When the bees stole their nectar, they decided to find a replacement

Eylam Ran could not come to terms with the fact that in the 21st century, when so much agriculture is based on advanced technologies and controlled almost completely by man – one tiny insect controls crop yield and feasibility. Here's the alternative solution he developed.

By Shelly Kling

For nearly 20 years, Eylam Ran worked as VP of R&D and Engineering at Plasan, an Israel-based protected vehicle manufacturer, located on Kibbutz Sasa, the place where Eylam was born and raised. Around the age of 46, after deciding to change course professionally, he quit the factory and started looking for a way to combine his mechanical engineering expertise with his passion for agriculture.

One evening, he attended a lecture given by Dr. Gad Ish-Am, an expert in botany and a kibbutz member, whose Ph.D at Tel Aviv University dealt with bee behavior and the relationship between bees and agriculture, with a special focus on Avocado orchards. Among other things, Ish-Am's talk highlighted the challenges faced by bees and humans in what he described as a forced relationship. He described a situation that Ran recalled from his time as a farmer, when he was responsible for the irrigation systems on his kibbutz's fruit plantations, in the 1990s, before his move to the defense industry.

"There was this period when the harvest failed in the kibbutz's apple orchards, which of course, was very damaging for the farmers," says Ran. " Dr. Ish-Am started to investigate why this had happened. He discovered the bees had found a way to enter the flower and extract nectar without touching the pollen. Because bees do not need the pollen, (apart from tiny amounts which they use to feed their larvae), they treat pollen as a nuisance that gets in their way and weighs them down. Bees communicate with each other and share information through a kind of dance, so it wasn't long before all the bees in the hive had learned this pollen by-pass manoeuvre and actually stopped pollinating the apple trees, which resulted in a major loss for the farmers and the kibbutz".

Ran describes this phenomenon as "nectar theft perpetrated by bees" since the hives are rented to pollinate the flowers, but the bees only take the nectar without doing their work for the farmers. According to Ran, this illustrates the highly problematic dependence that farmers have with bees, in addition to many other issues described by Ish-Am's research.

"As Gad spoke, the penny dropped for me big time! How could it be possible that in an age where advanced technologies, like automation and sensors, were rapidly being introduced into agriculture, when it comes down to it, everything depends on a tiny insect doing its job. One of my colleagues who was sitting next to me, who knew I was looking for an agricultural project to take on, gave me a nudge and said to me: 'Design a better bee!'. It was then I realized that I would create a mechanical pollination system, and Edete was in its way."

In 2016, Ran founded "Edete - Precision Technologies for Agriculture", whose goal is to provide a feasible solution for the problem of pollinating agricultural areas covering tens of thousands of acres.

Edete - Precision technologies for agriculture

Established: 2016 **Founders:** Uri Inbar, Keren Mimran, Elad Etgar and Eylam Ran **Employees:** 16 **Raised capital:** $14 million **Prominent investors:** Prof. Avraham Neuman, Prof. Yair Tauman, Prof. Ilon Kohlberg, Zohar Gilon, Dan Barnea, Uri Inbar.

Despite the advanced technologies applied in the field of agriculture, and almost total human control over all the parameters related to agricultural crops, the most important element - the pollination of flowers, without which fruits, vegetables and any kind of agricultural yield cannot grow - remains outside of human control. In fact, it is made by two completely capricious factors: wind and insects, with an almost total reliance on bees in particular.

