

Search for a Spanish Partner for a Bilateral R&D Project

Organization	
Date of Request:	October 8, 2026
Company name:	National Gene Bank, Agricultural Research Center (ARC), Egypt
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SECTION 1: Entity launching the partner search

(Please give brief / to the point explanations. For more explanation on any point below, you may add a short paragraph as an annexure, with this document.)

Sector	Agricultural Biotechnology / Plant Pathology & Smart Agriculture
Entity mission or core functions	Research and development in agricultural biotechnology, plant disease diagnostics, crop protection, and genetic resource preservation. The entity focuses on developing environmentally friendly, bio-safe disease control strategies and integrating smart Internet of Things (IoT) early-detection technology to reduce pre- and postharvest losses
Date of establishment	2004 (National Gene Bank)
Ownership (if public and traded, add stock exchange and ticker symbol)	Public / Government (Ministry of Agriculture and Land Reclamation, Egypt)
Total number of employees	+500
Number of employees in R&D	+150
Key products sold or services provided	Pre-symptomatic smart diagnostic devices/sensors for crop disease monitoring. Green-synthesized nano-formulations and natural antifungal extracts from plant by-products. Phytosanitary seed health testing, molecular diagnostics, and crop resistance screening.

Entity core technical competences	Pre-Symptomatic Smart Diagnostics: Multi-gas sensor arrays (MQ series) integrated with ESP32 microcontrollers for early detection of fungal Volatile Organic Compounds (VOCs) prior to visible symptom onset. Phytochemical Profiling & Nano-Synthesis: Extraction and characterization of bioactive plant extracts (e.g., <i>Eriobotrya japonica</i> loquat leaves) via GC-MS and green nano-formulation. In Silico Molecular Docking: Modeling thermodynamic binding affinities and molecular interactions between plant ligands and target fungal enzymes (CYP51 / Cytochrome P450). Toxicology & Biosafety Evaluation: In vivo genotoxicity and cytotoxicity testing (chromosomal aberration and micronucleus assays)
Key R&D programs and activities	Integrated disease management combining IoT smart early detection with botanical/nano-fungicides for horticultural crops (e.g., <i>Botrytis cinerea</i> gray mold in strawberries). Green nanotechnology for postharvest rot suppression and shelf-life extension. Toxicological and cytogenetic safety validation of natural agricultural treatments.
Examples of accomplishments	Successfully built and validated a functional ESP32-based multi-sensor array device capable of detecting pre-symptomatic <i>Botrytis cinerea</i> infections in strawberries. Formulated a 10% green loquat leaf nano-formulated extract achieving maximum in vitro and in vivo antifungal growth inhibition while maintaining fruit quality and extending shelf-life. Identified 120 bioactive phytochemical compounds via GC-MS (including erucic acid, oleic acid, cis-vaccenic acid) and confirmed strong target binding (-7.3 kcal/mol) in molecular docking simulations. Demonstrated the biosafety index of loquat extracts through low cytogenetic toxicity compared to chemical/disease controls.
Company strategic orientation	Pioneering sustainable, chemical-free crop protection platforms by pairing cutting-edge IoT sensor technology with nano-enabled

	botanical fungicides to replace synthetic chemicals, enhance food safety, and support agricultural exports
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SECTION 2: Spanish Company Profile

(Please provide a brief summary of the prospective partner company or organization. This summary may address some or all of the points below)

Profile of ideal technology partner	A Spanish tech company specializing in precision agriculture, smart IoT sensor hardware/firmware development, agricultural robotics/drones, or industrial bio-pesticide/nano-formulation manufacturing.
Core technological competencies and expertise	- Advanced sensor hardware optimization, signal processing, and miniaturization. - Integration of VOC/gas sensor systems into autonomous field robots or agricultural drones. - Industrial-scale green extraction, nano-encapsulation, and bio-fungicide formulation. - Field trial execution, commercialization, and EU regulatory compliance for natural crop protection products.
Other essential qualifications (e.g.: ownership, track records etc.)	Track record in international/bilateral R&D collaborations (e.g., EUREKA, PRIMA, Horizon Europe), experience in smart farming deployments, and established distribution networks in Mediterranean/European markets.
If you have a list of companies with whom you are in contact or interested in contacting, please provide contact details	
If you are interested in collaboration: please specify details and other important information you want to share with a potential company	
Interested areas of collaboration	Co-development and commercial prototyping of the smart pre-symptomatic diagnostic device (miniaturization, cloud software integration, drone/robotic integration). Scale-up synthesis and formulation of loquat leaf nano-extracts for fruit coatings and postharvest treatments. Joint field and greenhouse validation

Specific R&D contribution you are seeking/offering	trials across Spain and Egypt Offering: Expertise in fungal pathobiology, GC-MS phytochemical analysis, target enzyme molecular docking, green nano-synthesis, in vivo biosafety/toxicological assaying, and initial prototype design. Seeking: Hardware engineering for drone/robotic integration, AI/machine learning algorithms for sensor data analysis, industrial scale-up of natural extract production, and European regulatory/market access expertise.
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R&D Project Summary

This project represents an ambitious, cross-disciplinary effort to bridge precision hardware prototyping (electronic nose sensing) with green biotechnology (botanical extraction and nano-formulation) for sustainable agriculture.

