massive opportunity. There are other people in the market, but there isn't an established large player."

GroGuru has deployed the first version of its product, a sensor attached to a pole that can be pulled out of the ground, in fruit and nut tree orchards in the Central Valley and in Washington. The company is working on the next version of its product, a battery-powered sensor that can be buried in the ground for up to 10 years, which it hopes to launch next spring.

Without farmers needing to dig up and bury the sensors every planting and harvesting season, Henry said it could differentiate the company from its competitors. It also gives them the opportunity to collect more consistent data.

"I think it has the opportunity to open the bigger part of the market that the other competitors have not been able to crack yet," he said. "For annual crops, especially field crops ... you really need a solution that can be permanently installed to open up the market in a big way."

The company currently has six farms using its product. Henry hopes to expand to an additional 25 this spring, with anticipation of a bigger ramp-up next fall. The company is on target to hit \$200,000 in revenue by the end of the year.

GroGuru's team of nine is currently housed in local tech incubator **EvoNexus**. Henry said the startup is currently

raising funds to help fuel the company's growth by hiring engineers and building out its sales channels.

As with his company, Anjum said his home garden had also begun to bear fruit. He planted a pomegranate tree, for his wife, and tomatoes for himself.

"We had some nice tomatoes this year," he said.

Change Is in the Air

SLANTRANGE

CEO: Mike Ritter
AMOUNT OF FUNDING RAISED: \$7 million
NO. OF LOCAL EMPLOYEES: 14
INVESTORS: The Investor Group, Motus Ventures
HEADQUARTERS: La Jolla
YEAR FOUNDED: 2013
COMPANY DESCRIPTION: SlantRange builds sensors and software for drones that growers can use to monitor the health of crops.

San Diego-based **SlantRange** also uses sensors to provide growers more information about their crops. But instead of being buried underground, SlantRange attaches its sensors to drones that circle over fields.

The six-year-old company has its roots in General Atomics, where co-founders **Mike Ritter** and **Mike Milton** worked on the **Department of Defense's** Predator drones before realizing the technology could have a commercial use.

Tapping Local Talent

While the company has clients across the globe, Ritter said SlantRange's San Diego headquarters allow it to test its products year-round, and access a pipeline of solid engineering talent.

"UCSD and **Scripps Institution of Oceanography** have a lot of talent in remote sensing," he said. "There are a lot

Segment by Value in 2017

(total of \$1.774B)

Nursery and cut flower products: \$1.232B (69 percent of total)

Fruit and nut crops: \$331.59M (19 percent of total)

Vegetable and Vine crops: \$136.94M (8 percent of total)

Livestock and poultry products (milk, eggs, cheese): \$46.23M (3 percent of total)

Livestock and poultry: \$18.167M (1 percent of total)

Field crops: \$4.12M

Apiary products: \$3.765M

Timber products: \$836,872

(The last three above each represent less than one percent of total)

Segment by Acreage in 2017

(total of 243,029)

Field crops: 196,506 acres

Fruit and nuts: 30,710 acres

Nursery and cut flower products: 12,549 acres

Vegetables: 3,264 acres

GO GREEN AGRICULTURE



CEO: Pierre Sleiman
FINANCIAL DATA: Undisclosed
NO. OF LOCAL EMPLOYEES: 50
INVESTORS: Bootstrapped company
HEADQUARTERS: Encinitas
YEAR FOUNDED: 2009
COMPANY DESCRIPTION: GoGreen Agriculture uses hydroponics and automated greenhouses to grow organic lettuce

of remote-sensing scientists and talented people between those."

Traditionally, most farms apply herbicides or pesticides across an entire field. But these chemicals still frequently miss their targets.

SlantRange's tech can help farmers pinpoint problem areas by looking for plants that are under stress.

When plants are fighting against a nutrient deficiency or a pest infestation, they begin shutting down photosynthesis, making for less chlorophyll in the plant. SlantRange's sensor detects the concentration of chlorophyll in plants by picking up the color of the plants by how light bounces off of them.

