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# Smart Sensor Technologies for Sustainable Agriculture: New Frontiers in Nematode Detection

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Sustainable crop protection increasingly depends on innovative technologies to boost productivity while minimizing environmental impact. The EU co-funded **PurPest** and the FCT-funded **Globowarning** projects are driving precision agriculture by developing smart, field-deployable tools for early pest and disease detection, aiming at real-time, in-field monitoring of plant health.

**PurPest** focuses on a portable system that detects volatile organic compounds (VOCs) emitted either plant under stress or by pests, such as the pinewood nematode *Bursaphelenchus xylophilus*. This non-invasive approach integrates technologies including pre-concentrators, 3D-printed micro gas chromatography (µ-GC) systems, and optimized compound retention. Research on advanced coatings and surface-enhanced Raman scattering (SERS) sensors using MOF powders further improves sensitivity and selectivity, bringing portable prototypes closer to practical use in the field.

**Globowarning** complements this with a Lab-on-Chip platform that combines a magnetoresistive biosensor with rapid DNA extraction (FTA cards) and Loop-mediated Isothermal Amplification (LAMP) for on-site detection of the pale potato cyst nematode *Globodera pallida*, a very harmful quarantine nematode. The system detects a single juvenile even in samples of mixed species of nematodes, with high specificity and sensitivity, consistently distinguishing *G. pallida* from other cyst nematodes.

Together, these projects highlight the potential of merging chemical, molecular, and electronic sensing technologies into compact platforms, enabling rapid in-field pest detection and advancing sustainable, precise crop protection strategies.

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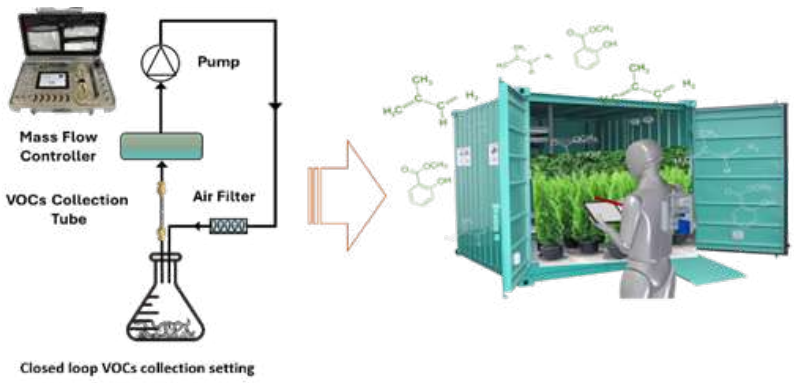


Fig. 1 - PurPest Project

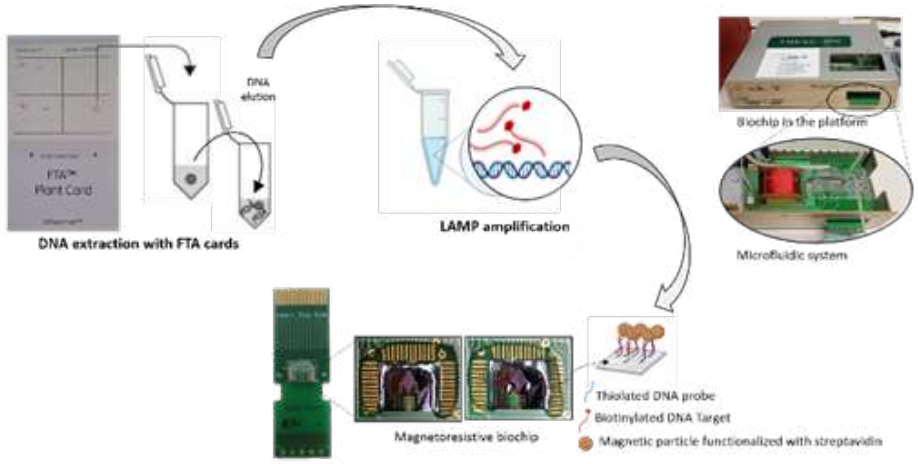


Fig. 2 - Globowarning Project

**Biography:**

Dr. Maria João Camacho is a researcher at INIAV, Portugal, specializing in molecular biology and biotechnology. She holds a PhD in Biology from the University of Évora (2024, with distinction), focusing on nano-based detection systems for plant-parasitic nematodes. Her research integrates molecular diagnostics, omics, and microfluidics for innovative biosensing solutions for agriculture. Dr. Camacho has over 30 peer-reviewed publications, international research experience in France, Belgium, Germany, and Serbia. She actively contributes to EU projects and teaches plant pathology and phytosanitary inspection.