Ultimately, from an R&D perspective, this project successfully proves the **feasibility of a closed-loop "sense-and-treat" agricultural system**. The primary challenge for the next R&D cycle is shifting from exploratory proof-of-concept work to strict statistical validation, standardization, and environmental robustness.

- **Project title:** "Integrated presymptomatic detection and loquat-based biocontrol of fungal plant Pathogens in important crops: a proof-of-concept smart agriculture platform"

- Project Overview & Objective

- **Core Goal:** To develop an integrated, low-cost "smart agriculture" proof-of-concept platform that combines **pre-symptomatic volatile sensing** (early detection) with a **plant-derived botanical intervention** (eco-friendly treatment) to fungal plant pathogens in important crops.

- **Background Rationale:** fungal plant pathogens cause quiescent (hidden) infections before visible decay appears, and conventional chemical fungicides face growing resistance issues.

- Key Components & Methodology

1. Smart Gas-Sensing Prototype (Early Detection):

- Built around an **ESP32-S microcontroller** paired with three metal-oxide gas sensors (**MQ-4, MQ-135, and MQ-9**).
- Operates via a 300-second warm-up, clean-air calibration (R_0), and continuous multi-sensor monitoring (normalized as R_s/R_0 every 2 seconds).
- Uses a rule-based multi-sensor classification system to categorize risk levels from clean to high-risk based on collective sensor response patterns.

2. Botanical Extract & Nano-Formulation Preparation:

- Utilized **Eriobotrya japonica (loquat)** leaf extracts (crude filtrates and nano-formulations prepared at 10%, 50%, and 100% concentrations).
- Evaluated antifungal efficacy against **fungal plant pathogens *in vitro*** over a 14-day period.

3. Chemical Profiling & Molecular Docking:

- **GC–MS Analysis:** Identified numerous volatile and semi-volatile constituents (e.g., methyl hexadecanoate, oleic acid, erucic acid, cis-vaccenic acid).
- **Molecular Docking:** Tested extract compounds against fungal targets like **CYP51** (lanosterol 14 α -demethylase) and cytochrome P450, showing favorable binding energies (e.g., **–7.3 kcal/mol** for erucic acid and oleic acid against CYP51).

4. Biosafety & Preliminary In Vivo Assessment:

- Evaluated potential genotoxicity and cytotoxicity using mouse bone-marrow chromosomal aberration and micronucleus assays.

- Major Findings & Results

- ***In Vitro* Antifungal Activity:** All tested loquat preparations reduced fungal colony growth compared to the positive control (3.9 cm at day 14). Notably, the **10% nano-formulation (N3)** achieved the smallest colony diameter (**1.8 cm** at day 14), representing a substantial descriptive reduction in fungal growth.
- **Prototype Functionality:** The multi-sensor hardware successfully demonstrated repeatable gas-response pattern acquisition, establishing a framework for electronic-nose-style disease monitoring.
- **Biosafety Insights:** Initial animal cytogenetic records showed lower frequencies of chromosomal aberrations and micronucleus-associated cytotoxicity in treated groups compared to the positive control group.

- Identified Limitations & Priorities for Future Development

The manuscript emphasizes that the study serves as an **engineering and experimental proof-of-concept** rather than a fully validated commercial tool. Key recommendations for next-stage research include:

- **Sensor Validation:** Requiring blind testing, independent validation datasets, and quantitative classification metrics (such as ROC-AUC, sensitivity, and specificity).
- **Environmental Robustness:** Factoring in environmental variables like temperature, humidity, airflow, and fruit ripeness.
- **Replication & Standardization:** Increasing biological replicates, providing raw statistical outputs, standardizing nano-formulation physical characteristics (particle size, zeta potential), and confirming GC–MS peaks with authentic standards.

- **Regulatory Compliance:** Reconciling animal study records, obtaining formal ethics approval identification numbers, and conducting field trials before agricultural deployment.

- Viewing the entire project through an R&D framework highlights its core innovation pipeline, technical trade-offs, and critical development milestones required to take the platform from a laboratory proof-of-concept to a field-ready commercial solution:

1. Technology Readiness Level (TRL) Assessment

- **Current Status (TRL 3–4):** The project has successfully established a laboratory-scale proof-of-concept. It demonstrates analytical feasibility (detecting VOC changes, synthesizing nano-extracts, docking compounds against fungal targets, and screening antifungal activity).
- **The Goal (TRL 7):** Advancing this to a commercial product requires moving from controlled laboratory benches to multi-location greenhouse and field trials, hardware ruggedization, and automated data logging.