The tech can also pick up on visual cues, such as how many heads of lettuce there are before a harvest, or if untidy weeds are growing amongst orderly plants.

Ritter and Milton first began testing

2017 Crop Report

Top Ten Crops: value and percent of total

1. Ornamental trees and shrubs: \$401.61M (27 percent)
2. Indoor Flowering and Foliage Plants: \$378.74M (25 percent)
3. Bedding plants and herbaceous perennials: \$255.45M (17 percent)
4. Avocados: \$122.19M (8 percent)
5. Cacti and succulents: \$77.44M (5 percent)
6. Lemons: \$69.5M (5 percent)
7. Miscellaneous veggies: \$55.77M (4 percent)
8. Tomatoes: \$52.94M (3 percent)
9. Oranges: \$49.32M (3 percent)
10. Other cut flower products: \$41.49M (3 percent)

Source: County of San Diego Crop Statistics and Annual Report, 2017

the concept back in 2013. At first, they had tried to grow corn in the backyard of their first office, but poor soil left six wilted plants.

Milton suggested testing the system on his family's corn and soybean fields in Nebraska.

"They (family members) were amused with the concept of a hobby drone flying around the fields. But when we showed them the data, they got interested quickly," Ritter said.

Expanding Customer Base

Since then, SlantRange has quickly grown its business. The company currently has customers in 45 countries, and several big clients, including Bayer CropScience and Syngenta. Locally, the company works with alfalfa growers in the San Pasqual Valley, that allow SlantRange to test its systems.

"We started working in corn and soybeans. We had a strategy going after this, with fields that are so big that humans can't go and reasonably inspect them," Ritter said.

Since then, growers of specialty crops that take less acreage, such as fruits and vegetables, also began buying the product.

More recently, his company has struck partnerships with drone manufacturer DJI and Microsoft, which is providing analytics and data security capabilities. In the long term, he hopes to fully automate the process, with drones programmed to fly daily.

Picking Problems to Solve

Pierre Sletman, founder of Encinitas-based Go Green Agriculture, is building high-tech greenhouses that use less land, less water, and pose a solution for the scarcity of labor. And in the midst of it, he's also trying to grow the perfect head of lettuce.

"I looked at what are all of these challenges, things that make agriculture not an attractive (job)," Sletman said. "We attacked all of those things using tech."

Sletman dreamed up the idea in college, when a professor was sharing about his work with NASA to grow lettuce on the international space station.

Seeing the amount of effort and technology that went into growing lettuce in space, Sletman asked, "Why are we not doing those things here on Earth?"

He built the first prototype in his garage in college. Since then, the company has grown into a large hydroponics operation, supplying leafy greens to major San Diego grocery stores including Whole Foods, Vons and Barons Market.

Sletman opened his first greenhouse in Encinitas with the goal of growing the perfect head of romaine lettuce.

"We put all of our resources, every dollar to R&D, into romaine," Sletman said. "That was where we placed our bet four years ago."

Each farm is about 20 acres, built in a fully climate-controlled greenhouse.

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in several parts of North County. That includes from the Lechtig Foundation, an Encinitas nonprofit that bought the last chunk of local Ecke flower operations.

The Eckes' marketing — including donating the plants to the talk show "The Tonight Show" in the 1950s — and revolutionary breeding methods popularized poinsettias.

Like the Eckes, Cibus wants to push plant breeding forward.

Its gene editing approach selects desirable traits in a way that mimics nature, free from the label of genetically modified organisms, or GMOs. GMOs — which incorporate DNA from other species — fall under burdensome regulations.

Cibus soon will launch three canola hybrids, among other products, and plans to license crop traits to leading seed companies.

The region's mild climate suits crop experimentation.

"If you're in upstate New York where I started my career, that's not so easy," Beetham said.

Cibus uses sequencing chemistry from San Diego's Illumina, a mainstay of the industry.

Much ink has been spilled over Illumina tools powering genetic services like Ancestry.com and clinical tests. Lesser known: researchers and farmers roundly turn to company technology for healthier dairy cows. And sweeter milk. And harder crops.