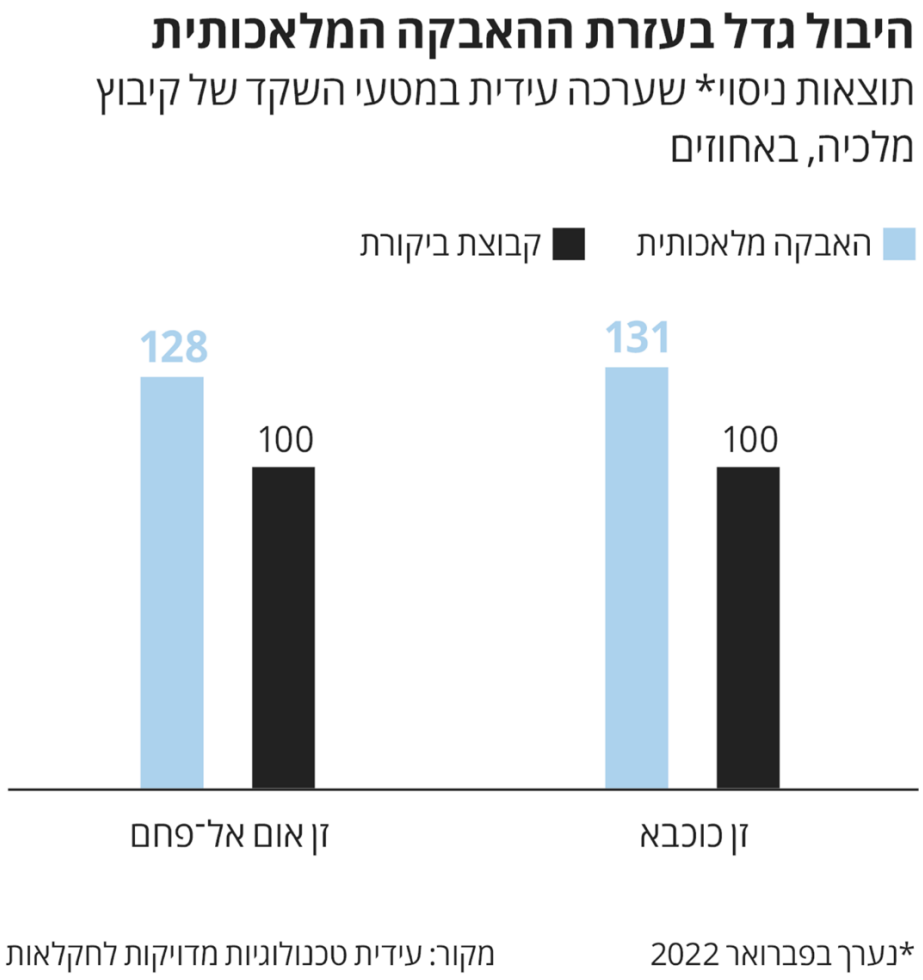
The rapid growth in the world's population and the constant need to increase the production quota of agricultural produce for economic reasons has driven the adoption of aggressive agricultural methods, including over-spraying, deforestation and monoculture (a method where only one type of crop is grown on a massive scale, dominating land utilization). Such methods harm the planet and contribute to climate change, resulting in the loss of natural habitats for insects and animals. This leads to a vicious cycle: an outbreak of diseases, the persistence of natural pests, the need for increased chemical spraying and a doubling down on monoculture agriculture.

Growth in yields using Precision Pollination
Results from trials conducted by Edete in Almond Orchards in Kibbutz Malka (in %)

Precision Pollination
Control Group

Cochava Variety
Uhm Al-Fahm Variety

Conducted in February 2022
Source: Edete – Precision Agriculture Technologies.



These actions and their consequences have dramatically degraded the population of pollinators, leading, in some cases, to their complete disappearance in various regions of the globe. 75% of the food humanity consumes, including vegetables, fruits and animal feed, are pollinated by bees. The remaining 25% are wind-pollinated crops such as corn, barley and wheat. Insects simply cannot keep up with the pace and scale of the agriculture that feeds the world.

A quick web search brings up images of Chinese farmers, dressed in traditional clothing and holding wooden brushes and pom-poms, climbing almond trees and pollinating them by hand. The pictures look pastoral, but the reality behind them is scary. As a result of over-spraying, the bee population in China has completely disappeared and whole families of farmers pollinate the flowers by hand, so as not to suffer loss of livelihood and starvation.

"Edete's Coca-Cola formula"

Ran was not entering an empty space. At that time, several international companies were engaged in harvesting pollen for commercial sale. Ran believed that since methods for collecting pollen existed, the need was to develop a mechanical solution to do the job of pollination instead of the bees. However, a few months after beginning development, Ran and his partners - Keren Mimran, Uri Inbar and Elad Atgar - realized that in addition to

developing a machine that would disperse the pollen on the trees effectively, they would also need to develop a method to mechanically harvest the pollen from the trees.

