

# Delisoil

Delivering soil improvers from circular food production processes to boost soil health



## Non-thermal atmospheric plasma as a tool to convert liquid food waste into soil improvers

### Summary

Food waste management is a major challenge in Europe, where around 20% of all food produced is lost every year. A large share of this waste comes from food processing and consists of nutrient-rich by-products such as vegetable peels, pulps and liquid extracts. These residues can cause environmental problems if poorly managed, but they also offer strong opportunities for circular economy solutions in agriculture.

Non-thermal atmospheric plasma (NTAP) is an innovative technology that uses electrical energy to generate a reactive gas at room temperature. When air is treated with NTAP, reactive nitrogen and oxygen species are formed, which can naturally fix nitrogen and enrich organic materials without using high temperatures or chemicals. In this practice, NTAP was applied to liquid beetroot processing residues to produce a value-added soil improver.

Plasma treatment increased nitrate and nitrite levels in the beetroot extracts, improving plant-available nitrogen while maintaining organic carbon and soil-friendly properties. In greenhouse trials with wheat, NTAP-treated beetroot extracts increased tiller number and fresh biomass compared to untreated controls. Plant growth was maintained even under water stress conditions, showing the potential of this soil improver to support crops during drought periods. Unlike mineral fertilisers, plasma-treated extracts helped stabilise soil pH and maintained soil phosphorus levels, contributing to soil health and nutrient balance.

### Author:

Márcia Oliveira, Avelino Álvarez Ordóñez, Victoria Crespo Torbado, Montserrat González-Raurich, Mercedes López. University of León

Yasmina Chourak, Enric Garcia Muchart, Pedro Federico Rizzo. UVic-UCC

### Country:

Europe, Spain

### Keywords:

NTAP  
Nitrogen fixation  
Beetroot

### Stakeholders:

Farmers  
Agri-food processors  
Advisory services  
Technology providers

# DeliSoil

Delivering soil improvers from circular food production processes to boost soil health

## Practical Recommendations

For practitioners, this approach offers a practical way to convert local vegetable processing residues into safe, effective soil improvers. NTAP systems operate at atmospheric pressure, require short treatment times, and can be integrated into decentralised or on-site residue management. The main benefit is reduced reliance on synthetic fertilisers, improved nutrient efficiency, and more resilient crop production under changing climate conditions.

## Needs addressed by the practice

Helping farmers and agri-food actors valorise organic side-streams into safe, efficient, and high-quality soil improvers while reducing reliance on synthetic fertilisers.

## Coordinator:

Ansa Palojarvi  
Luke  
[ansa.palojarvi@luke.fi](mailto:ansa.palojarvi@luke.fi)

## Contact:

Márcia Oliveira  
University of León  
[msouo@unileon.es](mailto:msouo@unileon.es)

Avelino Álvarez Ordóñez  
University of León  
[aalvo@unileon.es](mailto:aalvo@unileon.es)

## About DeliSoil

The EU-funded DeliSoil project is a four-year initiative that aims to transform food industry byproducts into safe, sustainable, and tailored soil improvers. This project addresses two pressing challenges: the poor recycling of industrial food processing byproducts and the degradation of soil health.

By harnessing a circular approach, DeliSoil will contribute to improving soil health and productivity, supporting the EU Mission "A Soil Deal for Europe" and the Farm to Fork Strategy, as well as other Circular and Bioeconomy Strategies and Plans.



Funded by  
the European Union

Funded by the European Union under the Horizon Europe Programme, Grant Agreement No. 101112855 (DeliSoil). Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or Research Executive Agency (REA). Neither the European Union nor the granting authority can be held responsible for them. Swiss partners (FiBL) have received funding from the Swiss State Secretariat for Education, Research and Innovation (SERI).

Designed by ERINN Innovation