Central to Illumina's agriculture technology is array genotyping, which examines specific parts of DNA, rather than an entire genome.

Livestock Genotyping

In a notable example, Illumina teamed up with the nonprofit Irish Cattle Breeding Federation to improve the genetic breeding of livestock in a program that started in 2015 and ends in two years.

Instead of the traditional method of eyeballing desirable traits, the program looks to provide quicker and more accurate breeding data.

The goal is to genotype more than two million animals over the project, in the hopes of sparking routine livestock genotyping.

"Our technology has really shifted the industry," said Eli Mirkusich, Illumina's marketing team lead for agrigenomics, adding seed production represents another major market.

Speeding Up the Process

Far from risky or controversial science, Mirkusich noted that customers use Illumina technology to quicken artificial selection, long used to spur new crops with desirable traits.

"Artificial selection selects for a trait. All that genomics does is speed up the process. So we're using the natural diversity that's already there, and saying we can shorten the generation time," he said.

Illumina — which posted 2017 revenue of \$2.75 billion — doesn't break down sales by segments. But the company's agriculture operations have grown over the last decade.

That's according to Cindy Lawley, a consultant with the firm GinkgoFish LLC and former Illumina employee. Success in dairy bovines prompted entry into other submarkets, like pig and sheep breeding, wheat, soy and fruits.

"Illumina was uniquely positioned to have that pipeline of both sequencing and genotyping," Lawley said.

Speak Agriculture

She added the company made inroads with key opinion leaders at the United States Department of Agriculture, and equivalent agencies in other countries, and built out sales teams that speak agriculture.

Illumina undoubtedly counts as a boon for local agbio. But unlike, say, North Carolina, San Diego lacks a cluster of agbio giants in its backyard.

"San Diego is not a location where people coming from Monsanto, Bayer, Syngenta, etc. mergers would naturally land," Lawley said, noting consolidation swept over the industry.

"Those people along with retiring professors from universities in the Midwest and retiring USDA scientists represent human capital creating those agbio startup companies."

On the flipside, the region's strengths, she said, stem from an entrepreneurial environment and the venture capital scene.

On that note, Finistere Ventures, an agtech venture firm, calls San Diego home, with offices in Palo Alto and Dublin, Ireland, as well. A recent report from the firm states global agtech investment from January to October hit \$1.6 billion, on pace to surpass a record year in 2017.

That has been driven, per the report, by everything from rapid investment in plant-based meat substitutes to more late-stage financing rounds. Cibus, for instance, took in a \$70 million Series C round ahead of its IPO filing.

Consolidation and Acquisition

San Diego cemented a place in agbio history through companies like Mycogen, which in the 1990s patented some of the first genetically modified plants. Dow Chemical Co. acquired Mycogen in 1998, among a number San Diego agbios uprooted.

"Just like in the drug industry in San Diego, there's been consolidation and acquisition," said Joe Panetta, the CEO of San Diego life sciences trade group Bio.com, and who once worked for Mycogen.

"But I think we still have a great base of agricultural biotechnology here."

Besides companies, Panetta highlighted Joanne Chory, a distinguished plant biologist with Salk Institute for Biological Studies.

Chory and other Salk biologists have developed plants aimed at interconnected problems: human emissions of carbon dioxide, smaller crop yields and declining ecosystems.

As testament to the area's reputation in agbio, the International Plant & Animal Genome conference will take place Jan. 12-16 in San Diego. Such regard has drawn outside companies to establish a footprint here, too.

NRGene — an Israeli startup that deploys big data and genomics for plant breeding — will soon open an office in San Diego. The company has partnered with the likes of Illumina.

(In a high-profile example, NRGene, Illumina and others — in collaboration with SeaWorld — recently sequenced a bottlenose dolphin genome, with one aim being conservation planning.)

"It's about being close to our customers, to our partners," said Nitay Gold, NRGene's general manager of North America.

Genomics, gene editing and more — bigger yields often begin in the lab.