

SPECIAL EVENT ISSUE: AGTECH NEXUS USA, CHICAGO 2019

GAI GAZETTE

SAVING THE BEES, SAVING OURSELVES

One in every three bites of food we eat is dependent on these pollinators, but colony collapse disorder threatens their existence. Can agtech solutions save the day?

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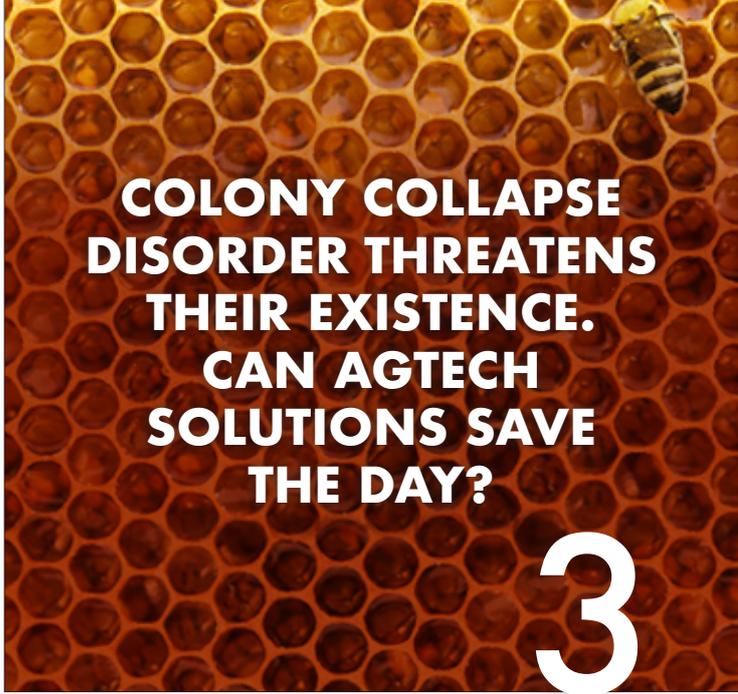
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SAVING THE BEES, SAVING OURSELVES

BY LYNDA KIERNAN AND
MICHELLE PELLETIER MARSHALL

**“IF THE BEE DISAPPEARED
OFF THE FACE OF THE EARTH,
MAN WOULD ONLY HAVE FOUR
YEARS LEFT TO LIVE.”**

**MAURICE MAETERLINCK,
BELGIAN NOBEL PRIZE
WINNER FOR LITERATURE,
THE LIFE OF THE BEE, 1901**

**“THEY ARE DANCERS,
ARCHITECTS, AND ALCHEMISTS,
MAKING GOLD...”**

**PEGGY HANSEN,
PHOTOGRAPHER AND
ORGANIC FARMER**

Bees are our critical partners, safeguarding human well-being and the success of our agricultural production systems. They are a key component to food security, with one out of every three bites¹ of food we eat being dependent on the work they do as pollinators. They ensure biodiversity, healthy ecosystems, and human nutrition, with 75 percent² of the world's fruit and seed crops dependent, at some level, on natural pollination for continued production.

From apples to almonds to alfalfa grown for cattle feed, every year crops valued at \$20 billion³ depend on bees, which also produce \$150 million in honey⁴ on an annual basis.

However, in recent years there has been a widely tracked and steady decline in honeybee numbers due to a phenomenon that has come to be known as colony collapse disorder. Over the winter of 2006-2007, beekeepers began to experience hive losses of between 30 and 90 percent, reporting scenarios that had never before been seen that included:

- ▶ The sudden disappearance of a large percentage of worker bees from a hive.
- ▶ Very few dead bees in the proximate area to the colony.
- ▶ The queen and young bees (brood) remaining in the hive with ample honey and pollen, yet destined to die because a hive cannot support itself without worker bees.

Stepping back and taking a longer view, this may have been happening for longer than was originally thought. Between 1947 and 2005 the honeybee population in the U.S. plummeted by more than 40 percent, with a third of the losses happening over the winter months, far outpacing the usual loss rate of 15 to 20 percent⁵ for a healthy bee colony. This shifted in 2005 when beekeepers reported more losses over the summer months than the winter for the first time.

The situation continued to escalate. In 2014 honeybee keepers lost 39 percent of their hives, followed by 42.1 percent in 2016. Then over the 12 months between April 2015 and April 2016, researchers found that honeybee keepers lost 44 percent of their colonies. If left unchecked, at this rate, it was determined that honeybees would disappear by 2035⁶.



"They [bees] are a key component to food security, with one out of every three bites of food we eat being dependent on the work they do as pollinators."

The economic fallout has already been felt. In California, pollination fees have almost quadrupled for the states' farmers, climbing from \$51.99 per hive in 2003⁷ to \$200 per hive⁸ for the 2018 growing season. And the financial toll is being felt on both sides of the equation. In 2012 the entire U.S. commercial honeybee industry had a value of approximately \$500 million⁹. However, over the course of the five years to 2017, Bret Adee, the largest beekeeper in the U.S., told *The New York Times* that he estimated the industry took an economic hit of possibly \$1.2 billion due to colony collapse disorder.

From bee suppliers to farmers to consumers, this phenomenon is financially affecting the entire supply chain, and agtech startups are working diligently to develop technologies that can mitigate the problem before our food supply is also negatively affected.

Tech Steps Up

The problem has been identified, tracked, and studied, but the exact cause of colony collapse disorder remains somewhat elusive. There are a number of factors that researchers believe are contributing to colony loss, including pesticide usage (particularly neonicotinoids, which have been proven to disrupt¹⁰ a bee's memory and ability to navigate), climate change, parasites and mites (*Varroa destructor*), and loss of habitat and biodiversity.

Although the exact cause has not been definitively isolated, the disorder remains – and tech companies have been working to develop novel and fascinating solutions.

A Japanese startup headed by Eijiro Myiako, a researcher at the country's National Institute of Advanced Industrial Science and Technology, has developed bee-sized quad-copter drones¹¹ that it hopes will one day serve as artificial pollinators.

The Wyss Institute for Biologically Inspired Robots at Harvard University is also using robotics to prepare for what it refers to as a "silent spring scenario," or a future with no bees at all, creating RoboBees,¹² or Autonomous Flying Microbots, that have both wings and sensors that allow them to respond to their environment.

After five years in development, researchers at the Wyss Institute believe that RoboBees could be the answer to future pollination, however, Christina Grozinger, director of the Center for Pollinator Research at Penn State University, told NBC News of her doubts.¹³

"The idea that we can mechanize that is not really likely," said Grozinger, noting that nature is far too complex for a one-stop solution.

"That's not going to fly. One problem is that there are more than 20,000 species of bees in the world, each of which has evolved to pollinate a particular plant or plants. Bumble bees are great at pollinating tomatoes. Honeybees are great pollinators for blueberries. And alfalfa leafcutter bees are great pollinators for, well, alfalfa."

In Australia, CSIRO and its partners are using wearable technology¹⁴ that is safely glued onto each bee, allowing researchers to track individual bees, collecting data on stress factors, disease, pollution, pesticides, and water contamination to determine exactly what is at the root of mass colony die-offs.

Two separate research initiatives at Washington State University have been working from different angles to save the bees. One found that mycelium extract from mushrooms has been shown to nearly completely eliminate¹⁵ the presence of certain virus strains in bee colonies. A second developed a microscopic particle¹⁶ that can be used in a powder form to act as a micro sponge, attracting pesticide residue that would normally build up in a bee's body.

Machine learning has also shown promise in fighting mites. Students at Switzerland's École Polytechnique Fédérale de Lausanne have developed ApiZoom,¹⁷ a high-speed image recognition tool. Beekeepers can take photos using their smartphone, upload it to the ApiZoom platform, and be alerted to the presence of mites on their bees within seconds.

A Warsaw startup, Saatchi & Saatchi, has created a biodegradable, glucose-infused paper¹⁸ that can act as a "refueling station" for tired bees, and scientists at MIT are working to develop an indoor synthetic apiary¹⁹ that acts as a controlled space where bees can live and thrive year-round.

Another startup on the front lines to save the bees is ApisProtect, an emerging company that presented at the AgTech Nexus 2017 Start-Up Hub in Dublin. This Irish company started by preeminent researchers, including CEO Dr. Fiona Edwards Murphy, uses the Internet of Things (IoT) to monitor honeybee colonies via real-time hive monitoring powered by satellite-enabled sensors that are retrofitted to existing beehives.

"... 75 percent of the world's fruit and seed crops dependent, at some level, on pollination for continued production."

The company then applies proprietary big data and machine learning techniques to convert the raw data collected into valuable information and actionable insights for beekeepers. The technology is currently used to monitor over six million honeybees in hives across Europe and North America, and the company is making connections daily with departments of agriculture, beekeeping organizations, and food suppliers all over the world.

The company's presentation at AgTech Nexus 2017 introduced it to the investors that enabled its latest announcement of financing, which was co-led by top-tier venture capital investors Finistere Ventures and Atlantic Bridge Capital, and included Radicle Growth, The Yield Lab, and Enterprise Ireland.

Since its successful funding, GAI News had the opportunity to sit down with company CEO Dr. Fiona Edwards Murphy to discuss the startup's technology and the funding that will advance its work.

1. Your doctoral research in 2013 was in the application of sensors and networking in honeybee hives. How did this lead to the formation of ApisProtect?

During my Ph.D. I published my research regularly, and began receiving recognition for my work in this area through awards and published articles. After a broadcast on national airwaves, there was huge demand from beekeepers to get involved with my Ph.D. research. This was the first spark that led me to think that IoT (Internet of Things) technology could have a major impact on commercial-scale beekeeping.

