DeNETer, on the path to sustainable agriculture

In September 2020, the transatlantic "DeNETer" project began as a collaboration between industries (Dubois Agrinovation (Canada), Texinov® (France)), universities (Polytechnique Montreal, McGill University) and the Institute of R&D in agro- environment (IRDA) for a period of 4 years. The diversity of species and diseases harmful to fruit and vegetable crops worldwide makes it difficult to reduce the use of pesticides, due to the lack of a sufficient supply of more ecological plant protection products.

*"The project aims to **develop protective nets designed from bio-based materials, incorporating the use of bioactive compounds possessing phytosanitary properties** (mating disruption, repellent effect), to create a product that can be **reused** over several seasons as a replacement for traditional pesticides.*

The DeNETer project is part of an **approach for more responsible pest management through the use of materials and processes** for the protection of fruit and vegetable crops that are **sustainable and accessible**.

PROJECT MILESTONES

PLA nets in the field

To improve the protection offered by optimized nets, the DeNETer project is based on various studies that have already proven their effectiveness in pest control. The project objectives are:

➘ Proven and durable protection

The effectiveness of exclusion nets as a passive mechanical barrier against the intrusion of certain pests has already been demonstrated through multiple studies by the project team members[(1)]. Two polymer candidates were selected for the project, **polylactic acid-based nets (PLA - compostable material)**, recommended by the company "Dubois Agrinovation" in collaboration with the manufacturer "Texinov®", and possibly **nylon polymer substrates**. This new approach of using a **biobased polymer improves the overall carbon footprint of exclusion netting**.

➘ Combined effects: exclusion combined with repellants or mating disruption

Based on previous studies, this aspect of the project consists of **combining the use of nets with emitters of bioactive compounds, studying in particular:**

- **Impregnation followed by the gradual release of bioactive compounds,** such as pheromones, repellents, etc.;
- **Obtain temporal stability by characterizing the charging / discharging cycles of active compounds** (sorption, desorption, resorption) to ensure emitters function over at least one growing season;

Mesh fibers under the microscope

These studies will take place in the laboratories of McGill University (polymer preparation) and Polytechnique Montréal (cycle characterization). At the same time, the Institute for Research and Development in Agroenvironment (IRDA) will study the spraying of trichogrammae, parasitoid organisms that prey on several harmful species, on polymer nets.

A **phase of tests under real conditions** will take place, supervised by IRDA. The Institute will oversee the **operational deployment of the solution** (installation, field monitoring, harvesting and data analysis) in an **experimental orchard**. The enhanced nets[(2,3)] will be applied to an experimental **orchard (between 0.1 and 0.2 ha)** with support from the partner university laboratories.

A PROJECT SUPPORTED BY MANY INSTITUTIONS

The innovative solution resulting from the DeNETer project is part of environmental initiatives undertaken to:

- Improve and optimize crop protection solutions promoting the emergence of a circular economy,
- Reduce the use of insecticides,
- And consequently, reduce their impact on health and the environment,
- Increase the supply of available biological protection.

The project will be based on an estimated research budget of CAN $ 421,760 spread over 4 years. Perfectly situated at the axes of ecological, sustainable development and the circular economy, this project benefits from the support of several federal and institutional Canadian and Quebec organizations, in addition to industrial partners:

• **NSERC** (Natural Sciences and Engineering Research Center of Canada) to the tune of CAN $ 178,560 over 4 years;

• The **Ministry of Economy and Innovation** grants financial assistance of CAN $ 133,920, through PRIMA Quebec (Pôle de Recherche et d'Innovation en Matériaux Avancés du Québec) over 3 years, a fourth year of funding may be implemented depending on the progress of the project;

• **CREPEC** (Centre de recherche sur les systèmes polymères et composites à hautes performances) has contributed CAN $ 20,000 in student scholarships over 2 years.

"Advanced materials are a growth vector for Quebec. Having myself been trained in materials engineering and being responsible for innovation projects in the agrifood industry, I am happy with this transatlantic initiative, which contributes to increasing the competitiveness of companies and to strengthening partnerships between industry and academia. The DeNETer project is a fine example of collaboration that has led to the development of a highly innovative solution in the agriculture sector. The Government of Quebec supports this initiative, since it will promote the protection of crops in a perspective of sustainable and ecological development," underlines MarieChantal Chassé, Member of Parliament for Châteauguay and Parliamentary Assistant to the Minister of the Economy and Innovation (office of innovation and entrepreneurship).

When completed, this project will lead to the training of highly qualified personnel, including Darius Klassen, a doctoral student, Adya Karthikeyan, a postdoctoral fellow, a master's student (to be recruited), summer interns and two research professionals.

