Layman's Report

2020

LIFE LEMNA: Lemna culture technology to improve nutrient management and efficiency resource consumption in pig production systems

http://www.life-lemna.eu

Project co-financed by LIFE Programm of the European Commission (LIFE15 ENV/ES/000382)

LIFE LEMNA project. Layman's Report

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More information about the project can be found at www.life-lemna.eu

ENVIRONMENTAL CHALLENGES IN PIG PRODUCTION SYSTEMS

One of the main challenges facing the intensive pig farming sector is to reduce the environmental impact caused by the excessive application of manure, rich in nitrogen and phosphorus, to agricultural soils. In Spain, it is estimated that more than 50 million tons of slurry are generated annually.

Nitrogen and Phosphorus are essential nutrients for plant production but its excess causes pollution of aquatic environments (eutrophication) and nitrate contamination of groundwater. On other hand, Phosphorus is a non-renewable natural resource that is extracted from mineral deposits rich in phosphates.

Despite there are several technologies to reduce the concentration of nitrogen and/or phosphorus content in the slurry (stripping and recovery of ammonium, nitrification-denitrification, struvite precipitation, etc.), their real implementation in pig farms it is minority due to its high economic cost.

Reduction of carbon footprint of feed is other relevant environmental challenge of the pig farm sector.

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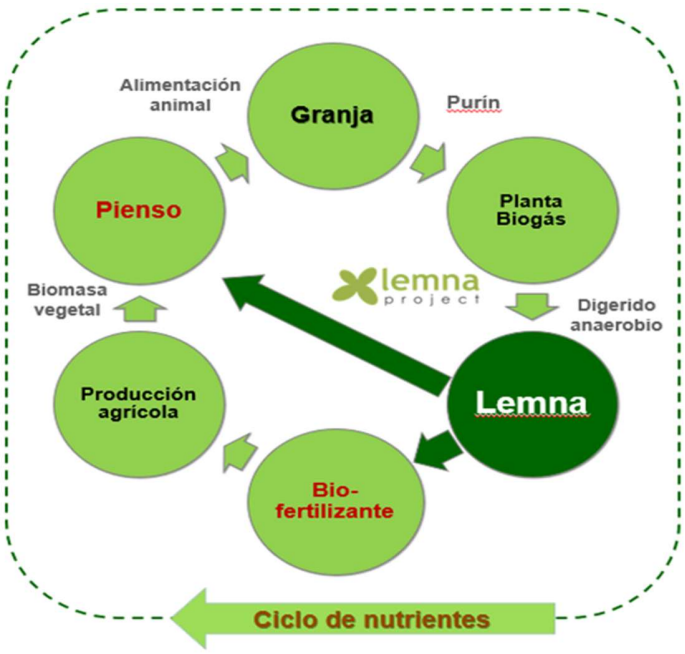
PROPOSED SOLUTION

LIFE LEMNA project proposes a new sustainable system for the recovery of nutrients (namely N and P) in pig manure based on the advanced use of duckweed technology.

Duckweed, also called water lentil or lemna, is a fast-growing and free-floating aquatic plant that have a great capacity to absorb nutrients such as nitrogen and phosphorus. It has of very simple structure, consisting of between one and four fronds (leaf-stem) of small size (0.1-1.5 cm) Main native species in Europe are Lemna minor, Lemna gibba and Spirodela polyrriza.



LIFE LEMNA system combines the anaerobic digestion of the pig slurry with the use of advanced duckweed cultivation to recover the nutrients The resulting duckweed biomass has a high nutritional value that makes them an excellent raw material for the production of pig feed and biofertilizers.

LIFE LEMNA is an example of the circular economy, in which the resources contained in waste generated at the farm (energy and nutrients) are recovered and reused on site or in nearby areas, reducing the dependence on non-renewable resources, as well as reducing the carbon footprint associated with pig production.