We have a really strong leadership team with a mix of engineering, science, beekeeping, and commercial backgrounds. We now have a team of seven and we look forward to growing the team with the help of this new investment.

2. It is estimated that the world is losing up to 50 percent of its honeybees every year due to disease, pests, and hive problems. How will your technology help rectify this?

For the last 20 to 30 years, bees have been facing problems that they never experienced before in history. Our technology is helping the beekeeper apply the knowledge that they already have, but in a much more effective and controlled

manner. Our ApisMonitor units use IoT technology, including in-hive sensors and long-range wireless communication, to monitor the health of honeybees.

Using this sensor data together with big data and machine learning techniques, we can provide actionable insights and alerts to help beekeepers prevent losses and increase productivity in their colonies.

This will enable commercial beekeepers to reduce their colony losses. For example, in the U.S. in 2015-2016, colony losses of up to 38 percent were reported. With our science-based technology, we can reduce these losses and help beekeepers manage the health of their colonies. We are already seeing interesting data coming through from our hives based in California, Delaware, St Louis, and Arizona.



3. How is the first round of funding being used to advance your company's work?

This investment will allow us to roll out our technology across North America, Europe, and South Africa, enabling us to monitor more climates, bee subspecies, and bee foraging areas.

It is busy year for the team, traveling to all our host sites to install the ApisMonitor units, but it has been fascinating to meet with our hosts in various states across the U.S. and see the common problems that commercial beekeepers experience, and how we will be able to help them.

We also are opening our first U.S. office at the Western Growers Association's WG Center for Innovation and Technology in Salinas, California, and will be growing our Cork office to a team of 25 over the next three years.

In the second quarter of 2019, we will be launching our first commercially available ApisMonitor revision. We look forward to working with our investors to get this on the market for beekeepers to ensure the health of their colonies for next winter.

4. Finistere Ventures and Atlantic Bridge - your two lead co-investors - have called ApisProtect a disruptor in the industry with huge potential for its robust technology. How will their guidance and expertise be funneled into your business?

Our investment partners offer deep knowledge of the pollination services market, as well as the agriculture and IoT technology sectors. This investment will allow us to accelerate our expansion as we work to create an extensive global hive health database to power our machine learning insights. The aim is to help commercial pollinators and growers to optimize pollination.

Our investors have a strong track record of supporting companies through key stages of development and helping them commercialize their technology globally through their networks.

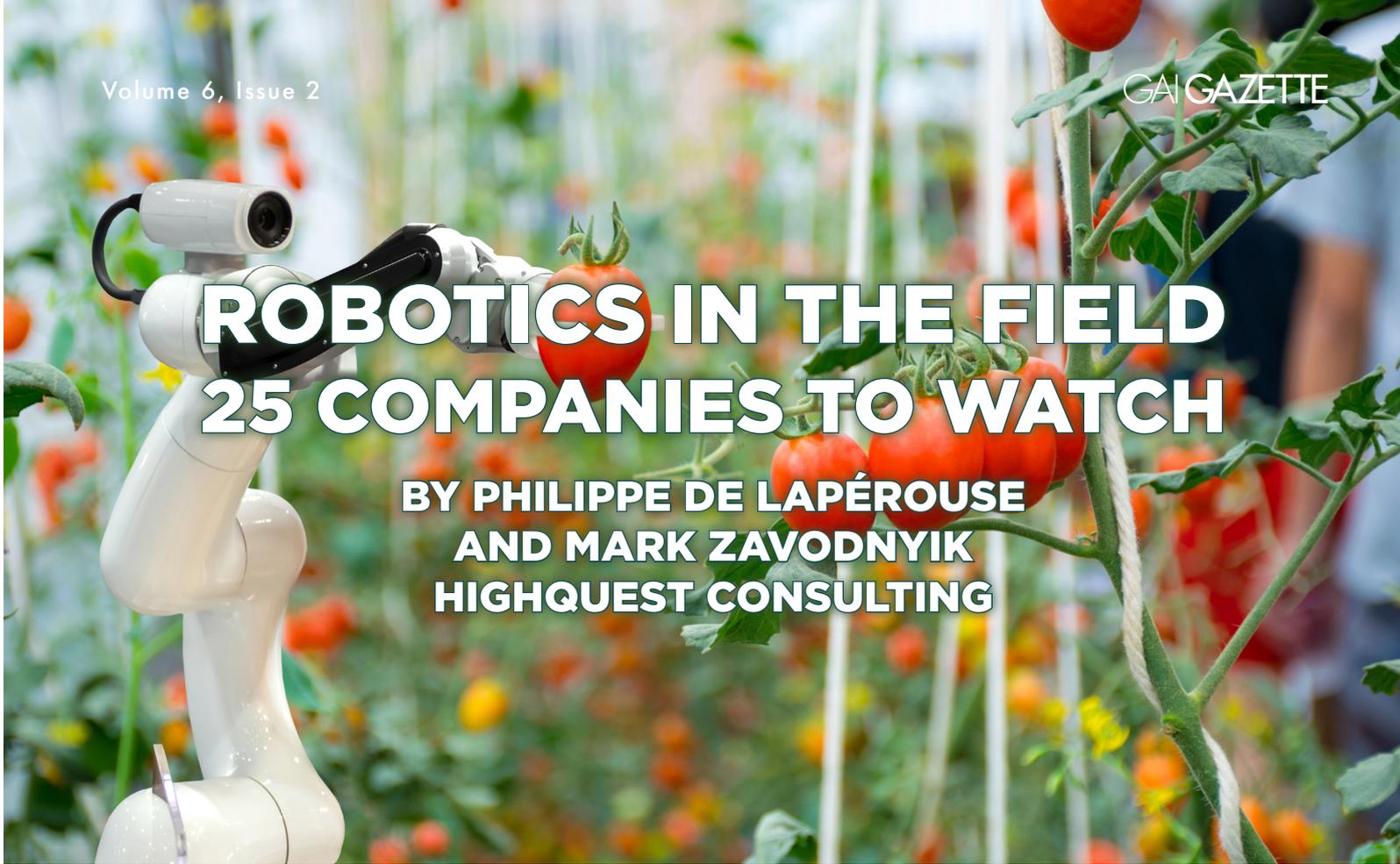
They also are keenly aware that there is a need for technologies to aid pollination in agriculture, and that the ApisProtect in-hive technology has massive potential in key markets like California. We look forward to learning and working closely with our investors to bring our product to market. 🍯

Endnotes

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ROBOTICS IN THE FIELD

25 COMPANIES TO WATCH

BY PHILIPPE DE LAPÉROUSE
AND MARK ZAVODNYIK
HIGHQUEST CONSULTING

Confronted with a shrinking and more expensive labor force, production agriculture (including row crops, permanent and specialty crops, and indoor agriculture) is seeking out and adopting the use of robotics to address not only a shortage in qualified labor, but to improve the timeliness and effectiveness of decision-making based on massive amounts of data.

Combining the use of robots with recent developments in artificial intelligence, growers can now mine massive volumes of data captured in the field to make precise, laser-like interventions in the field, resulting in reduced applications of inputs as well as supporting sustainability initiatives. The global market for ag robotics, estimated by industry analysts to be approximately \$3 billion, is expected to increase to \$12 to 13 billion over the next seven years. The list of companies to watch presented here is not intended to be exhaustive but rather representative of new technologies that are already being used in the field to fundamentally change agricultural practices.

HARVESTING AND PICKING

Abundant Robotics

Hayward, California

Crops:

- Apples

Apple picking system co-developed with Washington state apple growers.

The robot uses AI technology to identify ripe from unripe apples. Once identified, the robotic hand uses a vacuum system to pick the apple from the tree and deposit into a bin.

Agrobot

La Palma del Condado, Andalucia, Spain

Crops:

- Strawberries

Multi-arm robotic harvesters using AI for strawberry picking.

Robotic Harvesters use AI to determine ripeness and up to 24 arms (each with a camera) to pick by the stem, without contacting the fruit.

LABOR SAVING

Strict enforcement of increasingly stringent U.S. immigration laws is increasing the difficulty of hiring competent and qualified labor in production agriculture. While the national median annual cost of a U.S. farm worker in 2017 was \$23,730 (\$11.41 per hour), the median cost for farm labor in California, where the adoption of robots is experiencing the fastest growth in the U.S., is \$20 per hour. According to a California Farm Bureau Federation survey conducted in 2017, 55 percent of responding growers have experienced labor shortages in recent years. For a majority of growers who are growing high-value crops, such as berries and grapes, which are difficult to harvest mechanically, the labor shortage is particularly challenging.

The adoption of robots as an integral part of farm production provides labor cost savings and generates increased operating efficiencies. For example, the **Harvest CROO** Computerized Robotic Optimized Obtainer can pick a single strawberry plant in eight seconds and cover eight acres of strawberry fields in a single day, replacing the labor of 30 pickers.

DRONES

While drone or unmanned aerial vehicle (UAV) technologies are not covered in the 25 companies included on the "Companies to Watch" list, drones are playing a key role in enabling growers to collect more actionable data on a timely basis, facilitating faster and more informed decisions.

AgEagle of Neodesha, Kansas, uses UAV aerial imagery for data collection and to conduct analytics supporting sustainable and precision farming practices. For commercial growers, AgEagle's drones take thousands of high-resolution images to produce detailed prescription maps, identifying diseases, pests, weather impact, etc.