“All over the world, farmers do this process manually. They pick the flowers by hand, shake and dry them. It's time-consuming and very expensive. What we are doing is industrializing this process”, Ran explains.

The small output of hand-collected pollen cannot allow pollination of all the plants over many acres. The pollen produced manually today is often sold for "inserts" due to the difficulty that usually exists in collecting pollen in large enough quantities. Insert is a device that fit on the front of a beehive that contain a small quantity of pollen, bees must walk through the pollen as they exit the hive, picking up pollen and thus delivering additional pollen to the crop. But even in cases where the pollen can be collected relatively easily due to the nature of the crop - for example, in the date crops in the Jordan Valley - the dispersal of pollen back onto the trees is done in a non-precise scatter-gun way, which results in wasted raw material and allergies among residents of the area.

Operating in this domain requires an intimate understanding of bee behaviour. According to Mimran, the VP of Marketing and one of the company’s founders, "There is currently no alternative to the systematic pollination of flowers, other than using beehives. Increasing the amount of bees per area is impossible, because bees enter into competition with themselves and become aggressive. To get round this problem, farmers expand the agricultural area by cutting down more forest.”

"Even if one overlooks the ecological component, there’s a limit as to how much the amount of agricultural land can be increased," adds Ran. "The UN estimates the amount of agricultural land than can be increased by uncontrolled logging is about 10%. In about 30 years, the world's population will increase by 40%, so there is no real solution other than producing more agricultural crops from the same existing area already designated for agriculture."

Edete’s offices and research laboratory are located in the Bedouin settlement of Semat Tivon, a location chosen because it is recognized by the Innovation Authority as a Development Zone A. This provided the company with a financial investment of 2.5 million dollars at the beginning of its journey, a stamp of approval for potential investors.

Since its establishment, the company has raised $14 million and is set to raise another $4 million by the end of the year. Apart from Basmat Tivon, its research and development is also carried out in Bethlehem of Galilee and Emek Hula. The process of producing the pollen from flowers includes harvesting the flowers from the trees, sorting them and separating them from dirty material such as branches and dust, and then separating open flowers from mature buds i.e., flowers that have not yet opened and whose pollen has not become dirty and lost its quality.

As part of the research, specially produced artificial flowers made from silk are used. "One of the significant problems in R&D is the desire to avoid losing a season. A blooming season lasts about four weeks - a short time in which we must develop and test the actual application at the same time. We use artificial flowers to compensate for the weight and

mechanical properties of real plant material, in order to continue to finetune the behavior of the machines between seasons," explains Ran.

According to Ran, controlling the process of pollination and fertilization must also utilize the trees themselves. As such, Edete's pollination plan includes planting male tree plantations, which will allow the flowers to be picked for the purpose of harvesting their pollen. "Today the plantations are designed in a way that takes into account the picking of the fruit, but we are interested in picking the flowers. Pollen collection is typically done by shaking but we are interested in collecting the pollen together with the flowers, so the plan is to plant the plantation in such a way as to create a wall of flowers, which will allow machines to pick the flowers and collect them without the need for shaking - which causes the loss of precious raw material."

However, in order to develop such a plantation, a long process is necessary which requires overcoming the short flowering period of trees. "In collaboration with a nursery, we developed a method for taking young trees that are used to blooming in February and making them bloom in June and July as well. We put young trees into a long winter and wake them up in the summer instead of the spring. This allows our R&D department to continue testing and researching throughout the year and not just during the short blooming period. We don't want spend a year in the lab, then come to the season and discover there's a difference between what we discovered in the petri dish and the real thing".

After sorting, the flowers are transferred to a mobile environmental controlled container which is, where what Ran calls "Edete's Coca-Cola formula" takes place. "In order to produce high-quality pollen from the flowers, one must avoid drying the flower when extracting the pollen – because this impairs its quality. One of our innovative developments is a process in which the flower releases the pollen of its own accord - the flower goes through a series of processes involving changes in temperature, humidity and wind, which tricks it into thinking it is the right climate for it to open and release its pollen. This step is critical, because pollen must be collected quickly from the flowers - before it spoils. This process is carried out in a refrigerated container which can be transported by sea if necessary."