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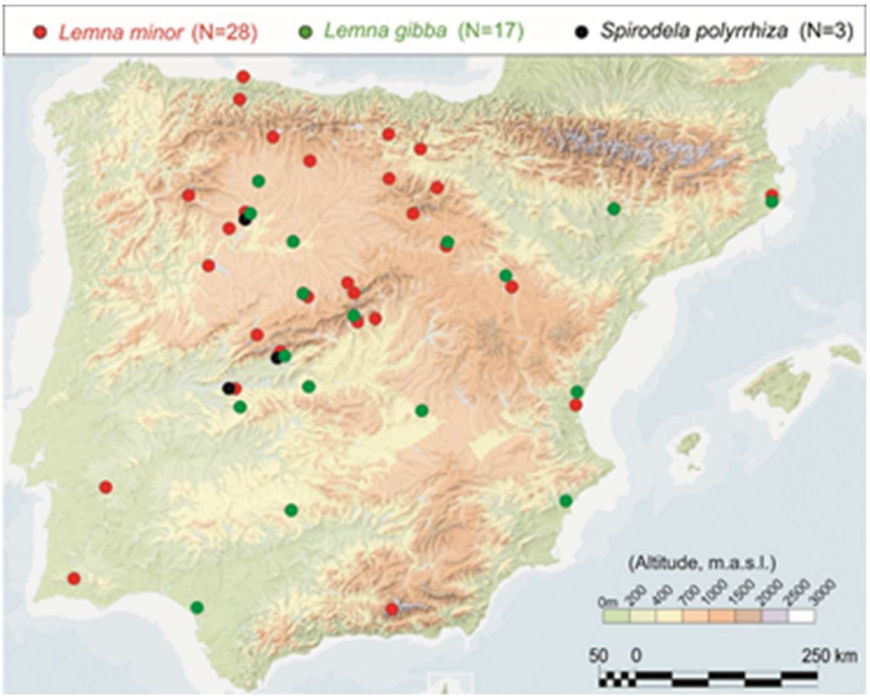
MAIN RESULTS OF THE PROJECT

Collection and characterization of indigenous duckweed strains

Up to 48 strains from three different duckweed species (*Lemna minor, Lemna Gibba* and *Spirodela polyrrhiza*) have been collected in more than 40 municipalities across the Iberian Peninsula.



Geographical distribution of duckweed sampling during LIFE-LEMNA project in the Iberian Peninsula.

Duckweed strains were cultivated at different pig slurry concentrations to determine the best cultivation conditions and identify which strain were the most feasible based on their biomass production and nutrient assimilation rates. 20-day cultivation tests showed that the duckweed can assimilate 1.24 mg N/g biomass and 0.28 mg P/g biomass.

Due to its simple morphology, it is very difficult to distinguish all strains of each specie or even between two species of duckweed. So, in the framework of the project, a catalogue of DNA markers was created for genetic distinction of water lentil strains.

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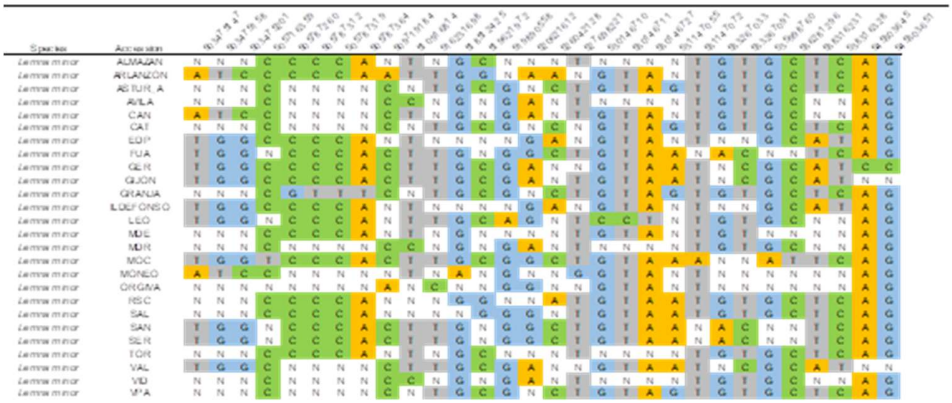

First prototype of lemna cultivation in EU

A 250 m^2 prototype of the LIFE LEMNA system was designed and constructed at the Porgaporcs pig farm (Vila-Sana, Spain) The prototype includes the modules of pretreatment of the digestate, cultivation reactors (4 x 60 m^2), harvesting and monitoring systems.

Continuously conducted trials with digested slurry show that duckweed yield up to 17 t of dry matter/ha-year with a protein richness of 35-40%. Nitrogen and Phosphorus removal rates reached 2.7 t N/ha-year and 1.2 t P/ha, respectively.

Analysis of the amino-acid profile showed that duckweed protein has a good quality with a similar profile to soy flour which is the world reference of vegetable protein.