The use of UAV technology is also taking off in Europe. Unlike other players in the drone imaging space that use multispectral imaging to map farmland, Gamaya, a Swiss developer of drone imaging technology, has developed a lightweight and data efficient 40-band hyperspectral camera combined with artificial intelligence to capture and analyze crop information that growers can use to significantly enhance their decision making. While it is a more expensive technology to use, hyperspectral imaging provides increased insights to growers via the use of multiple light spectrums that capture the reflection off of plants to measure the chemical composition of those plants. This provides insights on the plant's health and development during the season. Combining this technology with advancements in artificial intelligence, Gamaya believes it can increase the efficiency of capturing data in the field and improving productivity, while minimizing the environmental impact caused by intervention in the field.

Clearpath Robotics

Kitchener, Ontario, Canada

Crops:

- Apples

Developing a variety of robots for use across numerous agricultural applications

Clearpath robots use automation technology with a mounting platform which can be customized with a variety of sensors, manipulators, etc., to fit specific needs of growers.

Dogtooth Technologies

Royston, Barnsley, United Kingdom

Crops:

- Berries

Automated strawberry picker with capability to identify, locate, and pick ripe fruit.

The robots use "state-of-the-art computer vision and machine learning software to achieve visual acuity, dexterity, and picking speed," according to the company.

Energid Industries

Cambridge, Massachusetts

Crops:

- Citrus fruits

Energid has developed a robotic citrus fruit harvesting system offering significant cost and labor savings to growers.

According to Energid, the robot uses "multiple low-cost picking mechanisms organized into a grid. The extending parts of the picking mechanisms have no actuators and no sensors, making them robust, easy to manufacture, and easy to replace."

FFRobotics

Benei Dror, HaMerkaz, Israel

Crops:

- Apples

The FFRobot is a fruit picker with the ability to identify ripe fruit and collect & analyze data.

The robot uses image-processing technology and advanced algorithms to distinguish ripe fruit from damaged, unripe, or otherwise unusable fruit. According to the company, the robot will be able to be modified for different types of fruit.

Harvest CROO Robotics

Plant City, Florida

Crops:

- Strawberries

The **Berry 5** is an automatic harvester used for strawberry picking.

According to the company, the harvester uses "multiple robotic components to separate the picking functions of leaf gathering, visual inspection, picking, and then packing. This allows us to build simpler robots, which run faster and operate at the scale needed to support current farm operations."

Naïo Technologies

Toulouse, France

Crops:

- Leafy greens

The **Oz Weeding Robot** weeds, hoes, and helps farmers during harvest.

The Oz robot is meant for smaller fields and indoor growing environments. It is autonomous and can be controlled with a remote control to schedule, control, and adjust work plans.

Root AI

Somerville, Massachusetts

Crops:

- Tomatoes

The **Virgo 1** is autonomous and meant for indoor farms. It uses AI technology to identify ripe tomatoes and pick them without bruising the skin.

The robot uses sensors and cameras to navigate the greenhouse and identify ripe tomatoes. Robotic grippers have the capability to reach into vines and only pick ripe fruit. The arm is washable, making it easier for indoor farms to manage disease.

Tortuga Agricultural Technologies

Denver, Colorado

Crops:

- Strawberries

Developing robots for harvesting strawberries in controlled growing environments.

Robots use robotics, machine learning, and AI to pick, pack, and trim strawberries in a variety of indoor growing applications.

SORTING AND PACKING

Robotics Plus

Tauranga, New Zealand

Crops:

- Apples

The **Robotic Apple Packing Cell** sorts apples into trays for packhouses around the world.

The Robotic Apple Packing Cell includes a robot with the ability to pick and place the apples into trays, as well as the capability to orient the apples in the correct direction.

SPRAYING, PRUNING, MOWING, AND SEEDING

Agco Corporation (Fendt)

Marktobersdorf, Germany

Crops:

- Corn

Fendt's **Xaver** system is a series of 6-12 small robots which use swarm technology to sow, control weeds, collect data, and monitor corn planting.

According to the company, "Fewer sensors, robust control units, and a clear hardware structure make each individual Xaver robot extremely reliable and productive. At the same time, the use of a large number of small, identical robots operating in a swarm enables smooth running of the job, even in the event of the failure of a single unit."

Augmenta

Athens, Greece

Crops:

- Row crops

The **Field Analyzer** plug-n-play device mounts on tractors to help farmers more accurately fertilize.

The **Field Analyzer** uses AI technology to compile 4K video using hyperspectral computer vision and crop-focused intelligence to apply the precise amount of fertilizer.

Autonomous Solutions

Mendon, Utah

Crops:

- Broad acre crops

Autonomous tractor vehicles capable of operating 24 hours per day.

According to the company, "Each unmanned farm vehicle is equipped with a series of hardware and software components that permit a user to toggle between manual and robotic control. The components work with the existing by-wire, mechanical, or hydraulic control system and link vehicles to a central command station, allowing a single operator to simultaneously manage multiple vehicles throughout a farm operation."

Bear Flag Robotics

Sunnyvale, California

Crops:

- Broad acre
- Row crops
- Orchards
- Vineyards

Self-driving technology for farm tractors.

Bear Flag's technology uses perception sensors and robotic actuators to navigate fields and perform a variety of common farm tasks.

Blue River Technology

Sunnyvale, California

Crops:

- Cotton
- Soybeans

The **See & Spray** uses smart technology to more precisely apply herbicides.

The **See & Spray** uses computer vision and artificial intelligence to differentiate between plant and weed and apply herbicide only to the weed.

Deepfield Robotics

Ludwigsburg, Germany

Crops:

- Sugar beets

The **BoniRob** robot navigates fields, identifies and smashes weeds.

Rather than picking weeds, the robot uses a camera to identify them and stamp them down into the ground.

FUNDING

The following are examples of recent investments in ag robotics:

Most notably, **Blue River Technology** was acquired in 2017 by John Deere for \$305 million. Blue River's See & Spray devices combine machine learning with robots to pinpoint exactly where on a plant the application of herbicides will be most effective, thereby significantly reducing the overall usage of crop inputs.

More recently, the Swiss company **EcoRobotix** developed a 100 percent autonomous robot powered by solar energy to apply herbicides. The company announced in 2018 that it had raised \$10.7 million in Series B funding led by the French ag innovation fund Capagro and BASF's venture capital group. Rather than relying on operation by a human, the robot uses a camera, GPS, and sensors to navigate and identify weeds to be treated by robotic arms applying the herbicide. Solar powered, the robot can operate autonomously for up to 12 hours at a time.

ecoRobotix

Yverdon-les-Bains, Switzerland

Crops:

- Row crops

100% autonomous robot uses solar power to precisely apply herbicide.

Rather than human operation, the robot uses a camera, GPS, and sensors to navigate and identify weeds. Robotic arms apply herbicide. Solar powered, the robot can run up to 12 hours at a time.

Rowbot Systems

Minneapolis, Minnesota

Crops:

- Row crops

Self-driving rowbot equipped with sensors and GPS technology capable of spraying fertilizer.

Rowbots are intended to work in teams, navigating a row crop field during high growth season, and spraying fertilizer in precise amounts.

SIZE OF FARMING OPERATIONS USING ROBOTICS

The increasing adoption of robotics in agriculture is not just taking place in large-scale row crop operations. It is also being deployed in emerging markets where small scale agriculture is more pervasive.

In India, **TartanSense** is developing robotics and AI solutions specifically designed for use in small farms. The company's semi-autonomous robots are mounted with cameras and pesticide sprayers that use AI algorithms to identify weeds to be destroyed versus plants. **TartanSense** was founded by Jaisimha Rao in 2015 after he observed a lack of data-driven decision making on his own family's coffee plantation.

In order to support the growing indoor farming sector, Massachusetts-based **Root AI** has developed a robot called Virgo 1 that uses sensors and cameras to navigate greenhouses to identify ripe tomatoes. The robot's grippers can reach into vines to identify and pick only ripe fruit. The arm is also washable, enhancing the ability of indoor farms to avoid and manage diseases.

TartanSense

Bangalore, India

Crops:

- Cotton

Robotics and AI solutions for small farms

Semi autonomous robots mounted with cameras and pesticide sprayers use AI algorithms to identify weeds vs plants.

Wall-Ye

Macon, France

Crops:

- Grape vineyards

Mobile vineyard pruning robot

The robot uses AI and GPS technology to navigate the vineyard, identify key plant features, capture and use data, and prune leaves.

THINNING AND WEEDING

AgMechtronix

Silver City, New Mexico

Crops:

- Lettuce

Automated row crop thinner

According to the company, "the Agmechtronix Row Crop Thinner (RCT) is capable of thinning row crops such as lettuce using computer machine vision to identify plant locations and a herbicidal spray to eliminate the unwanted plants, replacing the traditional thinning method of hand labor."

F Poulsen Engineering

Hvalso, Denmark

Crops:

- Lettuce
- Cabbage
- Fennel
- Onions

The **robovator** is used to control weeds in row crops

According to the company, "The robot is equipped with a special plant detection camera above each row. It has a mechanical tool which is operated by hydraulic power."

TerraClear

Bellevue, Washington

Rock clearing

Developing an automated solution to clear rocks from farmland, a process normally involving significant manual labor.

TerraClear's system integrates GPS technology, drone capability, machine learning, and robotics to clear rocks from farms -- a solution to a labor intensive problem.

Vision Robotics

San Diego, California

Crops:

- Lettuce

The **VR lettuce thinner** uses intelligent spraying technology to identify unwanted plants. The thinner can cover 2-3 acres per hour.

The **VR lettuce thinner** uses cameras to identify and understand unwanted plants and only directs precise spray at those plants.

