RÉPUBLIQUE FRANÇAISE
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INRAE

Bioeconomy for urban areas

TeValU

Urine recovery in urban areas

Exploratory project
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Coordination

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Keywords

Bioeconomy
Fertiliser
Recovery
Urine
Valorisation
Urban/peri-urban area

INRAE division

AGROECOSYSTEM
ECOSOCIO
TRANSFORM

Some publications

Irene Gonzalez-Salgado, *et al.*. 2023. Influence of feed salinity on ammonia recovery from high-strength effluents in transmembrane chemical absorption process, Journal of Membrane Science, 687, 2023, 122086, https://doi.org/10.1016/j.memsci.2023.122086.

Min Zheng *et al.* 2024. Pathways to advanced resource recovery from sewage. Nature Sustainability, sept 2024.

> Production of nitrogen fertilizer, urine reprocessing, circular flows

The aim of the TeValU project was to study the local recovery of urine with a view to producing fertilisers. Urine is rich in nutrients that are useful for agricultural production and come from our food. The recovery of urine is therefore part of a circular economy approach to resources, since phosphorus is a mineral resource and the production of nitrogen fertiliser consumes a lot of fossil energy.

Progress and results

The aim was to optimise a process for extracting nitrogen and phosphorus in order to meet the criteria for products already on the market, while assessing the impact of the process by means of an energy analysis and, ultimately, a life cycle analysis.

1) The work carried out as part of the TEVALU project has made it possible to determine the optimum conditions for recovering ammonia by absorption on a gas-permeable membrane. The feasibility of extracting ammonium from real urine was confirmed by pilot tests. The pilot experiment produced a 20gN/L fertiliser solution. The experiments and modelling work demonstrate the effect of effluent characteristics (ammoniacal N : mineral C ratio) in determining pH and temperature set points, and the pre-treatment to be applied to minimise energy demand.

2) A territorial analysis of the Toulouse metropolitan area was carried out to quantify urine deposits and potential sinks through the agricultural use of fertilisers. This analysis was carried out using a GIS-type tool. It revealed an overall balance between the nitrogen available in urine (3555 tN/year) and the nitrogen requirements of the agricultural area (3107 tN/year) of the Toulouse metropolitan area and south-west Toulouse (Labège, Sicoval).

3) In addition, a survey of potential users showed that the acceptability of urino-fertiliser type products is good, and that two types of product are very complementary: a solid product from phosphorus precipitated in the form of struvite, and a liquid solution of ammoniacal nitrogen from the membrane process.

4) A deployment scenario was finally developed in 4 phases: experimentation, development, massification and harmonisation. A technical mission was carried out in Zurich, Switzerland, to discuss the results and visit an experimental site where urine separation had been implemented and other treatment technologies compared with TEVALU's (EAWAG building).

https://doi.org/10.1038/s41893-024-01423-6

5) The environmental analysis of the system was carried out on the basis of information acquired during the operation of the processes. An attempt was also made to monetise the environmental impacts, but this is still encountering difficulties in transposing the results from a small to a large scale.

The exploratory project TEVALU has helped to strengthen working synergies between players from INRAE units with different areas of expertise. The project was presented to a number of local stakeholders, who showed a great deal of interest. One of the project's Masters trainees has been taken on at SOLAGRO, in particular to continue monitoring urine separation and recovery projects in the region.

INRAE division	INRAE research units	Expertise and contributions
AGROECOSYSTEM (AES)	UMR ECOSYS	Analysis of agricultural inclusion of urine in crop fertilisers
ECOSOCIO	UMR TSET-R	Environmental and water economics, monetarisation of environmental impacts
TRANSFORM	UMR TBI	Technologies of urine treatment and nutrient recovery

Partners	Expertise and contributions
SOLAGRO	Territorialisation in the circular economy and agroecology, analysis of the uses of products derived from urine