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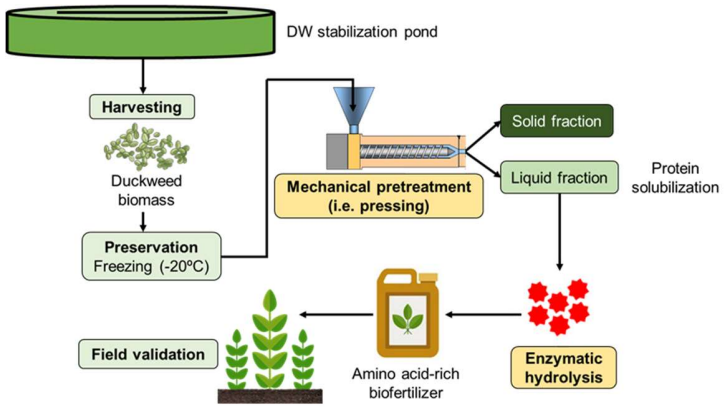
Duckweed-based bioproducts: FEED

Duckweed has a high protein content (35-40%) and has an amino acid profile similar to soybeans (compared to soybeans it is richer in leucine, threonine and tryptophan), so it can be considered as a new source of good quality protein. In addition, it also contains a high content of crude fiber and phosphorus.

Some tests were performed with piglets of 9-10 kg to see their reaction in terms of growth and feed consumption. The replacement of 8% of the compound feed by lemna (over dry weight) did not cause rejection in the piglets, but rather the opposite, and no detectable physiological problem was detected in the group compared to the control. It was observed that the inclusion of duckweed in the diet did not affect the feed consumption but piglets feed with lemna grew less than those in the control group.

Duckweed-based bioproducts: BIO-FERTILIZER

A semi-industrial scale method has been developed for the conversion of duckweed biomass into a liquid biofertilizer rich in amino acids. The biofertilizer met the requirements established in the Spanish legislation regarding its content in heavy metals and indicator pathogens (E. coli and Salmonella).



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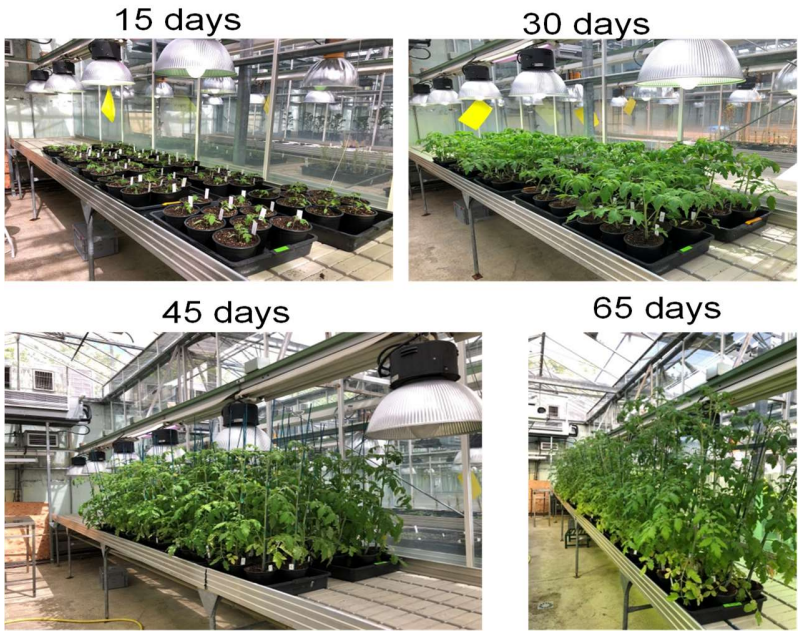
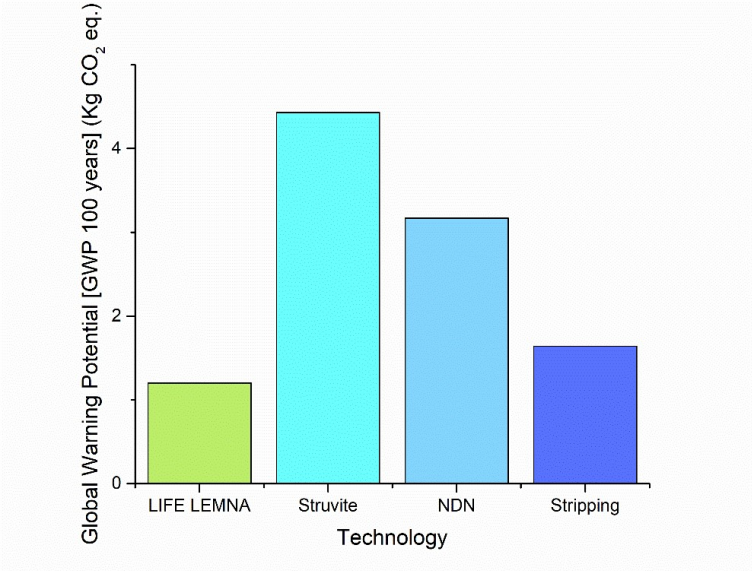
Biofertilizer has been tested in field trials with millet and tomato, showing in both tests a fertilizer efficacy similar to that obtained with inorganic fertilizers, both in biomass production and in fruit production.