CONCLUSION

While agriculture throughout history has demonstrated that new technologies providing enhanced efficiency and labor productivity will be adopted rapidly, new technologies adopted from adjacent industries such as robots integrated with artificial intelligence promise to accelerate the pace of change, and revolutionize how food and crops are produced in ways we have yet to fully appreciate. 🌱

ABOUT THE AUTHORS



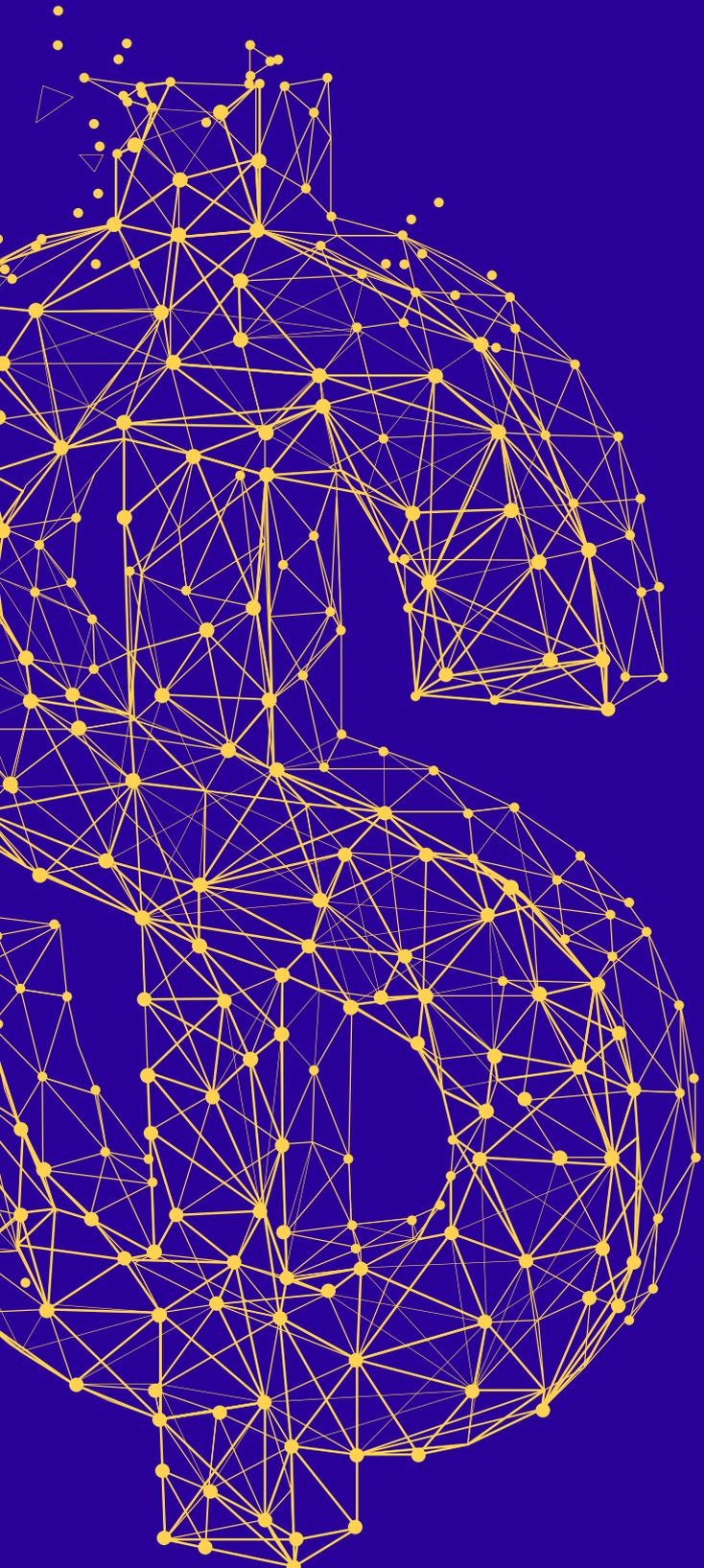
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Jonah Kolb

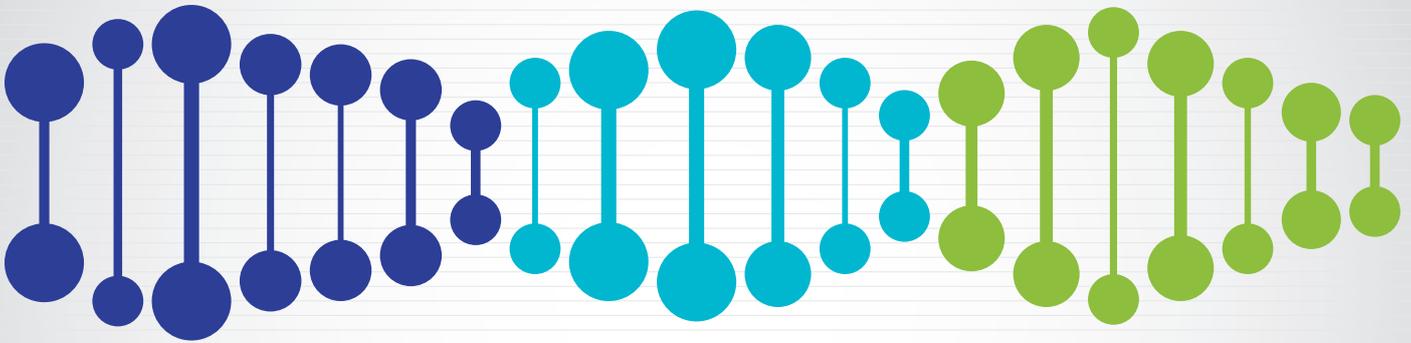
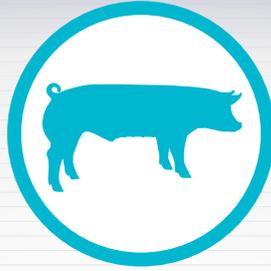
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What Does Gene Editing Mean for People, Pigs and the Planet?



1

PEOPLE

Healthy Pigs

=

Healthy Food

= **Healthy People**



**A COMMITMENT
TO FOOD SAFETY**

2

PIGS

More Resistant to Disease

=

Reduce Antibiotics Need

= **Healthy Pigs**



**IMPROVED
ANIMAL WELFARE**

3

PLANET

Healthy Pigs

=

Less Feed Consumed

= **Healthy Planet**



**SMALLER
CARBON FOOTPRINT**

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AGTECH:

Investment Trends to Watch in a Blooming Industry

By John Campbell, Ocean Park



The agricultural landscape has never looked more unpredictable, and deep changes may be on the way.

Farmers have adopted new technology for generations, but the speed, depth, and breadth of research and products hitting the market today is truly head-spinning. Dubbed “agtech”, the application of new breeding techniques, soil microbiome enhancements, and evermore precise field and climate data applications makes feeding a growing population on improved diets quite attainable. But this unfolds against the backdrop of a society with changing values on food production.

During the past five years, the U.S. agtech sector has shown rapid expansion, both in terms of the number and diversity of companies, and it continues to provide a growing source of investment for venture capital, private equity, and strategic players. With a future poised to bring more M&A activity in the sector, as well as capital infusion to the production side, agtech is on a path of true disruption. As you read the brief analysis below, see if you do not find yourself getting excited about the disruptive possibilities too!

AgTech Defined

For the purposes of this discussion, agtech will be classified into four segments:

- *Plant Health and Nutrition* – includes novel plant biologicals, breeding techniques, soil amendments, bio-stimulants, and bio-pesticides.
- *Animal Health and Nutrition* – includes animal disease vaccines and medicines, new animal feeds, genetic makeup, and livestock management.
- *Equipment and Data* – includes aerial monitoring, precision agriculture, agricultural equipment linked by the internet, big data, and data analysis services.
- *Food Technology* – includes cultured meat, novel ingredients, plant-based proteins, food safety, new production methods, and agricultural marketplace.

Top 5 AgTech Trends to Watch

- 1. The Rise of Problem Solvers:** The agtech industry will continue to grow as companies try to solve problems of sustainability, pesticide and herbicide resistance, antibiotic replacements, farm level productivity, and the challenging economics of traditional agricultural methods.
- 2. An Increasingly Diverse Landscape.** Since 2014, 282 agtech companies have raised \$5.5 billion of private capital across 481 transactions in the U.S. and Canada. Plant Health and Nutrition has attracted the most investment, with 159 deals raising \$2.2 billion, or 40 percent of all capital raised.
- 3. Robust Capital Raising Activity.** Agtech funding experienced substantial growth between 2014 – 2018, increasing from \$828 million raised in 2014 to \$1.4 billion in 2018, which represents a 13 percent CAGR. The average agtech capital raise has nearly doubled in size from \$7.7 million in 2014 to \$13.1 million in 2018, with activity growing most significantly in Food Technology and Plant Health and Nutrition.
- 4. Smaller Deal Sizes.** For the five-year period, the average M&A deal size was \$11.5 million, with 61 percent of all capital raises smaller than \$5 million and 27 percent larger than \$10 million. Since 2014, 86 agtech companies have closed 128 transactions larger than \$10 million. Plant Health and Nutrition had the most transactions (44 total) with deal sizes greater than \$10 million. Excluding the three largest transactions in each segment, the average deal size is \$8.4 million.
- 5. Fragmented Investor Base.** Since 2014, 219 institutional investors, including venture capital firms and family offices, have bet on agtech with transactions larger than \$10 million in size. Of note, more than 65 percent of those investors have participated in only one-off transactions. The 10 most active venture capital firms have made 112 agtech investments.