Once again, it is the challenge of the short blooming period that explains the need for this complex process. "Within a three to four week time window we must both collect the pollen and pollinate the plants. Therefore, if we don't have a bank of pollen that we can disperse during flowering - we fall into the same statistics of natural pollination."

Another problem is that flowers in the study have to be obtained from existing trees. Today Edete collaborates with farmers who are interested in helping achieve the vision of a sustainable pollination future. "We collect flowers from farmers and pay for the loss of the crop in the event that the plant is monoecious – that is, having both female and male flowers. When such a tree is shaken, the farmer loses about 15% of the crop (female flowers that could have developed into fruit also fall). Therefore, there is compensation. But if we are very efficient in the production process, and use only 3% of the crop area, and in the rest of the area we increase the yield by 25%, it makes financial sense for the farmer."

The autonomous pollinator, which was developed and tested in Israel, California and Australia, stands 7 meters tall and can be extended up to 10 meters. It includes drying and air cooling functions that preserve the pollen, which exits the machine through 15 thin outlets in a complex process, during which it is electro-statically charged to create - before the pollen reaches the tree - a layer of pollen that Ran likens to a wall or a tiny cloud.

In this way, the sticky pollen is turned into optimally dispersable magnetized particles, thanks to the fact trees are naturally grounded and create an electric circuit. The idea came to Ran and the R&D team from the field of car spraying, which today is done by charging the vehicles and the paint powder in reverse electric chargers, which causes the powder to be attracted to the body of the vehicle to ensure a more uniform and complete application of paint.

Ran explains that "a tree has mineral water that feeds it with salts and nutrients from the ground, which cause it to actually form an electric circuit, so electrically charged pollen sticks to the tree and to the flowers. During the flowering season, most of the tree's energy and nutrients are invested in the uterus - in the flower. Most of the electro-static effect focuses on the center of the flowers. The pollen not only sticks to the tree, but has a tendency to 'run' and stick to the female organs of the flower. In this way, we can be more efficient than the wind or the insects. In Nature there is tremendous over-compensation - a flower produces 10,000 times more pollen particles than necessary, knowing that a significant part of it will go to waste. We take advantage of this process, because we remove all the pollen particles from the tree and return them to the tree in a much more efficient fashion. This way, I can improve the processes of nature in the agricultural environment, which is completely unnatural."

Another feature taken from autonomous vehicles is LiDAR - autonomous laser-based object detection technology - which is installed on the autonomous pollinator and scan the tree, thus allowing the machine to choose whether to approach or move away from the tree and shoot the pollen from a distance of 30-40 cm away, minimizing waste and damage to the environment. "In the event that different varieties are grown in the agricultural area, the system will make sure to create turbulence inside the tree using blowers, thus creating internal pollination without spilling over to other trees. The system synchronizes the various tractors working in the field, and each machine is equipped with a computer that is fed with many parameters, such as the amount of air, cooling, the size of the tree, the required distance, and more."

Spring comes twice a year

Since 2016, Edete has conducted extensive pilots and collaborations with farmers and large agricultural companies in Australia - mainly in the wind-pollinated pistachio market, and in the USA - in the bee-pollinated almond market.

"Our activities in Australia and the USA allow us to gain a season, because in the southern hemisphere the seasons are opposite. In 2018, we started a research pilot in Australia with a contract for paid pollination, in collaboration with Select Harvest (Australia’s largest almond producer) after the CEO contacted me and said: 'We don't have a Plan B for the coming years, other than what Edete is proposing.' But due to Australia hermetically sealing its

borders during the corona pandemic, he put the pilot on hold and a refrigerator with pollen has remained there since February 2019. In Australia, we have a setup similar to what exists in Basmat Tivon, and the pollen bank is in the hangar of the farmer we worked with."