ENVIRONMENTAL SUSTAINABILITY

Life Cycle Assessment (LCA) methodology was used to compare the potential environmental impact of the LIFE LEMNA system and other nitrogen and / or phosphorus recovery/remove systems: a) precipitation of N and P as struvite, b) Nitrification-denitrification, c) stripping and ammonium recovery by using. The study showed that the LIFE LEMNA system has a lower environmental impact than the rest of the technologies considered in the main selected impact categories, such as eutrophication potential, soil acidification potential, the effect on global warming or the consumption of abiotic resources (materials and fossil resources).



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REPLICATION OF THE MODEL

A free electronic tool (e-lemnatool) has been developed to facilitate the economic and technical assessment of the replication of LIFE LEMNA system to other pig farms at EU level. Based on a series of basic farm data (geographical location, surplus volume of anaerobic digests, concentration of N and P in digest, cost of nutrient elimination, etc.) the user can calculate the main technical and economic variables of a lemna growing facility

The tool also allows to establish different scenarios in terms of the level of complexity of the installation (which influences the investment and OPEX of the system) and the use that is intended to give to the biomass of lemna produced (which influences the price assigned to the biomass)

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KEY DISSEMINATION ACTIONS

Main dissemination actions were:

- web page with more than 14.000 visitors,
- video,
- Layman's Report,
- 6 Technical publications
- 2 Press releases (generating 57 impacts in media),
- 2 posters,
- radio and TV interviews,
- notice boards at the prototype site,
- 30 participation in workshops and events,
- social media (mainly twitter) and
- networking with other European projects, associations and technology platforms, and companies.

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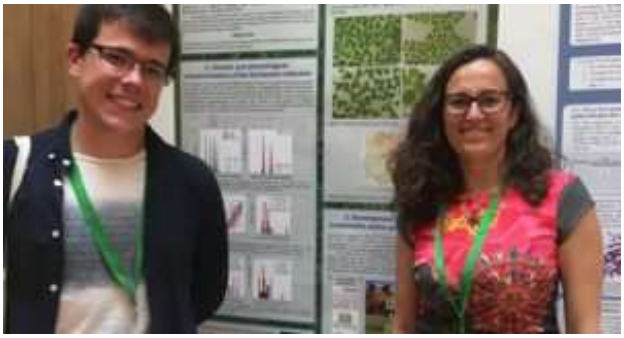

AFTER LIFE PROJECT

The LIFE LEMNA project has demonstrated the technical and economic viability of a system based on the use of duckweed for nutrient recovery in anaerobic effluents from pig farms. In the future, the use of the genetic diversity available in the native species of the Iberian Peninsula and the modernization of the cultivation systems must be deepened, in order to optimize the yield of the recovery of nutrients, the adaptation of the cultivation to the climatic conditions and the obtaining of a vegetable biomass of greater value for its use in the animal feeding and in the production of biofertilizers.

The LIFE LEMNA system has proven to be a more sustainable technology for the recovery of nutrients from slurry and anaerobic digests of pig farms, whose economic viability in pig farms can be evaluated using the e-lemna tool.

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ABOUT THE PROJECT

LIFE Lemna project (*LIFE15 ENV/ES/00038*) has been developed under the support of the Life Program of the European Commission

Title: LIFE LEMNA: Lemna culture technology to improve nutrient management and efficiency resource consumption in pig production systems

Budget: 1.298.994 € (financing UE: 60%)

Duration: from 01/10/2016 to 31/03/2020

Consortium:

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