AgTech Capital Raises by Segment

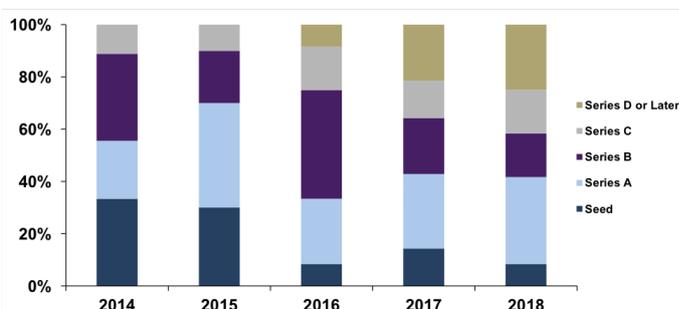
Plant Health and Nutrition

Plant Health and Nutrition (including biologicals) have raised the most equity capital of all the segments, totaling \$2.1 billion since 2014. The biggest year was in 2018 with \$787 million raised, led by Indigo with a \$250 million raise. Indigo also leads the pack for the five-year period, with over \$550 million raised in three funding rounds.

A subset of particular interest within this segment is biologicals, including biopesticides, bioherbicides, and soil biostimulants. In this class, we see fewer seed-stage rounds and increasing size of later-stage rounds. Fully 40 percent of the Plant Health and Nutrition investment category have been for biologicals. Significant capital raises include Indigo, Pivot Bio, Concentric Ag (formerly known as Inocor), Marrone Bio Innovations, and NewLeaf Synbiotics.

Biologicals Deal Activity⁽¹⁾⁽²⁾

Seed-stage activity has fallen over the past 5 years amidst increases in late-stage dealmaking.



Source: S&P Capital IQ, Crunchbase, AgFunder, Finistors Ventures and OP Research.
 Note: Graph only contains transactions with available data.
 (1) Includes transactions of biostimulant, biopesticide and biofertilizer companies.
 (2) Transactions included in Biologicals are also reflected in Plant Health and Nutrition statistics herein.

Animal Health and Nutrition

We saw little animal health and nutrition capital raising activity in 2018, but for the five-year period, companies raised \$831 million through 78 deals. Ginkgo Bioworks (which is not exclusively Animal Health and Nutrition) clearly led this category, capturing nearly 60 percent of the funding. Kemin, Calysta, Recombinetics, and Agrivida raised the balance of 40 percent among the top 10.

Equipment and Data

Since 2014, this sector has raised over \$1 billion. Leading the pack is Farmers Business Network (FBN) with \$150 million raised in two rounds in 2017. The 10 largest raises, totaling \$423 million, represented 41 percent of the all capital raised in the five-year period. In addition to the two FBN raises, Benson Hill Biosystems, FarmLink, Farmers Edge, CiBO Technologies, Caribou Biosciences, Mavrx, and FarmLogs rounded out the remaining 59 percent of capital raised among the top 10.

Food Technology

In the Food Technology segment (excluding food delivery), over \$1.6 billion of private equity capital has been raised since 2014. The 10 largest transactions accounted for nearly 58 percent of the total. In three raises, Impossible Foods accounted for nearly \$400 million, or 25 percent of total funding. Plenty, Impossible Foods, JUST, Ripple, Bright Farms, Beyond Meat, and Soylent rounded out the top 10 raises. In May 2019, Beyond Meat successfully raised \$241 million in its initial public offering.

Case Study: Ginkgo Bioworks

A fascinating success story, the Bill Gates-backed company Ginkgo Bioworks is not to be classified into one category. Once a billion-dollar startup, the company designs custom microbes for customers across multiple markets for a variety of end uses. The nine-year-old company may be the first billion-dollar unicorn in the agtech sector. Formed by a stellar team of MIT PhD students and old pros, including Tom Knight, former MIT professor and grandfather of synthetic biology; George Church, a Harvard geneticist; and Craig Venter, whose company, Synthetic Genomics, first mapped the Human Genome. Launched from the Y Combinator American seed incubator, Ginkgo has gone on to form functional groups.

On the ag front, Ginkgo formed a \$100 million joint venture with Bayer called Joyn Bio to focus on microbial fixation of nitrogen, thus leading to less synthetic fertilizer use. In the food sector, Ginkgo recently spun out Motif Ingredients in a \$90 million Series A round, led by Gates and fellow billionaires, aimed at plant-based proteins.

Similarly, Precision BioSciences and Recombinetics are not included in this analysis as their technology has wide-ranging applications toward agriculture as well as human and industrial efforts.

Recent Deal Activity

In year-to-date 2019, the Food Technology segment has attracted five of the 10 largest agtech capital raises, driven by rising consumer demand for plant-based foods such as meat substitutes and alternative proteins. Five Motif Ingredients, 80 Acres Farms, Clara Foods, Myco Technology, and TemperPack have collectively raised \$223 million, or 71 percent among the top 10 raises.

Agtech Funders

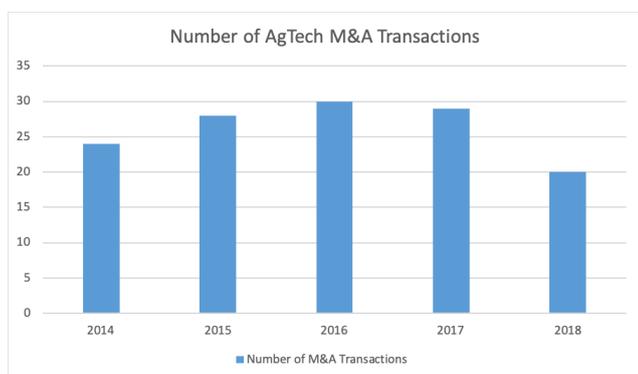
Since 2014, the 10 most active financial sponsors have made 112 of the 481 transactions, or around 23 percent of the agtech investments in the U.S. The most active investor, S2G Ventures, has made 17 investments spanning all four agtech segments. Khosla Ventures is close behind with 16 investments in all segments except Animal Health and Nutrition.

Among funders, Y Combinator, Google Ventures, MGVC, Middleland Capital, Cultivian Sandbox, Kliener Perkins, The Yield Lab, and Anterra Capital round out the top 10, each with multiple capital inserts across the spectrum of agtech. Many investors appear to be making intra-sector investments with multiple bets in the same space. These statistics indicate that financial sponsorship is widely diverse and not highly concentrated among a few funders.

Mergers and Acquisitions

Since 2014, there have been 131 transactions totaling \$6.3 billion of M&A activity. This analysis does not include the mega-mergers. Ten buyers accounted for 22 percent of transaction volume since 2014.

Number of AgTech M&A Transactions



Source: S&P Capital IQ, Crunchbase and OP Research.

Only 20 transactions were recorded in 2018, making it the quietest year out of the last five. The mega-mergers of Dow/DuPont with BASF, Bayer's acquisition of Monsanto, ChemChina's acquisition of Syngenta, the Agrium/PotashCorp merger that formed Nutrien, and Eastman Chemical's acquisitions of Taminco drew attention away from smaller deals.

We at Ocean Park believe that M&A activity will accelerate as these new mega companies complete their reorganizations and go back on the hunt for accretive acquisitions. The most active acquirers with multiple transactions in the period include Pinnacle Agriculture, The Climate Corporation, Scotts Miracle-Gro, Intrexon, Nutrien, Bayer, DTN, DuPont, John Deere, and Verdesian. These companies accounted for about 22 percent of M&A volume since 2014.

Key Takeaways and Forecasting

The agtech industry continues to garner significant investment and interest from institutional and strategic investors. We believe future trends are likely to include the following:

1. Agtech is a growing industry, which is likely to continue, both from the number of companies entering the space and from the amount of investments deploying in the industry.
2. Some subsectors are more highly invested than others, with Plant Health and Nutrition and Food Technology garnering the lion's share of capital invested.
3. Significant opportunity exists within underinvested sectors, such as animal health and food traceability, with promising, scalable technologies.
4. Larger deal sizes will rule the day. Transaction sizes are getting larger as companies in the industry begin to mature, and their financial capital needs increase in order to enter broader market commercialization.
5. As investment rounds grow, the target investor universe will expand to attract more sophisticated institutional investors, but whose demands for investment will require more polished marketing materials (i.e., teaser, management presentation, and financial model), and clear pathways to commercialization and profitability.

When we study agtech, we are really looking at food and the food production system. Is the recent Beyond Meat IPO a (vegetarian) flash in the pan, or are we seeing a fundamental shift in dietary patterns? Regardless, phrases like “sustainability” and “climate change” are on the lips of every major food retailer. We have yet to see how this filters down through the supply chain and what it means to farmers, ranchers, and the industries that serve them.

One thing is for sure – past technology has primarily pursued ever-higher crop yields and predictably lower prices, but we stand on the verge of that model's disruption. Today, a significant number of consumers show more concern about how their food is produced and its impact on the environment, human health, and animal welfare, rather than how much it costs. That trend shows no sign of slowing down.

For those companies able to crack the newly emerging social contract between food production and consumption, the future looks very bright indeed. 🌱

About the Author



John Campbell serves as managing director of Ocean Park, a leading boutique investment bank that advises on mergers and acquisitions, financings, and restructurings. Campbell spent over 20 years managing the Industrial Products division of Ag Processing (AGP), a multibillion-dollar value-added soybean cooperative and biodiesel producer. He served as Deputy Undersecretary of Agriculture during the George H.W. Bush Administration. He received his BA in Animal Science from the University of Nebraska and his post graduate Diploma from the University of Sydney, Australia in Agricultural Economics.