The focus at the moment is on the almond market, which is constantly growing. Global almond consumption is constantly increasing, driven by the popularity of vegetarianism and veganism, while the almond, which is considered a super food, forms the basis for the production of milk and cheese substitutes.

Looking towards 2023, Edete is currently working on establishing a factory - which will include a production line a storage, and the pollination machines - in the San Joaquin Valley in central California where most of the world's almond cultivation is concentrated. With a value of around 7-8 billion dollars this year, 82% of the almonds consumed in the world are produced in this long narrow valley that stretches over an area of 58,000 km. These include vast agricultural areas belonging to large companies and conglomerates such as Blue Diamond Growers and Olam.

While almond trees are indeed pollinated by bees, bees don’t like pollinating this crop. In addition, because of the short blooming season, the bees are transported by the beekeepers - a distance of six hours traveling from farm to farm - which increases bee mortality rates and hive rental prices. In 2021, valley farmers spent a total of 530 million dollars on the use of beehives and manual pollination, and due to the rise in consumption of and demand for almonds, this amount is expected to double in the coming years.

According to Edete’s own data, which is based on publications of the United States Department of Agriculture, in 2001 the supply of beehives for rent for agricultural purposes in California was 2.5 million beehives, at a price of $44 per beehive rented for the flowering season. In 2021, the supply remained unchanged, but the amount of almond crops increased by more than 100% - from 2,144 square kilometers in 2001 to 5,382 square kilometers in 2021. A decade from now, the number of almond trees is expected to increase by about 50%, which will lead to an increase in expenses. In 2021, the cost of renting a beehive has already risen to $220. According to this data, by 2028 California growers will need a million more beehives than today. However, according to the current rate of bee extinction, the chance of meeting this growth is virtually nil.

Until now, we’ve carried out pollination of trees for research purposes only in plots of 2-10 acres in the Hula Valley and Tel Arad region in Israel, and in California and Australia. However, in February 2023, Edete is planning on doing a commercial pilot in cooperation with the valley farmers in California. "For the first time, we will pollinate outside Israel, across 70 acres with 7,500 almond trees of the Sonora variety," explains Ran, "which was planted to act as a pollination stimulus for other varieties in the field, but this is a variety that blooms early, so there is no yielding variety that blooms at the same time. We will enable farmers to achieve almond crop yields from these trees as well."

Eight pollination machines will be operated in California - four for almonds and four for pistachios. "We are working on contracts with farmers, aiming to pollinate 2-4 thousand acres for a fee. Many farmers have contacted us and are interested in cooperating without

payment on their part, because it is accepted that start-ups pay farmers to carry out experiments on their land, but Edete is not interested in this format.

“The service we provide has significant logistics and operating costs, and naturally we expect farmers to defray some of this outlay. My work over the years has taught me that payment is a sign of commitment and seriousness on the part of the farmer. For example, we once did a free pilot, but the farmer mixed our produce with other produce, and it ruined a year's work for us. In 2023, at the same time as the pilots, we are establishing a pollen production plant. In previous pilots we had to purchase pollen, but as we enter the market, we need to have the ability to produce pollen independently."

Ran predicts by 2024, Edete will enter the commercial market for pistachio pollination and by 2025 for almond pollination. "We plan to build a factory that provides end-to-end solutions, and in 2025 will provide a solution of 10 tons of pollen per season. A ton of pollen replaces about 5,000 beehives, and a farmer uses one beehive for every 0.5 acres."

Do you have competitors today?

"Not on a commercial agricultural level. If you want to find a real solution, you have to invest in it and operate as a manufacturing plant. Today people are looking to make an exit, they want to create something Google will buy, but that's not our mentality. We work in agriculture, and that means patience and playing the long game.”

When did you realize it was so complicated?

"When we realized pollen also needed to be harvested four or five months from the beginning of the process. This transformed the whole enterprise into an end-to-end project. I could have stopped there, but I didn’t. Because I realized what a catastrophe we and our children are heading for if we don’t find an alternative pollination solution for agriculture. We have a tremendous need to give the world a solution that doesn't exist, which will mean, in the future, it's not only millionaires who’ll be able to buy fruit and vegetables."