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Adapting Nature: The Revolutionary Journey of Francisco's Pollinator-Assisted Breeding Project

The initiative to document and share stories from projects within DeepSync offers a unique opportunity to connect with fellow members and innovators by showcasing each project's journey, including both successes and challenges. By highlighting the key moments and insights that have shaped your path, these stories contribute to a richer collective knowledge base. This effort aims to raise visibility, foster a deeper understanding, and enhance the sharing of knowledge across the community.

Francisco Pérez Alfocea *is a research professor at CEBAS (Centro de Edafología y Biología Aplicada del Segura), the largest public research body in Spain. Based in Murcia, a vibrant city in the southeast of the country, Francisco has spent years focused on improving tolerance to abiotic stresses in horticultural crops, primarily tomatoes.*

As a plant physiologist, Francisco has always been fascinated by the interactions within plants, particularly between the organs that generate resources and those that transport and utilise these resources for growth. In plants, this process is known as *source-sink relationships*. The "source" typically refers to the leaves, where photosynthesis occurs, producing the energy and nutrients needed by the plant. The "sink" refers to the parts of the plant, often the fruit, which receive and use these assimilates to grow and produce biomass, whether for human consumption or other purposes. His work has consistently focused on understanding and analysing these critical relationships.

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The genesis of the DARkWIN project, a **pioneering effort in pollinator-assisted breeding**, began in Francisco with a simple but powerful observation. Traditional plant phenotyping platforms, which rely heavily on imaging to assess plant health and growth, are often limited to small plants and struggle to effectively monitor flowering traits. These traits, however, are crucial as they are the most sensitive to environmental stresses like heat and water scarcity. Considering these limitations, Francisco decided to overcome them and began exploring alternative methods to analyse these critical plant characteristics on a larger scale.

The breakthrough came with the idea of using "natural drones" – pollinating insects – to assess the health and productivity of plants. "*I started thinking about how these insects, which have co-evolved with plants over millions of years, could serve as natural sensors*," Francisco explains. The hypothesis was that insects would naturally prefer plants that produce better food under stressful conditions, making these plants ideal candidates for breeding.

In 2017, Francisco began exploring the possibility of developing this idea, by first reaching out to a colleague in Madrid who specialised in electronic tracking systems. Together, they developed a technological setup that used RFID technology to track the movements of pollinating insects across a wide range of plants. Despite the challenges of working with such small subjects and the complexities of detecting insect-plant interactions, their experiments surprisingly yielded prominent results.

The next challenge ahead was securing adequate funding. After two unsuccessful attempts, they didn't lose hope, and the project finally received backing on the third try. "*The key was perseverance*," Francisco says. With the necessary resources, they constructed a state-of-the-art phenotyping platform within a greenhouse in Murcia, equipped with advanced tracking devices to monitor insect behaviour and plant interactions, in a so called 'Living IoT' technology.

Hence, the project's scope expanded significantly shortly after it began. After testing on 8-16 plants, the team is now working with **over 1,000 tomato plants**, with about 350 being electronically tracked for insect preferences. This large-scale experiment aimed to demonstrate that the system can reliably select the most resilient plants based on ecological decisions mediated by pollinators.

Bringing together a heterogeneous team of experts in entomology, genetics, robotics, and plant metabolomics, including members from **Spain**, **Germany** and **France**, the project represents a true interdisciplinary effort. "*It was crucial to involve specialists from different fields*," Francisco added.

As the project continues, Francisco and the team are amazed by their progress. "*So far, the results are better than we expected*", he says. The team is now in the process of presenting their findings to the industry, hoping to attract interest from international companies.

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On a personal level, Francisco takes great pride in the project, remembering with a smile that just a year ago he was sharing what was merely an idea with his daughter. The project's successes have also greatly motivated the team, pushing them to overcome challenges and push the boundaries of what's possible in plant breeding.

Francisco is also looking ahead, focused on ensuring the project's successful impact. The goal is to develop new phenotyping systems and potentially bring this innovative technology to market. "*We're just at the beginning*," he says, "*but if we can achieve what we hope, this could potentially change the future of agriculture*."

Francisco is determined to secure additional funding to keep the team together and continue their pioneering work. "*It's been a challenging journey, but seeing this idea come to life has been incredibly rewarding*. *Now, we're just waiting to see where it takes us.*"

DARkWIN - Deepsync

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