The Ocean Park team has significant operations and transaction experience in the renewable fuels, energy, food, and agribusiness sectors. Since its founding in 2004, Ocean Park has successfully completed over 60 transactions and client engagements. For more information, please visit oceanpk.com or call 310.670.2093.

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Executive Profile:

CRAIG RATAJCZYK

CEO of Illinois Soybean Association



Craig Ratajczyk has been at the helm of the Illinois Soybean Association (ISA) since 2010, and leads on the premise that second place is not good enough. "I don't recall anyone being happy with placing second. Illinois should be the number one soybean producing state, the global trendsetter for maximizing producer profitability through best business practices and market development programs, and the center for technology/innovation in soybean research. We can achieve that goal by remaining focused and committed to making a substantial and quantifiable difference," Ratajczyk said when moving into the role of CEO.

The vision of ISA, which represents more than 43,000 soybean producers statewide who support the organization through a checkoff program, is to enable Illinois soybean producers to be the most knowledgeable, sustainable, and profitable in the global marketplace. As a testament to that, Illinois has led all U.S. states in soybean production in five of the last six years.

Ratajczyk's invigorated focus on the benefits that Illinois producers can reap from successful incubation and implementation of agtech innovations led to the organization co-hosting *GAI's AgTech Nexus USA* this year, which is a two-day conference where producers, investors, and innovators convene to discuss opportunities surrounding this compelling, nascent sector. The goal of this partnership, said Ratajczyk in a recent

press release, is to "explore, examine and adopt the next generation of technological solutions that promise prosperity for our members, as well as make a sustainable and quantifiable difference in the sector as a whole."

GAI Gazette got the chance to better understand Ratajczyk's thought leadership during a recent interview.

1. ISA is co-hosting AgTech Nexus USA this year in July. What was the motivation for bringing an event like this to Chicago?

We realized we have the opportunity and ability to convene stakeholders of the agtech ecosystem in the heartland, and present the unique assets available here. We have world-class academics, innovators and investors, farmers and farmland, and Chicago is a world-class city.

Having AgTech Nexus USA in the heartland, at this time of year, allows us to be farmer forward. We hear from agtech innovators and investors that they want more access and engagement with farmers, and here it is. There is an incredible amount of excitement in Illinois about our ability to bring key agtech players together here in the same room.

When we opened the ISA Chicago office two years ago it was part of our board's efforts to be more competitive in promotion of the

assets of the state... beyond our farmers and farmland. Chicago is one such asset for improving the ability of our producers to compete globally. ATN will introduce more of the agtech ecosystem to resources available here, including manufacturers, innovation hubs, and efficient transportation/market access.

2. Agtech has not traditionally seen associations out front. Why is ISA getting involved, and what is its role and mission in this endeavor?

Global leadership requires the embrace of new technology, as disruptive innovation creates value at the expense of existing systems. ISA needs to help producers have a current focus, but with a view of the future, away from the status quo and toward opportunities that will help them and their successors thrive in a changing world.

Multiple, well-established farming agronomic and business practices are being targeted for radical reinvention in the current wave of agtech. As this occurs, we're working to ensure Illinois soybean producers are aware of, exposed to, and can position their operations to take advantage. We're a significant soybean producing state in the U.S., and need to maintain our edge domestically and worldwide.

One way to do so is to help speed agtech acceptance at the producer level in Illinois, accelerating the value being created. Faster adoption of new technology and practices at the producer level means quicker realization of benefits, not only at the producer level but more broadly across the state.

Another priority is to make sure the benefits being derived are inclusive, and not at a cost to producers. Agtech will create new value and ISA can generate return on checkoff dollars by influencing the ecosystem to ensure producers capture some of that value along with investors and entrepreneurs.

Finally, an advantage of being an association is that we can bring major players from industry, institutions, investor groups, entrepreneurs, and farmers, around the same table to strengthen the agtech ecosystem in Illinois. Private industry, the university system, and legislative efforts are all underway, and as an advocate for the interests of producers we're able to encourage and support these broader industry efforts.

3. Do you see broad adoption of ag technologies by ISA members? What can be done additionally to develop just-right innovation(s) and introduce them to producers?

Yes to the first question. Producers are already cooperating in the development and testing of digital and agronomic-based innovations on thousands of acres in Illinois.

To improve both value and pace of introductions we need to provide tech companies with the farm-level connections they seek for their product development. One crop cycle or perhaps a doublecrop situation in the Midwest limits both the number of modifications or versions of a technology that can be fielded in season, as well as opportunities for customer interaction. Understanding early in development the cost benefit to the ag producer, how the producer perceives the value being created, the ease of implementation/utilization, and then positioning that total value against other opportunity costs provides the feedback necessary to evaluate agtech feasibility.

And, education is key. To that end, ISA has created a program for the summer of 2019 to provide firsthand agtech exposure for producers, allowing them to evaluate innovations and familiarize themselves with the associated value propositions. In addition, the program provides participating agtech providers and financiers

"Agtech will create new value and ISA can generate return on checkoff dollars by influencing the ecosystem to ensure producers capture some of that value along with investors and entrepreneurs."

knowledge and insight into the current ag production system. This allows them to refine test programs already in-field, and also observe where inefficiencies exist, leading to new ag business/technology/operations models.

4. What value(s) does ISA see being created for producers as a result of increased agtech activity in Illinois?

First, exposure. We know we won't get thousands of our producers to Silicon Valley or other agtech centers, but we can expand their mindset and vision by bringing the latest in agtech here. Working with universities, government, other agriculture associations, and non-profits will help in establishing Illinois as a Midwest agtech corridor that will attract further investment/development and advance the economic/financial/environmental viability of soy to Illinois ag producers.

Second, familiarity. Some of the value generated will be recognized, such as creating additional efficiencies within traditional agronomic and economic structures. However, participating in development and testing in areas such as sensor data, data analytics, precision breeding and direct marketing opportunities allow ISA producers to observe firsthand what's required for brands to satisfy demands for transparency in how food/feed/fuel is produced.

Ultimately, increased activity and the accompanying education, exposure, and experience will help create an "adopt early mentality" among our producers, a mentality required for those producers and ISA to remain globally competitive.

5. What is the ecosystem for agtech like in the state of Illinois? Does ISA engage with other organizations -- associations, universities, etc. -- in its goal to increase agtech adoption?

Great organizations – from the agtech presence at the Research Park at University of Illinois Champaign-Urbana – to venture and private equity investors based in Chicago and downstate – to organizations like Illinois Corn, Illinois Pork, Illinois Beef, Illinois Farm Bureau, FARM Illinois, and others are all contributing to the developing ecosystem here. We have not had – yet – the coordinated efforts of some states, and that's part of the reason to co-host this event – to help kick-off that dialog with everyone in the room.

Our view is that we add value by being a catalyst and convener – we can get the right people in the room to share the ideas that spark innovation – and we're eager to work with any others that share our vision of a rapidly changing world and continued importance of the farmer.

6. What are some of the emerging ag technologies that ISA is excited about?

Everything related to sustainability, whether it's a combination of AI and mechanical, optimizing what's already in the field environment or creating novel new systems through synthetic biology.

An example of the first, AI and mechanical, already in the field on a trial basis are imaging, analytics, and application systems created to automate delivery of herbicides, insecticides, fertilizers, RNA applications, and more using the right source, at the right rate, at the right time, and in the right place. Less product used on a more precise basis means environmental and financial upsides.

Additionally, we see vastly increased utilization of autonomous vehicles, facilities, and farm equipment. Time and labor are major costs to any business and access to more efficient logistics such as autonomous grain trucks, container transports, grain elevators for delivery of grains 24/7/365, and field equipment (no one is in the equipment or sitting next to the field watching the equipment) will improve efficiencies as well as integrate data capture. Higher speed, higher capacity rural broadband networks organizations like Space X are examining will facilitate implementation of many of these technologies and directly impact producer profitability, to the positive.

For the second, optimizing what's already in the field environment, microbiome work from companies like Indigo Ag (recently landing the No. 1 spot on the CNBC Disruptor 50 list for 2019) is recognized by farmers and investors for the ability to improve the soil environment and maximize plant performance. Increased yields and reduced chemical applications are being noticed, with acreage treated with Indigo technology expected to expand from 1 million acres in 2018 to 4 million acres in 2019.

Synthetic biology efforts can really be game changers, if farther out. In one instance researchers are looking at improving the efficiency level of photosynthesis within the plant,

potentially improving plant health and yields with no additional inputs. A second area of exploration is related to land use. Marginal/contaminated soils could become more productive if genes with the ability to neutralize contaminants are created and expressed in the crop.

A common element in all of agtech is actionable data. We've had soil maps, weather patterns, yield history, and multiple other data sets for years but lacked effective tools to aggregate and analyze the numbers and turn them into useable information. Those platforms need to be more ubiquitous, with more competitive service providers. The digitization of agriculture, along with AI and eventually design intelligence is leading to a much more sustainable, competitive, and robust decision-making environment in our industry.

There are multiple reasons to anticipate tremendous societal benefits from agtech. The emerging winners in Illinois will have a common element of a solid financial proposition for ISA producers.

ABOUT CRAIG RATAJCZYK

Craig Ratajczyk started as CEO for the Illinois Soybean Association (ISA) in 2010. He has 22 years of experience in the soybean industry and 30 years of international experience. Prior to working for ISA, he worked for the United Soybean Board, American Soybean Association and U.S. Soybean Export Council. He recently retired from the U.S. Navy after serving more than 29 years, in both active and in a reserve capacity, with the U.S. Navy Intelligence Community.