2. Core R&D Streams & Technical Breakdown

- Stream A: Smart Hardware & Sensor Integration (The "Early Warning" System)

- **R&D Objective:** Detect quiescent (pre-symptomatic) fungal infections before visible symptoms appear using low-cost components.
- **Engineering Design:** Utilizing an ESP32-S microcontroller paired with broadly responsive metal-oxide sensors (MQ-4, MQ-135, MQ-9) configured with a baseline calibration (R_0) and multi-sensor threshold rules.
- **R&D Bottlenecks & Next Steps:**
 - **Cross-Sensitivity & Selectivity:** Metal-oxide sensors react to multiple volatile organic compounds (VOCs). The R&D team must shift from simple deterministic thresholds (counting triggered

sensors) to **multivariate machine learning algorithms** (such as PCA, Random Forests, or SVMs) to distinguish fungal plant pathogen signatures from background agricultural noise (e.g., humidity, fruit-ripening gases, fertilizer VOCs).

- **Environmental Compensation:** Hardware must integrate real-time temperature and relative humidity compensation to prevent false positives/negatives in changing field environments.

- **Stream B: Phytochemical Extraction & Nano-Formulation (The "Intervention" System)**

- **R&D Objective:** Optimize the delivery and efficacy of *Eriobotrya japonica* (loquat) leaf extracts against different fungal plant pathogens.
- **Formulation Science:** Testing crude filtrates versus nano-formulated variants (N1–N3). Interestingly, R&D data revealed that the **10% nano-formulation (N3)** outperformed higher concentrations (1.8 cm colony diameter vs. 2.3–3.9 cm).
- **R&D Bottlenecks & Next Steps:**
 - **Physicochemical Characterization:** The R&D pipeline must rigorously document particle size distribution, polydispersity index (PDI), zeta potential, encapsulation efficiency, and release kinetics to explain **why** lower concentrations performed better (e.g., better dispersion or cellular penetration).
 - **Analytical Standardization:** GC–MS profiles identify active components (like oleic acid and erucic acid), but these must be validated using authentic chemical standards and quantified to ensure batch-to-batch reproducibility.

- **Stream C: Mechanistic Validation (*In Silico* to *In Vitro*)**

- **R&D Objective:** Elucidate the botanical extract's mechanism of action.

- ***In Silico* Screening:** Molecular docking demonstrated favorable predicted binding energies (e.g., -7.3 kcal/mol) against key fungal targets like **CYP51** (lanosterol 14 α -demethylase) and cytochrome P450.

- **R&D Bottlenecks & Next Steps:**

- Docking is strictly a computational hypothesis-generation tool. The R&D team needs to validate target engagement via ***in vitro* enzyme inhibition assays**, fungal membrane integrity studies, and gene expression (transcriptomic) analyses to confirm how the botanical compounds inhibit the pathogen.

- **Stream D: Biosafety & Pre-Clinical Toxicology**

- **R&D Objective:** Ensure safety for agricultural workers, consumers, and the environment.
- **Preliminary Findings:** Mouse bone-marrow chromosomal aberration and micronucleus assays showed lower genotoxicity/cytotoxicity relative to positive controls.
- **R&D Bottlenecks & Next Steps:**
 - Protocol discrepancies in the source text must be resolved, official animal ethics approval numbers must be formally registered, and safety metrics must be expanded into **food residue analysis, phytotoxicity assessments on important crops, and acute/chronic toxicity testing** before any regulatory food-safety approval can be pursued.



Cairo, October 12, 2026

To Whom It May Concern,

It is with great enthusiasm that we write to confirm our official partnership and support for **Dr. Heba Afifi**, Researcher at the National Gene Bank, Agricultural Research Center (ARC), Egypt.

AGREE CHEM - specializing in the production and trading of premium scientific equipment and chemicals—is proud to back Dr. Afifi in her participation for the grant funded by the Science, Technology & Innovation Funding Authority (STDF) under the Egyptian-Spanish Joint Technological Co-operation Program (Call-11).

We are fully committed to collaborating on the vital project entitled: “**Integrated presymptomatic detection and loquat-based biocontrol of fungal plant pathogens in important crops**: a proof-of-concept smart agriculture platform”. Our team looks forward to providing the necessary technical and logistical backing to ensure the success of this innovative initiative.

AGREE CHEM deeply values this strategic scientific cooperation and eagerly anticipates expanding our collaborative efforts in the future.

Yours sincerely,

[Authorized Representative Name] **Mohamed Ahmed Mohamed**

[Title/Position] **General Manager**

NAME OF COMPANY: **AGREE CHEM**



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