A PARTNERSHIP OF EXPERTS: INDUSTRIES, UNIVERSITIES, RESEARCH CENTERS AND GOVERNMENT AGENCIES

Dubois Agrinovation

Team member: Éric Ménard, business development

Dubois Agrinovation is the partner of choice for North American market farmers, greenhouses, nurseries, vineyards and orchards for advice and solutions in irrigation, growth, equipment, tools and crop protection. Thanks to a vision based on the union of agriculture and innovation, the company is constantly developing and researching new technologies in order to improve the ratio of quality to profitability.

www.duboisag.com

texinov® AGROTEXTILES

Team Member: Francis Moinereau, Development & Commercial Director, Agro-Environment Activity MDB

Texinov®, a French company, manufactures technical textiles (nets) for the protection of crops against insects / pests, weather hazards and develops a bio-compostable insect protection net.

www.texinov.com

POLYTECHNIQUE MONTRÉAL
UNIVERSITÉ D'INGÉNIERIE

Team Member: Professor Jason R. Tavares, Department of Chemical Engineering (Principal Applicant)

Founded in 1873, Polytechnique Montréal is one of the most important engineering teaching and research universities in Canada. It ranks first in Quebec for the scope and intensity of its engineering research activities. It is located on the University of Montreal campus, the largest French-speaking university complex in America. With more than 50,000 graduates, Polytechnique has trained 22% of practicing engineers who are members of the Ordre des ingénieurs du Québec (OIQ). It offers more than 120 training programs. Polytechnique has 280 professors and 9,000 students.

www.polymtl.ca/crepec

McGill UNIVERSITY

Team Member: Professor Marie-Josée Dumont, Department of Bioresource Engineering (co-applicant)

The Department of Bioresource Engineering is part of the Faculty of Agriculture and Environmental Sciences at McGill University. Integrating engineering, design and biological sciences, it applies engineering principles to the development and sustainability of the world's natural resources. Bioresource engineers seek solutions to problems that involve plants, animals and the environment.

www.mcgill.ca

Team member: Gérald Chouinard, entomologist and researcher (co-applicant)

The IRDA is a research and development institute whose mission is to support the development of sustainable agriculture in Quebec by promoting the use of innovation and partnerships. It is recognized as the Quebec leader in agri-environmental R&D.

www.irda.qc.ca

The mission of the Centre de recherche sur les systèmes polymères et composites à hautes performances (CREPEC) is to boost innovation and train highly skilled personnel to develop the next generation of innovative high performance polymer and composite systems, their manufacturing processes and their multiscale characterization. In a context of sustainable development, achieving this objective will place Québec at the forefront of science and engineering of value-added polymers and composites.

www.polymtl.ca/crepec

The leading Canadian organization supporting excellence in discovery and innovation, the Natural Sciences and Engineering Research Council of Canada (NSERC) supports visionary, curious and innovative minds who aspire to achieve scientific and technical breakthroughs for the benefit of our country. It works with universities, colleges, businesses, governments and not-for-profit organizations to remove barriers, create opportunities and attract new research talent to enable Canada's scientific community to excel. Driven by a desire to push boundaries and limits, NSERC empowers Canadian researchers and engineers to think outside the box.

www.nserc-crsng.gc.ca

PRIMA Quebec, the advanced materials research and innovation center, drives and supports the advanced materials ecosystem, an engine of innovation and growth for Quebec. Through its support and the funding offered, it helps stimulate the competitiveness of Quebec businesses by allowing them to benefit from research expertise. As a sectoral industrial research group (RSRI), PRIMA Quebec relies on the financial support of the Quebec government and the private sector to promote research-industry relations.

www.prima.ca

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(2) « Dip-dip-dry » (DDD) surface patterning – This surface modification approach relies on successive dipping, first in a solvent for the polymer, then a coagulant. DDD was first developed to alter wettability of polymer substrates, forming nanostructures on nets that lead to hydrophobic surface properties, or pockets for compounds such as limonene. See Knoch et al. 2019 and Knoch et al. 2020. In the journal « Colloids and Surfaces A: Physicochemical and Engineering Aspects »

(3) Bérard et al. 2016 - the DDD approach does not substantially degrade substrate mechanical properties, and has high temporal stability, compared to fragile spray-on coatings. Read more in « Scientific Reports » (Bérard A., Patience G.S., Chouinard G., Tavares J.R. (2016), Photo Initiated Chemical Vapour Deposition to Increase Polymer Hydrophobicity, Scientific Reports 6, 31574, 10.1038/srep31574)