Ratajczyk is a graduate of Southern Illinois University Carbondale with a bachelor's degree in international marketing and Russian language. He has an MBA from the American Graduate School of International Management "Thunderbird" and is an alumnus of the Harvard Business School. 🌱

"Ultimately, increased activity and the accompanying education, exposure, and experience will help create an "adopt early mentality" among our producers, a mentality required for those producers and ISA to remain globally competitive."

COMMENTARY:

*KEEPING YOUR EYES ON THE
ROAD OF AGTECH INNOVATION
BY JAMES COOPER-JONES, CEO OF CROPLOGIC*





I am travelling between CropLogic's operations in Oregon and Washington State on the I-84 and a 1978 Pontiac Firebird Trans Am Special Edition appears in my rear-view mirror. Black in colour it is unmistakable with its gold firebird on the bonnet and iconic T-top roof. It's as though it has just driven off the set of *Smokey and the Bandit*, and I half expect to see Burt Reynolds at the wheel.

In 1978 the American Muscle car, the Firebird, with the Ford Mustang, and Chevrolet Camaro, were the kings of the road. Their powerful engines quickly turned litres of gasoline into raw, adrenaline-pumping power. They were the envy of the neighbourhood, kings of the mountain. More efficient Japanese and European imports were no threat. Everyone knew that that hero of the car show was the American muscle car.

"I'm sympathetic, but with an increasingly environmentally conscious global consumer that has a hunger for traceability and how their food is grown, I'm unfortunately not optimistic."

But this landscape changed. In the 1970's gasoline was at its cheapest for many years, but this price more than doubled in the following decades.¹ A series of disasters and crises also brought environmental concerns front of mind for many consumers. This increase in the cost of inputs, such as gasoline, and an increasing environment awareness, changed consumer habits. This spelled the end of the era of the American muscle car as the dominant species on the road. In 1966 Ford sold 607,500 Ford Mustangs. In 2009 that number was 66,700.² In 1983 Toyota sold 52,621 Camrys. In 2009 that number has increased to 356,824.³ It was the smart investor who saw these trends in 1983 and backed the car manufacturers that were investing in more efficient engine technology.

As the Firebird flicks on its indicator, revs and moves into the left lane in preparation to pass me, my mind turns to a recent conversation with my agronomists in Mildura, Australia. Mildura, located at the juncture of three Australian states – New South Wales, Victoria and South Australia – is also located within the Murray-Darling basin, one of Australia's largest irrigation areas.⁴ During a crippling drought, the cost of irrigation water has more than doubled in the past 12 months in some Murray-Darling regions. There also is less water to go around as the Federal Australian Government, bowing to environmental pressures from an increasingly environmentally conscious electorate, has reclaimed significant amounts of irrigation water for environmental reasons.⁵

Growers hope that this increase in cost of inputs will translate to better prices for their produce. I'm sympathetic, but with an increasingly environmentally conscious global consumer that has a hunger for traceability and how their food is grown, I'm unfortunately not optimistic. Did muscle car manufacturing executives have similar aspirations that consumers would absorb increasing gasoline prices? My mind turns to how these pressures of high costs of inputs, such as water and changes in consumer practices, will affect farming methods. Will growers be able to afford to continue the less efficient growing methods of the past? As consumers get an ever-clearer window into how their food is grown, will they increasingly "vote with their feet" and buy food that uses less inputs and is kinder to the environment?

It makes me think about what role precision agriculture and agricultural technology have to play in this. The words "you can't manage what you don't know and you can't know what you don't measure" ring in my ears. It reminds me that data is the key to any process of efficiency. With data, trends can be identified and addressed. Accurate application of inputs such as water, fertilizer, and pesticides can be applied, and the impacts on growing



patterns can be monitored and recorded. Value can be even added when things go wrong through a process of lessons learned when accurate data is recorded. It suggests to me that data collecting agricultural technologies such as sensors and aerial imagery, which have the ability to record data remotely, objectively, and in real time, are likely to play a key role in cropping efficiencies in the future.

As the Firebird moves from my rear-view mirror across to my left side mirror and begins to pass me with ease I wonder, "if technology has so much to offer, and as many research institutes suggest, could add billions to agriculture industries around the world, what are the keys to its adoption by growers?" I remember reading the following from a CSIRO report: "If technology remains isolated from knowledge of agriculture and an understanding of the actual on-farm realities and business problems, then instead of contributing solutions it will remain on the shelf or be of interest only to niche hobbyists."⁶

This seems consistent with what my agronomist in the Tri-Cities, Washington

1 <https://www.titlemax.com/discovery-center/planes-trains-and-automobiles/average-gas-prices-through-history/>

2 <https://www.cjponyparts.com/resources/mustang-sales-throughout-years>

3 <http://carsalesbase.com/us-car-sales-data/toyota/toyota-camry/>

4 https://en.wikipedia.org/wiki/Murray%E2%80%93Darling_basin

5 <https://www.abc.net.au/news/2018-11-09/increasing-water-market-making-farmers-think-twice/10474518>

6 <https://blog.csiro.au/digital-agriculture-whats-all-the-fuss-about/>

"Will growers be able to afford to continue the less efficient growing methods of the past?"



State tell me. The Tri-Cities is located at the juncture of three significant rivers in the Pacific NorthWest -- the Yakima, Columbia, and Snake Rivers. Known as the Columbia Basin, this region has some of the best soils and growing yields per acre in the world. Some of CropLogic's agronomists have been servicing this region for 30 years and have a sound "knowledge of agriculture" and I have found them never shy of vocalising their "understanding of the actual on-farm realities". This has been to CropLogic's technologies' benefit, and a big part of its success.

The average age of growers in Australia and the U.S. is approximately between 55 and 60 years of age.⁷ And so although data is the key, this data needs to be interpretable and understandable to this target market – the grower. I reflect on what I once heard said, "For technology to work on the farm it needs to be complex enough to give you good and reliable data but simple enough to give the grower the answer they need at the click of a button." This process of "ground trothing" -- taking sound technology and combining it with practical "call a spade a spade", "no bones about it" real-life growing knowledge has the effect of producing a product that is understandable to the grower and easily integrated into their farm plan.

It then makes me think that when compared to other technology industries, perhaps the key to agricultural technology adoption is not one of disruption and displacement, but of collaboration and integration.

As the Firebird now pulls away from me, I reflect on the dramatic change this piece of road must have been witness to over the past 40 years, from the age of the Firebird, to the age of the Camry, to now perhaps the age of the Tesla. I imagine the rugged Firebird would look with disdain at the prospect of its crown passing to the likes of the clean-living Tesla, but as a wise man once said "Change is the law of life. And those who look only to the past or present are certain to miss the future,"⁸ and there is no doubt there is a fundamental change accruing in the agricultural industry. 😊

About CropLogic

CropLogic is an award-winning global agricultural technology company listed on the Australian Securities Exchange (ASX). After launching its product into Washington State, USA in 2017, CropLogic is currently servicing a significant portion of horticultural growers in this region, with a market share as high as 30 percent in some crops. Following significant growth (2017-2018) in Washington State, in 2018, CropLogic expanded into the Idaho, Oregon, and Australian market. CropLogic offers growers of irrigated crops agronomy expertise and digital agricultural technology applications, including CropLogic realTime and CropLogic aerial imagery, based upon scientific research and delivered with cutting-edge technology – science, agronomy, and technology interwoven into an expert system for decision support. <http://www.croplogic.com/>

About the Author

James Cooper-Jones is the CEO of CropLogic Limited and has overseen and been involved in the launch of CropLogic's suite of agricultural technologies and agronomy business in the USA, Australia, and New Zealand. Cooper-Jones is a passionate believer in the impact practical agricultural technology can have on the global cropping industry. Cooper-Jones also is a classic car tragic and is the proud owner of a 1965 MGB in British racing green, a 'project car' with his two teenage sons.

7 <https://www.usnews.com/news/blogs/data-mine/2014/02/24/us-farmers-are-old-and-getting-much-older>

8 J.F. Kennedy

SPOTLIGHT ON FFA:

Skill building for the next generation

By Mark Poeschl, CEO, National FFA



Arming the next generation of ag students with the tools to address exploding population growth and other global challenges in the food supply chain.



Chrysta Beck

Chrysta Beck from Ohio grew up raising chickens on her family's farm. When she joined FFA in ninth grade, she began experimenting with poultry health. Soon, the project grew in scope. By her senior year, Chrysta was testing how different probiotics, when injected into an egg before a chicken hatches, improved the chicken's health and reduced the need for antibiotic treatments. Chrysta now studies at Mississippi State University and plans to be a poultry veterinarian.

As a teenage FFA member, Eric Koehlmoos convinced his parents to let him build an ethanol production facility in the basement of their Iowa home so he could test switchgrass as the primary ingredient in ethanol. Eric's goal was to consider how lower-quality land could still be used as a fuel replacement to oil. Now he's studying to be an agricultural education teacher because he wants to "spark new ideas in the next generation of agriculturists."

Libby Baker-Mikesell, a Pennsylvania FFA member, lives in the Chesapeake Bay watershed, an area impaired by the phosphorous runoff created by large-scale production agriculture. As a student, she grew crops like buckwheat, sorghum, and oats to study, which resulted in the most phosphorus uptake to reduce runoff and restore water health. She learned that sorghum was the most beneficial, and helped produce new management practices for farmers across the region as they try to increase the health of the entire Chesapeake Bay.

Telling the stories of these FFA members and the countless others just like them is the best part of my job. They give me a feeling of hope and pride in what the next generation can do as we face daunting challenges. And, they show the result of the financial support FFA uses to deliver and grow the opportunities these students have maximized.

It's incredible to go to work each day knowing that we are turning the investment our generous supporters have made in FFA into a program that improves the lives and communities of our students, while moving the world toward solving some astonishingly large problems.

You've probably heard that the growth of our global population will require a 50 percent increase in the world's food and fiber output. In the next decade alone, we'll add one billion people to our planet that will need to be fed, clothed, and sheltered. Meanwhile, these extraordinary challenges are running head-on into major roadblocks such as global trade tensions and climate change. Another hurdle to

solving these problems is developing the next generation of leaders and workers who will have the talents, knowledge, and desire to find answers to it all.

This is where FFA is ready to make a difference. Students like Chrysta, Eric, and Libby are just three examples of how our local FFA chapters are the best way to develop tomorrow's leaders we so desperately need.

FFA has been around since 1928. Back then, when the organization was known as the Future Farmers of America, it was designed to give purpose and direction to young farm boys who lacked the opportunity to develop leadership and self-expression. Today, our focus is on lifting students in all communities to become the leaders, workers, and innovators who will meet the demand of our growing population. We've focused on being inclusive and robust in our offerings. FFA is giving students additional skills and a realization that their talents are valuable in the world economy.

FFA is students like Chrysta, Eric, and Libby – and more than 670,000 more who are engaged in the premier school-based youth leadership development organization in America. That's a record for our organization, and I expect us to reach 1 million student members in less than 10 years. More than any other school-based organization, FFA has the most prepared and extensive platform to deliver students who will meet the challenges of the next generation.

Yet we see these gains despite the difficulties in reaching every student every day. The biggest issue we face is a shortage of qualified teachers in agricultural education.

The model that makes FFA possible requires a school to have a functioning agricultural education program. Without that, students have no avenue to the leadership and life skills taught in FFA, nor can they access the competitive FFA events that encourage innovative and technological skill development.

That means we are laser-focused on recruiting and retaining teachers to guide agricultural education and FFA programs. Last year, nearly 50,000 students nationwide saw their experience in an agricultural education and FFA environment negatively impacted by a lack of qualified teaching professionals.



Eric Koehlmoos



Libby Baker-Mikesell

The demand for FFA programs by students, teachers, and community leaders is only making that challenge tougher. More student involvement in FFA and agricultural education is creating demand for additional instructors at successful programs. School boards and administrators are seeing the incredible value of FFA as the only leadership development program that offers the unique combination of classroom curriculum, experiential work-based learning, and leadership/ life skills.

Even with the challenges of making sure agricultural education classrooms and FFA can reach as many students as possible, we are actively building our organization to suit the needs of the 21st century.

We're doing this by increasing the relevancy of our programs, driving more teacher access to advanced training programs, and developing new concepts that detail the innovative and technological side of agriculture today. Our focus on engaging FFA members in innovation and technology hit a new level last year with our launch of FFA Blue 365 and the FFA Blue Room at the National FFA Convention & Expo. This initiative drew unparalleled attention from both traditional supporters of FFA, such as John Deere, and new ones like Microsoft and Amazon, and delivered such a stirring experience for students that more than 96 percent of the participants identified a new career interest after taking part in the FFA Blue Room.

It was thrilling to see such a positive reception to the innovative concepts our world desperately needs more of, and I look forward to growing those ideas further.

All told, FFA is a unique organization. If you come from a school that is tied to one of our more than 8,600 chapters across the United States, Puerto Rico, and the U.S. Virgin Islands, FFA might feel like a natural institution in the education environment. But the fact is, FFA is a nonprofit national organization funded largely by sponsors and donors. Without support, our model and our impact on students wouldn't exist.

But that also gives us an advantage. Our program is one that can exist in any educational environment. We're in public schools, private schools, charter schools, and even home schools in some areas.



We're built that way because we have to be. The students who will become tomorrow's leaders deserve the FFA experience, regardless of their school setting. I'm determined to make sure more and more students get that opportunity.

Since I've been at FFA, we've accelerated our pace to become more than a legacy organization that parents and former members remember fondly. We have sharpened our focus because it's clear that the world is demanding it. Our future is dependent on students like Chrysta, Eric, and Libby – and hundreds of thousands more behind them – to solve the massive challenges ahead.

The answers to an exploding global population and the strain of other global challenges won't come easy. But if we invest in solutions that are already producing students mindful of and willing to tackle the problems, we'll get there a lot quicker. 🌱

ABOUT THE AUTHOR:

Mark Poeschl has been CEO of the National FFA Organization and the National FFA Foundation since 2016. Poeschl spent 33 years in the animal nutrition industry. He began his career at Ralston Purina in 1983. He joined Carl S. Akey, Inc., in 1987, where he served as CFO, COO, and VP of operations. In 2007, Poeschl was named president and CEO for Provimi's North American business and later became Group VP for business operations in North America, Europe, the Middle East and Africa. In 2011, Provimi was sold to Cargill, and he was named VP, group director at Cargill Animal Nutrition. Poeschl earned a degree in agriculture from the University of Nebraska in 1983.

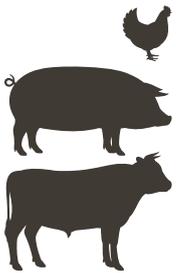
ALTERNATIVE PROTEINS ON THE RISE



Thirty percent of the calories consumed globally by humans come from meat products.



Global protein consumption will reach 943 MMT by 2054, rising at a 1.7% CAGR.



Alternative protein sources could claim as much as 33% of total protein consumption by 2054.



The global plant protein market was valued at US\$6.41 billion in 2018, and is expected to register an estimated CAGR of 7.1%, during the forecast period, 2019-2024.



Soy – the first generation protein – is expected to account for about 80% of the alternative protein market by 2024.

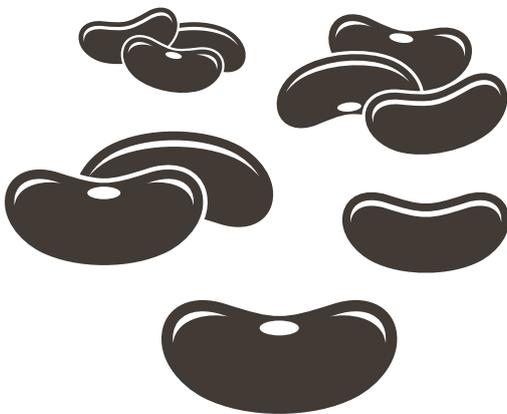


The “second generation” proteins – pea, rice, canola, etc. – and “third generation” – insects, algae, and synthetic biology – could make up as much as 50 percent of alternative protein market by 2054.





North America is the most prominent market for plant-based proteins.



Plantings of U.S. pulse crops – dry beans and peas, lentils, and chickpeas – are up 69% since 2013.



Sales of pulse-focused foods are up to \$800 million annually, up from \$10 million in the late 1990s.

A Plant-Based Products Council, that includes the likes of Cargill and ADM, was founded January 2019.



THE DEALS

2015

Impossible Foods' second round raised \$108 million to further its plant-based burger that "bleeds its own blood".

Beyond Meat raised \$17 million from investors.

2016

Memphis Meats received an investment of \$17 million to put towards its lab-grown meat, where the cost of its first "meat" was \$18,000 per pound.

Tyson Foods became the first meat company to invest in an alternative meat company, **Beyond Meat**.

2017

Maple Leaf Foods acquired plant-based protein manufacturer **LightLife Foods** for \$140 million.

Nestlé, the largest food company in the world, acquired plant-based foods manufacturer **Sweet Earth**.

Hollywood director **James Cameron** and his wife, **Suzy Amis Cameron**, formed **Verdient Foods**, the largest organic pea protein facility in North America.

2018

Cargill made an undisclosed investment in **PURIS**, the largest pea protein producer in North America.

Aussie venture capital firm **Blackbird Ventures** led a US\$6.87 million Series A for **SunFed**, a New Zealand-based maker of plant-based meat alternative products made from pea protein.

Ingredion made \$140 million in strategic investments in pea protein opportunities.

2019

Impossible Foods received another \$300 million in funding for a total raise of \$687.5 million.

Beyond Meat saw its stock price surge 163% after its IPO in May.

What We've Heard... about AgTech

"Most growers will try any technology but the issue is to focus on the business problem you're solving and understand that first, then make strong user-centric designs with the grower at the center of that..."

Ros Harvey
Founder of The Yield

"We imagine the combination of satellite data and machine learning providing a spectrum of insights to growers - from the past, in the present, and for the future of their farms."

Geoffrey von Maltzahn
Co-Founder and CIO, Indigo

"Some of the innovative trends that the team will be following include vertical farming, alternative protein products, packaging that significantly extends the shelf life of products, and agricultural technology companies with monetizable value propositions."

Deborah Perkins
Global Head of Food and Agribusiness, ING

"Overall, from the start-up and investor front, there is often a lack of understanding of farm operations/ stage of digitization on farm, and what technologies really drive value for growers.... Better alignment will come when we focus on tools that are easy to adopt and do not reinvent farming paradigms."

Arama Kukatai
Finistere Ventures

"One thing that sets agtech apart is the success rate: about one in 10 agtech startups will succeed, while in pharma the number is closer to one in 1,000."

Dr. Michael Helmstetter
CEO of TechAccel

"Consumers want foods that are sustainably produced and traceable, with benefits beyond basic nutrition. We're investing in startups that can help meet these new standards for productivity, environmental sustainability, and social responsibility."

Nick Rosa
*Managing Director,
Cultivian Sandbox*

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